Vol. 30. No. 241. January 1944.

PETROLEUM REFINING TERMINOLOGY.

Benzine Manufacture and Refining.*

By M. E. Kelly (Associate Member) and D. A. Howes (Fellow).

Introduction.

The Petroleum Refining Industry has made many rapid advances during the past few years which are not so much advances in manufacturing and refining technique as the large-scale development of processes based on hydrocarbon reactions of recent discovery. Such advances have brought about the introduction of a somewhat complicated terminology, and in writing this paper the authors have responded to a suggestion made to them by Dr. Dunstan that this terminology might be simply described and explained for the benefit of those who are not in daily touch with new refining developments.

The paper is arranged as follows :

A. *Recent Synthetic Processes.*

1. Alkylation.
2. Catalytic Cracking.
3. Dehydrogenation.
4. Hydroforming.
5. Hydrogenation.
6. Isomerization.
7. Polymerization.
8. Thermal Cracking.

B. *Recent Refining Processes.*

1. Removal of Hydrogen Sulphide from Gases.
2. Removal of Mercaptans from Sour Benzines.

C. *Recent Distillation Processes.*

A. *Recent Synthetic Processes.*

Processes recently developed for the production of hydrocarbons by synthetic means deal mainly with the production of motor fuel and aviation fuel components of high octane number, and similar processes for the production of superior grade kerosines and high-speed diesel fuels have not as yet been adopted. Synthetic lubricating oils and lubricating oil addition agents are, on the other hand, well established.

1. *Alkylation.*

This is by far the most important synthetic process used for the manufacture of 100 octane number aviation spirit components, the products so

* It is proposed to follow up this review with others dealing with the various branches of petroleum technology. (Editors—*J. Inst. Petrol.*)

obtained being termed *alkylates.* In a chemical sense the term alkylation denotes a process in which an alkyl group (CH_3, C_2H_5, C_3H_7, etc.) is added to a reactive molecule, and the following are typical examples :

Benzene + Ethylene ⟶ Ethyl benzene
Naphthalene + Pentenes ⟶ Amyl naphthalenes
Phenol + Methyl alcohol ⟶ Cresols

Such alkylations may be either *catalytic* or may proceed in the absence of catalysts, in which case they are termed *thermal alkylations.*

However, the term alkylation is now usually employed to denote the specific case of the alkylation of *iso*butane with propylene, butenes, or pentenes. This is effected using concentrated sulphuric acid or anhydrous hydrofluoric acid as the catalyst, and the products are named in terms of the olefines used in their manufacture—*e.g.*, propylene alkylate, butene alkylate, or pentene alkylate. Cracked spirits may also be alkylated with *iso*butane to give fully saturated products, and benzene may be alkylated with propylene to give the valuable material cumene.

An important example of thermal alkylation is the production of *neo*-hexane by the combination of *iso*butane and ethylene—a process developed by Phillips Petroleum Company.

$$\underset{\text{Ethylene.}}{CH_2{=}CH_2} + \underset{\text{\textit{iso}Butane.}}{CH_3{-}\underset{\underset{CH_3}{|}}{CH}{-}CH_3} \longrightarrow \underset{\text{\textit{neo}Hexane.}}{CH_3{-}\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}{-}CH_2{-}CH_3}$$

A particular case of alkylation, which has, however, not yet been adopted for large-scale operation, and in which simple alkylation is accompanied by decomposition of hydrocarbons, is known as *destructive alkylation.* For example, when a mixture of hexane and benzene is treated with aluminium chloride, the hexane decomposes into ethylene and *iso*butane, and the ethylene reacts with the benzene to form ethyl benzene :

$$C_6H_{14} \longrightarrow C_2H_4 + C_4H_{10}$$
$$C_2H_4 + C_6H_6 \longrightarrow C_2H_5{-}C_6H_5$$

In this connection it should be noted that, in the production of alkylates from *iso*butane and olefines by the action of sulphuric acid, products other than those which are formed by direct union of the reactants result. Thus, in the reaction between butene-1 and *iso*butane a product is obtained which contains material boiling both below and above the isomeric octanes. Clearly the term destructive alkylation should be applied to this reaction.

2. *Catalytic Cracking.*

Cracking processes involving the use of catalysts—mainly silica–alumina compositions—have assumed considerable importance. The term *catalytic cracking* is applied to such processes in which gasolines are produced from higher-boiling oils, and is not used to describe the corresponding catalytic version of naphtha reforming (see *Hydroforming*). Catalytic cracking processes are of two main types : those in which the catalyst remains stationary in the reaction chambers or *cases*, and those in which the

catalyst moves through the reaction zone, either concurrent with the oil or counter-current. In the first case the term *static* or *fixed bed* is employed, and in the second case the corresponding description is *continuous*, *fluid catalyst* or *moving bed*. The Houdry catalytic cracking process is a good example of the first category; in operation, coke is deposited on the catalyst, and must periodically be burned off; in the original form of the process the heat generated in burning off was removed by a fluid circulated through the chamber-jackets, but very recently a new development has been announced, the *adiabatic* process, in which it appears that a catalyst of very high heat capacity is used and the temperature variation over the whole cycle is kept low. The second category, in which the catalyst moves through the reaction zone, includes the *fluid* process of the Standard Oil Development Company and the *Thermofor* process of the Socony-Vacuum Oil Company. In the *fluid* process the catalyst moves with the oil-stream in a state of fine division, the powder behaving very much like a fluid, and being handled as such, while in the *Thermofor* process—which takes its name from the peculiar type of kiln used in revivifying the catalyst—the catalyst flow is against the oil-stream, and so a granular rather than a powdered catalyst must be used.

3. *Dehydrogenation.*

The *dehydrogenation* process is now used for the conversion of the lower paraffin hydrocarbons ethane, propane, and butanes into the corresponding olefines ethylene, propylene, and butenes.

$$\underset{\text{Ethane.}}{CH_3{-}CH_3} \longrightarrow \underset{\text{Ethylene.}}{CH_2{=}CH_2} + H_2$$

This conversion is effected by the use of elevated temperatures, and in the case of propane and butanes catalysts are usually employed to enable the reactions to be carried out at temperatures below those at which side reactions occur.

The dehydrogenation process is also used for the production of butadiene from butenes:

$$\underset{\text{Butene-2.}}{CH_3{-}CH{=}CH_2{-}CH_3} \longrightarrow \underset{\text{1:3-Butadiene.}}{CH_2{=}CH{-}CH{=}CH_2}$$

Dehydrogenation of light distillates for the production of aromatic hydrocarbons is mentioned below under "Hydroforming."

4. *Hydroforming.*

This process was originally developed as an improvement on conventional non-catalytic naphtha reforming operations for the production of gasolines of high anti-knock value, and for this reason was first described as *catalytic reforming*. Later it was found that the process could be improved by maintaining in the reaction zone a high partial pressure of hydrogen, which was realized by the circulation of product gas, and the term *hydroforming* was generally adopted. The term *catalytic reforming* now refers to such catalytic processes carried out in the absence of hydrogen. Feed-

obtained being termed *alkylates*. In a chemical sense the term alkylation denotes a process in which an alkyl group (CH_3, C_2H_5, C_3H_7, etc.) is added to a reactive molecule, and the following are typical examples:

Benzene + Ethylene ⟶ Ethyl benzene
Naphthalene + Pentenes ⟶ Amyl naphthalenes
Phenol + Methyl alcohol ⟶ Cresols

Such alkylations may be either *catalytic* or may proceed in the absence of catalysts, in which case they are termed *thermal alkylations*.

However, the term alkylation is now usually employed to denote the specific case of the alkylation of *iso*butane with propylene, butenes, or pentenes. This is effected using concentrated sulphuric acid or anhydrous hydrofluoric acid as the catalyst, and the products are named in terms of the olefines used in their manufacture—*e.g.*, propylene alkylate, butene alkylate, or pentene alkylate. Cracked spirits may also be alkylated with *iso*butane to give fully saturated products, and benzene may be alkylated with propylene to give the valuable material cumene.

An important example of thermal alkylation is the production of *neo*-hexane by the combination of *iso*butane and ethylene—a process developed by Phillips Petroleum Company.

$$\underset{\text{Ethylene.}}{CH_2{=}CH_2} + \underset{\text{isoButane.}}{CH_3{-}\underset{\underset{CH_3}{|}}{CH}{-}CH_3} \longrightarrow \underset{\text{neoHexane.}}{CH_3{-}\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}{-}CH_2{-}CH_3}$$

A particular case of alkylation, which has, however, not yet been adopted for large-scale operation, and in which simple alkylation is accompanied by decomposition of hydrocarbons, is known as *destructive alkylation*. For example, when a mixture of hexane and benzene is treated with aluminium chloride, the hexane decomposes into ethylene and *iso*butane, and the ethylene reacts with the benzene to form ethyl benzene:

$$C_6H_{14} \longrightarrow C_2H_4 + C_4H_{10}$$
$$C_2H_4 + C_6H_6 \longrightarrow C_2H_5{-}C_6H_5$$

In this connection it should be noted that, in the production of alkylates from *iso*butane and olefines by the action of sulphuric acid, products other than those which are formed by direct union of the reactants result. Thus, in the reaction between butene-1 and *iso*butane a product is obtained which contains material boiling both below and above the isomeric octanes. Clearly the term destructive alkylation should be applied to this reaction.

2. *Catalytic Cracking.*

Cracking processes involving the use of catalysts—mainly silica–alumina compositions—have assumed considerable importance. The term *catalytic cracking* is applied to such processes in which gasolines are produced from higher-boiling oils, and is not used to describe the corresponding catalytic version of naphtha reforming (see *Hydroforming*). Catalytic cracking processes are of two main types: those in which the catalyst remains stationary in the reaction chambers or *cases*, and those in which the

catalyst moves through the reaction zone, either concurrent with the oil or counter-current. In the first case the term *static* or *fixed bed* is employed, and in the second case the corresponding description is *continuous, fluid catalyst* or *moving bed.* The Houdry catalytic cracking process is a good example of the first category; in operation, coke is deposited on the catalyst, and must periodically be burned off; in the original form of the process the heat generated in burning off was removed by a fluid circulated through the chamber-jackets, but very recently a new development has been announced, the *adiabatic* process, in which it appears that a catalyst of very high heat capacity is used and the temperature variation over the whole cycle is kept low. The second category, in which the catalyst moves through the reaction zone, includes the *fluid* process of the Standard Oil Development Company and the *Thermofor* process of the Socony-Vacuum Oil Company. In the *fluid* process the catalyst moves with the oil-stream in a state of fine division, the powder behaving very much like a fluid, and being handled as such, while in the *Thermofor* process—which takes its name from the peculiar type of kiln used in revivifying the catalyst—the catalyst flow is against the oil-stream, and so a granular rather than a powdered catalyst must be used.

3. *Dehydrogenation.*

The *dehydrogenation* process is now used for the conversion of the lower paraffin hydrocarbons ethane, propane, and butanes into the corresponding olefines ethylene, propylene, and butenes.

$$\underset{\text{Ethane.}}{CH_3{-}CH_3} \longrightarrow \underset{\text{Ethylene.}}{CH_2{=}CH_2} + H_2$$

This conversion is effected by the use of elevated temperatures, and in the case of propane and butanes catalysts are usually employed to enable the reactions to be carried out at temperatures below those at which side reactions occur.

The dehydrogenation process is also used for the production of butadiene from butenes:

$$\underset{\text{Butene-2.}}{CH_3{-}CH{=}CH_2{-}CH_3} \longrightarrow \underset{\text{1:3-Butadiene.}}{CH_2{=}CH{-}CH{=}CH_2}$$

Dehydrogenation of light distillates for the production of aromatic hydrocarbons is mentioned below under "Hydroforming."

4. *Hydroforming.*

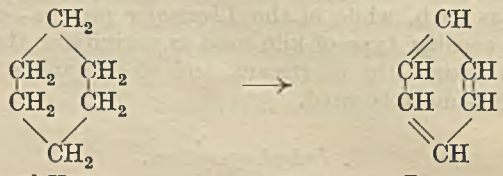
This process was originally developed as an improvement on conventional non-catalytic naphtha reforming operations for the production of gasolines of high anti-knock value, and for this reason was first described as *catalytic reforming.* Later it was found that the process could be improved by maintaining in the reaction zone a high partial pressure of hydrogen, which was realized by the circulation of product gas, and the term *hydroforming* was generally adopted. The term *catalytic reforming* now refers to such catalytic processes carried out in the absence of hydrogen. Feed-

stocks are restricted to straight-run and cracked naphthas and low-boiling distillates.

The chemical reactions involved in such processes are complex, but are generally considered to consist mainly of *dehydrogenation* and *cyclization*, although molecular breakdown (*i.e.*, cracking) with the production of hydrocarbons containing a smaller number of carbon atoms, hydrogenation and desulphurization also occur to extents which depend on the actual process conditions employed. The dehydrogenation reactions involved are of two types. Firstly the production of olefines from the corresponding paraffins, *e.g.*:

$$\underset{n\text{-Pentane.}}{CH_3{=}(CH_2)_3{-}CH_3} \longrightarrow \underset{\text{Pentene-1.}}{CH_3{-}CH_2{-}CH_2{-}CH{=}CH_2} + H_2$$

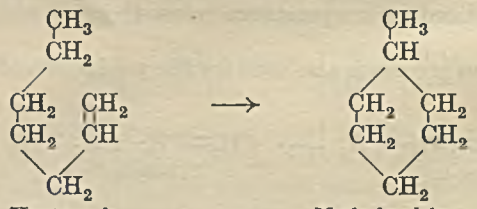
and secondly the production of an aromatic hydrocarbon from the corresponding six-membered ring naphthene or hydro-aromatic, *e.g.*:



*cyclo*Hexane. Benzene.

This second reaction, involving the production of aromatics, is also termed *aromatization*.

The cyclization reactions involved are also of two types : those involving simple ring closure without loss of hydrogen, and those in which loss of hydrogen takes place simultaneously. Thus, the conversion of heptenes into methyl*cyclo*hexane is an isomerization reaction which is known as cyclization or ring closure.



Heptene-1. Methyl*cyclo*hexane. *Cyclization.*

Whereas the overall conversion of heptane to toluene, involving in the first place the production of heptenes and the eventual conversion of methyl*cyclo*hexane to toluene, is referred to as *dehydrocyclization*.

Hydroforming operations are usually carried out on straight-run naphthas with the object of producing therefrom benzines of high octane number —*i.e.*, 75 to 85. Such benzines are typified by high contents of aromatic hydrocarbons and very low sulphur contents. The process may also be operated in such a manner that very little formation of aromatics takes place, but almost complete desulphurization results and unsaturateds are converted into other hydrocarbons. In this case the process is referred to as *hydrofining*.

5. *Hydrogenation.*

Very few new developments in the hydrogenation process have lately been reported. Hydrogenation reactions are of two main kinds, one—termed *destructive hydrogenation*—allows the production of distillates of lower average boiling point and molecular weight and having a smaller number of carbon atoms per molecule than the feed-stock, whereas the other, termed *saturation hydrogenation*, is confined to the production of paraffins or naphthenes from the corresponding olefines or aromatics. Destructive hydrogenation is also referred to as hydrogenation cracking or *hydro-cracking*, and the word hydrogenation is often abbreviated to *hydro*, as for example in *hydrospirit*, *hydronaphtha*, *hydro-butanes*, *hydro-lubes*, etc., etc.

6. *Isomerization Processes.*

Isomerization, by which the chemical composition of a hydrocarbon is changed without altering its constituent atoms or molecular weight, is now applied in petroleum refining for two different purposes. These are:

1. The conversion of normal butane into *iso*butane. This is often necessary in order to provide increased supplies of *iso*butane for the alkylation process.
2. The production of high-octane number saturated *iso*paraffinic gasolines from straight-run gasolines.

The reactions involved are very simple. Thus

$$\underset{n\text{-Butane.}}{CH_3{-}CH_2{-}CH_2{-}CH_3} \longrightarrow \underset{iso\text{Butane.}}{\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!CH{-}CH_3}$$

$$\underset{n\text{-Hexane.}}{CH_3{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_3} \longrightarrow \underset{iso\text{Hexane (2-methyl-pentane).}}{\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!CH{-}CH_2{-}CH_2{-}CH_3}$$

$$\underset{\text{2-Methyl-pentane.}}{\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!CH{-}CH_2{-}CH_2{-}CH_3} \longrightarrow \underset{\text{2 : 3-Dimethyl-butane.}}{CH_3{-}\underset{CH_3}{CH}{-}\underset{CH_3}{CH}{-}CH_3}$$

The liquid product obtained as a result of isomerizing a straight-run gasoline is sometimes termed an *isomate*.

7. *Polymerization Processes.*

Although of comparatively recent development, polymerization processes are now well established in the petroleum refining industry and, in order to meet demands for higher-quality products, the *catalytic* processes have advanced more rapidly than their *non-catalytic* or *thermal* counterparts. In nearly all cases the processes have been applied to the production of high-grade motor-fuel and aviation-fuel components from cracked gases. The chemical reaction involved is the combination of olefine molecules to form hydrocarbons of higher molecular weight and boiling point, *e.g.*:

$$\underset{\text{Propylene (Gas).}}{CH_3{-}CH{=}CH_2} \longrightarrow \underset{\text{Hexene (b.p. 63·7° C.).}}{CH_3{-}CH_2{-}CH_2{-}CH_2{-}CH{=}CH_2}$$

$$\underset{\text{Butene-1 (Gas).}}{CH_3{-}CH_2{-}CH{=}CH_2} \longrightarrow \underset{\text{Octene (b.p. 121·6° C.).}}{CH_3{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH{=}CH_2}$$

When the product is formed by the union of two identical olefine molecules it is referred to as a *dimer*, and when it is formed by the union of three such molecules it is known as a *trimer*, etc., etc. Similarly, two unlike molecules may be combined together, *e.g.* :

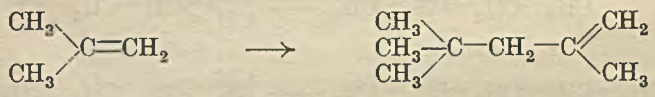
$$\underset{\text{Propylene.}}{CH_3{-}CH{=}CH_2} + \underset{\text{iso}\textbf{Butylene.}}{\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!C{=}CH_2} \longrightarrow \underset{\text{iso}\textbf{Heptene.}}{\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!C{-}CH_2{-}CH_2{-}CH{=}CH_2}$$

In this case the term *co-polymerization* is employed, and the products obtained are known as *co-polymers*.

Several polymerization catalysts are employed in commercial operations, of which phosphoric acid, phosphates, sulphuric acid, aluminium chloride, and boron trifluoride are the most important. Particular mention must be made of the polymerization of butenes for the production of polymers which, after saturation hydrogenation, yield valuable aviation spirit components. For this purpose three processes are available :

1. Polymerization using cold sulphuric acid catalyst of about 60 per cent. strength.
2. Polymerization using hot sulphuric acid catalyst.
3. Polymerization using supported phosphoric acid and phosphate type catalysts.

The first of these is limited to the production of di*iso*butylene and, when desired, of higher polymers, from *iso*butylene—thus :



iso-*octane*.

(2 : 2 : 4-Trimethylpentane) is produced from di*iso*butylene (*D.I.B.*) by hydrogenation. It is often referred to as *cold acid octane*.

The second process, using hot sulphuric acid, effects a co-polymerization between *iso*butylene and the normal butenes to give a product known as hot acid octenes or *mixed octenes*, which on hydrogenation gives *hot acid octanes* or *mixed octanes*. The third process affects the same co-polymerization and yields *codimer*, which hydrogenates to *hydro codimer*. It may, however, also be employed to produce the co-polymers of propylene and normal butenes or of propylene and *iso*butylene, and in this case the product is known as *co-polymer* or C_3–C_4 polymer, and the hydrogenated derivatives as *hydro polymers*.

With regard to the thermal polymerization processes now in use, some of these are misnamed because they operate on saturated gaseous feedstocks—*e.g.*, straight-run butanes. Such processes should be named pyrolysis-polymerization because pyrolysis must occur as an initial step. For example :

$$\underset{n\text{-Butane.}}{CH_3{-}CH_2{-}CH_2{-}CH_3} \longrightarrow \underset{\text{Propylene + Methane.}}{CH_3{-}CH{=}CH_2 + CH_4}$$

$$\underset{\text{Propylene.}}{CH_3{-}CH{-}CH_2} \longrightarrow \text{Polymers, etc.}$$

A further important point with regard to thermal polymerization processes is that the chemical reactions involved are most complex and the liquid products obtained contain, in addition to olefines, aromatic, naphthenic and paraffinic hydrocarbons. In this respect they differ markedly from the catalytic processes.

8. *Thermal Cracking.*

Although, to the chemist, *cracking* and *pyrolysis* are synonymous terms, it has become customary in petroleum technology to reserve the term *pyrolysis* to cracking reactions carried out under very high temperature conditions—*e.g.*, above about 1300° F. Such reactions are employed for the production of benzene, toluene, and higher aromatic hydrocarbons from straight-run and cracked gases and also from low-boiling naphthas. In the thermal cracking field, a recent development is a process in which condensible gases, such as C_3 and C_4 hydrocarbons, produced in thermal cracking operations, are recycled to the cracking furnace. In such a manner it is possible to subject the oil feed-stock to higher temperatures and higher degrees of conversion per pass than would be possible under otherwise similar conditions, without excessive coke formation in the cracking tubes. The process, known as *polyforming* or *gas reversion*, results in the production of gasoline in higher yield and of higher octane number than can be obtained by subjecting the same oil to a conventional thermal cracking or reforming operation. The operation may be either *self-contained*—*i.e.*, operate entirely on recycle light hydrocarbons produced in the process itself, or *extraneous* light hydrocarbons may be introduced.

B. Recent Refining Processes.

Particular attention has been devoted to methods of sulphur removal from gases and gasolines, the former because when the gases are used in synthetic processes such as polymerization it is desirable to render them sulphur-free before processing and the latter because of the beneficial effect of sulphur removal on lead response.

Processes for Removal of Hydrogen Sulphide from Gases.

The Shell Phosphate Process.—This comprises a regenerative liquid purification system for the removal and recovery of hydrogen sulphide (H_2S) from gaseous and liquid hydrocarbons. It consists essentially of two steps: absorption or scrubbing with a solution of tripotassium phosphate, and regeneration of the spent solution by heating with steam.

The chemical reactions involved are:

Absorption. $H_2S + K_3PO_4 \longrightarrow KHS + K_2HPO_4$

Regeneration. $KHS + K_2HPO_4 \longrightarrow H_2S + K_3PO_4$

The Amine Processes of the Girdler Corporation.—The three ethanolamines, and particularly triethanolamine, are good solvents for hydrogen sulphide and carbon dioxide, and are used for removing these substances from gases in counter-current operations. The dissolved gases are readily removed from the absorption liquids by heating.

Processes for the Removal of Mercaptans from Sour Benzines.

Solutizer Process.—This is a process invented by the Shell Development Co. for the extraction of mercaptans from gasoline, based on the fact that the presence of sodium or potassium *iso*butyrate in caustic soda solution increases the solubility of mercaptans therein. The sour gasoline is contacted with such a solution, and the solution regenerated by boiling and stripping with steam.

It will be noted that this process effects removal of mercaptans and not conversion to disulphides, as in plumbite and hypochlorite treating.

Caustic Methanol Process.—This process also effects the substantially complete removal of mercaptans from benzines and employs an aqueous solution of caustic soda and methanol, operating on the regenerative principle.

Copper Sweetening Processes.—These processes, developed by Perco Incorporated, do not effect *removal* of mercaptans, but effect conversion of mercaptans into disulphides, as in the well-known plumbite and hypochlorite treatments. They involve the use of cupric chloride as a slurry mixed with clay, in the form of an aqueous solution, or deposited from aqueous solution on a porous support such as fuller's earth, bauxite, etc. The reactions are :

$$\underset{\text{Mercaptan.}}{2RSH} + \underset{\text{Cupric Chloride.}}{2CuCl_2} \longrightarrow \underset{\text{Disulphide.}}{RS{-}SR} + \underset{\text{Cuprous Chloride.}}{Cu_2Cl_2} + 2HCl$$

$$Cu_2Cl_2 + 2HCl + \tfrac{1}{2}O_2 \longrightarrow 2CuCl_2 + H_2O$$

The nett result is oxidation of mercaptan to disulphide by oxygen in the presence of cupric chloride catalyst.

Catalytic Desulphurization.

Processes have recently been introduced for the catalytic desulphurization of gasolines in which the raw feeds are passed over a catalyst at about 600–900° F. and at pressures up to about 200 lb. per square inch. Under these conditions, mercaptans, alkyl, and aromatic sulphides and disulphides are readily converted into H_2S and the corresponding hydrocarbons; thiophanes and carbon disulphide react with more difficulty, and thiophenes least readily of all. Reduction of sulphur content achieved is therefore dependent on the original thiophene content, and is generally at least 85 per cent. for straight-run gasolines, and at least 50–60 per cent. for cracked gasolines.

C. Recent Distillation Processes.

Despite the fact that distillation processes are the basis of all petroleum refining operations and have been in universal use since the industry began, the past two or three years have seen impressive developments in this field. In particular the degree of separation obtainable by close fractionation has been improved considerably by the operation of more efficient equipment. Thus, fractionating columns having efficiencies equivalent to that of 50–100 theoretical plates are now being operated for the separation of particular hydrocarbons from light gasoline fractions, and this new development has given rise to the term *superfractionation.*

Azeotropic Distillation.

This is also now being used commercially in the petroleum refining industry—particularly for the isolation of aromatic hydrocarbons in a high degree of purity. This process is based on the fact that many organic compounds—for example, methanol and acetic acid—form minimum boiling azeotropic mixtures with hydrocarbons, paraffin hydrocarbons giving the lowest-boiling mixtures, and aromatic hydrocarbons the highest-boiling mixtures. It is thus possible by this means to separate paraffin and aromatic hydrocarbons boiling so close together that their separation by straightforward fractionation would be practically impossible.

THE INSTITUTE OF PETROLEUM.

A MEETING of the Institute of Petroleum was held at the Junior Institution of Engineers, 39, Victoria Street, London, S.W.1, on Tuesday, 29th September, 1942, at 3 p.m. The President, Mr. C. DALLEY, occupied the Chair.

The following paper was presented by Dr. D. A. Howes :—

"Petroleum Refining Terminology." By M. E. Kelly, B.Sc. (Associate Member), and D. A. Howes, D.Sc., F.I.C. (Fellow) (see pp. 1–9).

DISCUSSION.

In presenting the paper DR. HOWES said : A few weeks ago Dr. Dunstan suggested that a paper might be prepared and read before the Institute explaining the many technical terms which have been developed during the past few years and have now been accepted by the petroleum industry in referring to new processes and new products. To those of us who are in more or less daily contact with this industry, and particularly with these recent developments, I am afraid the paper will contain nothing that is new; in fact, it will be rather worse than that : it will be incomplete. On the other hand, if the paper does prove to be of any value to those who are not intimately connected with the new developments, the authors will be satisfied with their efforts on this occasion.

You will notice that the paper is concerned entirely with nomenclature, and I am anxious that the discussion should be limited to this aspect of the subject. The object of the paper was not to discuss the relative merits of processes or to describe the conditions under which they operate, the materials which they employ, or the products which they give.

It is rather remarkable, in looking through the names used in the industry, to notice how descriptive they are but how incorrect or indistinct they are from the scientific point of view. For instance, the word "cracking" is certainly descriptive, but it does not really explain what is happening, and the same applies to "re-running," "sweetening," "stabilizing," and so forth.

Some years ago a body was set up called the International Union of Pure and Applied Chemistry, which took upon itself the task of unifying chemical terms, and it might be well to spend a few moments in mentioning the terms that have now been adopted or suggested for the hydrocarbons. These have not yet come into universal use, but they are gradually gaining favour. You remember that we used to classify the petroleum hydrocarbons as saturated on the one hand and unsaturated on the other, and that the saturated were subdivided into paraffins and naphthenes and the unsaturated into olefines and aromatics. Those terms are still very widely used, but they are gradually being replaced, and all the saturated hydrocarbons are characterized by the suffix "-ane." Paraffin is now called "alkane" and naphthene "*cyclo*-alkane." The olefines are characterized by the suffix "-ene," and an olefine is now called an "alkene." A typical example is that ethylene is now called "ethene." These terms are scientifically correct, and enable one to picture the composition of the material from its name. Similarly, the acetylenes are called "alkynes." I mention that because it might be stated that this paper dealing with terminology is not up to date, inasmuch as ethylene is referred to by that name and not by the term "ethene," and so forth. The reason for that is that these old terms are still in very wide use and we wanted to keep the paper as simple as possible.

The PRESIDENT, in opening the discussion, said that the curve of petroleum refining progress had been for so many years a horizontal line, that it was difficult to realize the tremendous strides which had been made in the last few years, and that the curve was now almost vertical.

As was frequently the case with branches of a developing industry, refining had now become a highly specialized subject, and he, as a general practitioner, was therefore grateful to the authors of the paper for explaining some of the terms which were now considered necessary to designate the processes that had been developed. The members would understand that, as a general practitioner, he was quite unable to discuss the paper, and he would therefore ask Dr. Dunstan to open the discussion.

Dr. A. E. Dunstan, before referring to the subject of the paper, said that the present meeting was the first domestic meeting of the Institute which had been held for a considerable time, and he thought the thanks of the members should be tendered to the President and the Honorary Secretary for the efforts they had made to bring the Institute back from Birmingham to the Imperial College of Science, where the members could meet from time to time in congenial surroundings, and discuss subjects of general interest. The programme which had been arranged by the Publication Committee for the next six months showed that the Institute, after having been moribund for so long, had now become a live society again.

The present paper had arisen from a very informal discussion at a recent Council meeting, and a general feeling that many of the new expressions and terms that were used freely in the technical Press might well be defined. At the present time they were, he supposed, the preserve of a rather specialized community in the industry, but there was no reason why the general body of those engaged in the industry should not understand the language of a community that was a part of themselves. When the matter was discussed with Dr. Howes, who was fortunately able, with Mr. Kelly, to step into the breach and prepare a paper, it was felt that there was a definite need for some sort of explanatory glossary of common terminology on the chemists' side of the industry. He had then talked the matter over still further with Professor Illing, who had been delighted with the idea and thought that the geologists and geophysicists might return the compliment. Again, the President might feel that there were certain terms used by our engineering confrères every day with which chemists were not very familiar. The idea had therefore come into his mind, that just as a book of standard tests was published periodically, so the Institute might very well take upon itself the task of publishing from time to time an up-to-date authoritative glossary of terms in use throughout the whole industry, and he thought there was a great deal to be said in favour of that, because it was not desired that the Institute should be too specialized. The idea of the Institute all along had been to bring together the representatives of the various technical departments concerned in the petroleum industry, and the Institute should therefore speak as a community, and not as several discrete groups.

He thought that the authors' paper gave a broad and general view of the modern chemical jargon of petroleum technology. He did not know whether any of the members present would care to amplify it. He had been through it himself, and thought it was extremely good and complete, and he hoped the members would agree with him that the authors had done work of substantial value. It was a pioneer effort, striking out a new line, and he thought it would be of real value to the members of the Institute.

Mr. T. Dewhurst agreed with the comments made by Dr. Dunstan, and said that two small points had occurred to him in connection with the paper.

His first point was that Dr. Howes had referred to new, exact and scientific names, and then explained that he had not used them in the paper, but had adhered to the old names that had become known in the industry. He suggested that that might be a mistake, and that both terms should be given in the paper; for instance, after the word "ethylene" the new, correct, and scientific term should be put in brackets. If that was done, when the members saw a name that was not in the paper now they would know what it meant, and he thought that would be very helpful.

His second point was a very small one. In Section 2 of the paper, dealing with catalytic cracking, the authors referred to a "fluid catalyst," but it now appeared that that catalyst was not a fluid, but a powder. It seemed to him that it was not exact and scientific to use the word "fluid" if the catalyst was really a powder, and he thought the fact that it was a powder ought to be indicated in the paper.

Mr. E. A. Evans said he had very much enjoyed hearing Dr. Howes' address, which had expanded the information given in the printed paper, and he hoped that the paper would be published in the form in which it had been delivered that afternoon.

Dr. Dunstan had mentioned the programme which had been prepared for the forthcoming session, and he would like to refer for a moment to what the Institute had been doing before its recent quiescent period. He felt that a stage had been reached when the members were expected to know a great deal before they opened their *Journal*; they were too proud to admit that they did not know certain things, although it was very difficult to find the information which was lacking. He had recently been studying some of Hilditch's work on fatty oils, and had been handicapped by lack of information, and it is the same with other literature on any subject. It was almost impossible to follow Hilditch's work unless one knew the up-to-date nomenclature. He felt that the members should be a little more open in acknowledging their difficulties. With regard to the paper on viscosity which was to be read during the present session, some of the members were very ignorant indeed about the modern views on viscosity, and the meeting at which that paper was read would provide an opportunity for an open discussion on the subject. He suggested that the discussions at the meetings of the Institute for the next year or so should be more open, and that the members should seek information more freely than they had in the past.

Mr. R. J. Ward agreed with Mr. Evans, and hoped that in future the *Journal* would give more information of the kind in question. He had very much appreciated the explicit and simple way in which Dr. Howes had dealt with the subject under discussion on the present occasion.

He was very glad that the Institute had returned to London and would be holding meetings there during the present session, and he wished to express his thanks for the announcement of the programme which had been prepared for that session.

Dr. D. A. Howes, in replying to the discussion, welcomed the suggestion made by Mr. Dewhurst that the new terms should be put in brackets after the old ones in the paper. It would be a simple matter to do that, because in only three or four cases had the old terms been used in the paper to the exclusion of the new ones.

He agreed with Mr. Dewhurst that the expression "fluid catalyst" in the paragraph to which Mr. Dewhurst had referred was misleading. The word "fluid" was used because the plant arrangement was such that the powdered catalyst flowed as a fluid. It was so finely powdered that it flowed as a fluid through pumps, valves, meters, and so forth, and behaved as a fluid in almost very way.

With regard to Mr. Evans' point that what he had said that afternoon constituted to a certain extent an expansion of the paper as printed, the paper had been rather hurriedly prepared, and the authors would be happy to expand it if that was permissible.

He wished to thank Dr. Dunstan for the kind remarks he had made with reference to the paper.

On the motion of the President, a vote of thanks was accorded to the authors for their paper, which had given the members a very pleasant afternoon and was a good augury for the coming session, and the meeting then terminated.

TWENTY-NINTH ANNUAL REPORT.

1942.

THE Twenty-Ninth Annual Report of the Council, covering the activities of the Institute during 1942, is presented for the information of the members.

MEMBERSHIP.

Details of membership are set out in the Table below :—

	Total, 31st Dec., 1941.	Total, 31st Dec., 1942.
Hon. Members	16	12
Fellows	408	417
Members	507	538
Assoc. Members	549	569
Students	152	160
Totals	1632	1696

At the present time the above figures can only be regarded as approximate, as contact has been lost with more than 150 members in enemy-occupied countries and the Far East, though their names are retained on the roll of the Institute.

The Council has to record with deep regret the decease of the following members during 1942 :—

	Date elected.	Class of membership.
H. STANDISH BALL	1923	Fellow
T. M. HICKMAN	1931	Assoc. Member
J. A. ROMANES	1919	Member
P. A. STIFF	1930	Assoc. Member
E. R. STYLES	1931	Fellow

HONOURS.

His Majesty The King conferred the following honours upon members of the Institute during 1942 :

Knight Bachelor : Frederick Godber, Esq.
Distinguished Service Cross : W. M. Wright, Esq.

and approved the following award :—

Greek Distinguished Service Medal : Major Percy R. Clark.

Meetings.

Four meetings were held in London during 1942, of which one was a joint meeting with the Institution of Chemical Engineers and the Chemical Engineering Group, and another with the Oil Industries Club. A list of papers presented is given below :—

Date, 1942.	Subject.	Authors.
14th July.	"The Separation of Gases."	Dr. Martin Ruhemann.
5th Nov.	"Notes on the Fourth Edition of Standard Methods for Testing Petroleum and its Products."	J. Cantor, E. P. Driscoll and A. Osborn.
1st Dec.	"Engineering Development in the Petroleum Industry."	C. Dalley.
17th Dec.	"The Oilfields of Western Canada."	Campbell M. Hunter, O.B.E.

The thanks of the Council are tendered to the Imperial College of Science and Technology, the Institution of Chemical Engineers, the Institution of Mechanical Engineers, the Junior Institution of Engineers and the Royal Society of Arts for the use of meeting-rooms.

A Luncheon of the Institute was held on Friday, 29th May, 1942, when Mr. C. Dalley was inducted as President.

Publications.

In spite of the difficulty of obtaining contributions, combined with rationing of paper supplies, it was found possible to issue the *Journal* each month. The Abstracts have been well maintained.

Chemical Standardization.

During 1942 the Chemical Standardization Committee changed its name to the Standardization Committee. The deliberations of the Committee were incorporated in the 4th edition of "Standard Methods for Testing Petroleum and its Products," which ran into two editions owing to the enormous demand for the publication.

Sub-Committees.

The Council desire to place on record their appreciation and thanks to the several members of the Sub-Committees for the work carried out by them during 1942.

Finance.

The audited accounts for the year, with the Balance Sheet, the accounts of the Benevolent Fund, and the list of contributors to the latter, are given in the following pages, and, as will be seen, the financial condition of the Institute continues to be satisfactory.

The preparation of the accounts has been somewhat delayed, chiefly in consequence of the reduction and changes in staff created by war conditions, with the result that the auditors have not been able to devote the necessary time to them.

Offices.

During 1942, on the recommendation of the Past-Presidents' Committee to Council, it was decided that the offices of the Institute should be removed from Birmingham to London, and accommodation was eventually found at the Imperial College of Science and Technology, Prince Consort Road, S.W. 7.

Council and Officers.

As mentioned above, Mr. C. Dalley, M.I.E.E., F.Inst.Pet., was elected by the Council to be President of the Institute for the year 1943–44.

Messrs. Ashley Carter, G. H. Coxon, F. H. Garner, A. C. Hartley, V. C. Illing, and F. B. Thole were elected Vice-Presidents, and Messrs. E. A. Evans, J. S. Jackson, H. C. Tett and A. Wade were elected members of Council at the Annual General Meeting.

Acknowledgments.

The Council records its appreciation of the services to the Institute of the Rt. Hon. Lord Plender, G.B.E., Hon. Treasurer; Messrs. Price Waterhouse & Co., Auditors; Messrs. Ashurst, Morris, Crisp & Co., Solicitors; Westminster Bank, Limited; and the members of the Staff.

Approved for publication on behalf of the Council of the Institute.

Christopher Dalley, President.
Arthur W. Eastlake } Joint Hon. Secretaries.
Ashley Carter }
F. H. Coe, Secretary.

9th November, 1943.

THE INSTITUTE

(*A Company limited by Guarantee*

BALANCE SHEET AS

	£	s.	d.	£	s.	d
Capital of the Institute under Bye-Law Section 6, Paragraphs 14 and 15 :—						
Life Membership Fund—	£	s.	d.			
As at 31st December, 1941 . . .	819	14	0			
Additions during year	79	10	0			
				899	4	0
Entrance and Transfer Fees—						
As at 31st December, 1941 . . .	3714	10	9			
Additions during year—						
Entrance Fees	51	9	0			
Transfer Fees	2	2	0			
				3768	1	9
Profit on Sale of Investments—						
As at 31st December, 1941				351	10	11
Donations—						
As at 31st December, 1941				326	5	0
Research Fund						
T. C. J. Burgess Prize Fund :—						
As at 31st December, 1941						
War Contingencies Reserve :—						
As at 31st December, 1941						
Members' Subscriptions Received in Advance .						
Journal Subscriptions Received in Advance . .						
Sundry Creditors, General Account . . .						
World Petroleum Congress						
Revenue Account :—						
Balance as at 31st December, 1941				2735	3	2
Add Surplus for year as per separate statement . .				473	6	0

£	s.	d.
5345	1	8
132	19	7
5	0	0
1764	1	0
75	0	0
202	12	5
964	6	2
235	15	8
3208	9	2
£11,933	5	8

C. DALLEY, President.
ARTHUR W. EASTLAKE } Joint Honorary Secretaries.
ASHLEY CARTER }

AUDITORS'

We report to the Members of THE INSTITUTE OF PETROLEUM that we have obtained all the information and explanations we have required. We are of the correct view of the state of the Institute's affairs as at 31st December, 1942, according the books of the Institute.

3, FREDERICK'S PLACE,
OLD JEWRY, LONDON, E.C. 2.
14*th October*, 1943.

OF PETROLEUM.

and not having a Share Capital.)

AT 31ST DECEMBER, 1942.

	£	s.	d.	£	s.	d.
Investments :—						
On Account of Capital, at cost—						
£461 12 0 3% Conversion Stock, 1948/53	491	12	6			
664 6 6 3% London County Consolidated Stock, 1920	481	10	6			
806 8 3 3% Manchester Corporation Redeemable Consolidated Stock, 1958	845	17	7			
867 8 6 2¾% Bristol Corporation Redeemable Stock, 1955/65	845	17	7			
150 0 0 5% Wandsworth and District Gas Co. Debenture Stock	154	8	6			
400 0 0 3% Metropolitan Water Board "A" Stock, 1963	346	10	7			
125 0 0 5% Great Western Railway Co. Consolidated Preference Stock	105	4	9			
150 0 0 3% Luton Corporation Redeemable Stock, 1958	151	6	7			
150 0 0 3% Smethwick Corporation Redeemable Stock, 1956/58	151	4	9			
600 0 0 3% Bristol Corporation Redeemable Stock, 1958/63	597	7	3			
500 0 0 3% Defence Bonds	500	0	0			
525 0 0 3% Savings Bonds, 1955/65	525	0	0			
	5196	0	7			
(Market Value at 31st December, 1942, £5392.)						
Cash awaiting Investment on Deposit with Post Office Savings Bank	149	1	1			
				5345	1	8
On Account of Revenue, at cost—						
£790 8 3 3% Conversion Stock, 1948/53	842	8	0			
500 0 0 3% Defence Bonds	500	0	0			
475 0 0 3% Savings Bonds, 1955/65	475	0	0			
				1817	8	0
(Market Value at 31st December, 1942, £1799.)						
On Account of Research Fund, at cost—						
£336 5 10 3% Conversion Stock, 1948/53				357	14	8
(Market Value at 31st December, 1942, £348.)						
Office and Library Furniture (excluding Presentations) :—						
As at 31st December, 1941	1	0	0			
Additions during year	33	15	0			
				34	15	0
Library Books (excluding Presentations) :—						
As at 31st December, 1941					—	
Subscriptions in Arrear :—						
Not Valued					—	
Sundry Debtors, less Reserve for Doubtful Debts				617	6	6
Cash at Bank on Current Account and in Hand				770	8	3
Cash on Deposit with Post Office Savings Bank :—						
General Account	2754	15	11			
World Petroleum Congress Account	235	15	8			
				2990	11	7
				£11,933	5	8

REPORT.

examined the above Balance Sheet with the books of the Institute and have opinion that such Balance Sheet is properly drawn up so as to exhibit a true and to the best of our information and the explanations given to us, and as shown by

PRICE, WATERHOUSE & Co.,
Chartered Accountants.
Auditors.

REVENUE ACCOUNT FOR THE

	£ s. d.	£ s. d.	1941 £
To Administration Expenses :—			
Staff Salaries	1440 1 4		*1650*
Honoraria to Staff	73 10 0		—
Printing and Stationery	183 18 0		*164*
General Postages	143 16 5		*169*
Telephone, Cables, and Telegrams	13 3 4		*8*
		1854 9 1	
,, Establishment Charges :—			
Rent, Rates, etc.	212 2 2		*338*
Cleaning and Lighting	32 15 4		*34*
Repairs and Renewals	—		*5*
		244 17 6	
,, Publications :—			
Journal Expenses	1363 12 6		*1313*
Abstractors' Fees	216 15 7		*243*
Postage on Journals	133 10 7		*167*
Cost of Other Publications	656 13 11		*442*
		2370 12 7	
,, Meetings :—			
Hire of Hall, Pre-prints, Reporting		77 16 8	*171*
,, Professional Fees :—			
Legal Expenses	8 8 0		*28*
Auditor's Fee	47 5 0		*42*
		55 13 0	
,, Students' Scholarships and Prizes		40 0 0	*87*
,, Library Expenditure		28 16 5	*34*
,, Branches and Sections :—			
Students Section	26 0 0		
Trinidad Branch	20 0 0		
		46 0 0	*34*
,, Sundry Expenses		165 19 7	*196*
,, War Damage Contribution and War Risks Insurance		27 2 6	*76*
,, Donation to R.A.F. Benevolent Fund		—	*105*
,, Donation to Birmingham Branch, British Empire Cancer Campaign		26 5 0	—
,, Evacuation, Removal and Travelling Expenses		368 9 7	—
,, Reserve for Claim for Dilapidations		97 8 0	—
,, Balance, being Surplus for Year, carried to Balance Sheet		473 6 0	*210*
		£5876 15 11	*£5525*

RESEARCH FUND INCOME AND EXPENDITURE

	£ s. d.
To Grant Made During Year :—	
British Electrical and Allied Industries Research Association	15 0 0
,, Balance as at 31st December, 1942	132 19 7
	£147 19 7

OF PETROLEUM.

YEAR ENDED 31ST DECEMBER, 1942.

	£	s.	d.	£	s.	d.	1941 £
By Subscriptions for 1942 received . .				3022	9	6	*3199*
,, Special Subscription				20	0	0	*20*
,, Subscriptions in Arrear, received during year				226	16	0	*130*
,, Publications				2304	15	6	*1928*
,, Interest and Dividends (Gross) . .				274	1	11	*246*
,, War Damage Contribution Reserve not required				28	13	0	—
,, Compensation Received from Ministry of Works and Buildings for 1942 . .	500	0	0				
Add Grant received in Aid of Rent . .	346	5	3				
	846	5	3				
Less Rent payable to the Adelphi for 1942 (Lease disclaimed as of 30th June, 1942).	846	5	3				
				£5876	15	11	*£5525*

ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1942.

	£	s.	d.
By Balance as at 31st December, 1941	137	17	10
,, Interest Received During Year	10	1	9
	£147	19	7

BENEVOLENT FUND.

Receipts and Payments Account for Year ended 31st December, 1942.

Receipts.

	£ s. d.	£ s. d.
Balance on 1st January, 1942		927 13 4
Receipts during 1942 :—		
Subscriptions and Donations	89 10 11	
Subscriptions and Donations received in advance	1 8 0	
Interest	20 10 1	
Income Tax recovered	9 0 0	
		120 9 0
		£1048 2 4

Payments.

	£ s. d.
Benevolent Fund :—	
Grants in Aid	62 0 0
Balance on 31st December, 1942 *	986 2 4
	£1048 2 4

* The Balance on 31st December, 1942, was held as follows :—

	£ s. d.
Cash at Bank on Current Account	65 17 9
Cash with the Institute of Petroleum	41 7 7
3% Defence Bonds	350 0 0
£600 0 0 3% Local Loans at cost †	528 17 0
	£986 2 4

† (Market Value at 31st December, 1942, £583.)

We have examined the above Receipts and Payments Account with the books and vouchers of the Fund and find it to be in accordance therewith. We have verified the Investments and the Balances with Bankers and the Institute of Petroleum comprising the Balance on 31st December, 1942.

3, Frederick's Place,
London, E.C. 2.

Price, Waterhouse & Co.
14th October, 1943.

A. E. Dunstan, Chairman, Benevolent Fund Committee.
Christopher Dalley, President.

LIST OF DONORS AND SUBSCRIBERS DURING 1942.

Adams, A. C.
Auld, S. J. M.
Bell, O. A.
Blakiston, J. H.
Bolton, R. P.
Bowrey, S. E.
Bralley, B. S.
Bressey, R. J.
Brodie, N. M.
Brown, C. B.
Brown, R. G.
Bushe, L. A.
Cameron, I.
Carter, Ashley.
Catchpole, W.
Chandler, R.
Charlton, H. E.
Chrisman, A. E.
Clement, L.
Clifford, J.
Connor, W. W.
Cox, A. W.
Crichton, R.
Dalley, C.
Davson, C. W.
Dewhurst, T.
Downs, W. W.
Duck, A. E.
Dunkley, G. W.
Dunstan, A. E.
Dyson, G. M.
Ellis, J.
Evans, A.
Evans, E. B.
Eves, H. B. Heath.
Farrant, V. M.
Farthing, V. L.
Fay, E.
Ferembre, R. G. de.
Fox, D. A.
Gent, E. L.
Gottesmann, M.
Grant, J.
Gray, W.
Griffiths, P. M.
Haworth, A. J.
Heaton, W. B.
Henson, F. R. S.
Hersch, L. H.
Hotham, E.
Howard, G. P. E.
Hunting, E. A.
Jameson, J.
Jewell, J. C.
Kenyon, H.
Kidd, T. G.
Le Mesurier, L. J.
McCreath, T. T.
McCue, C. F.
Macklilligan, R. S.
McKinney, R. D.
Maclean, T. T.
Macniven, H. B.
Maskell, L. O.
Masters, J. S. S.
Mitchell, R. G.
Moon, C. A.
Odams, R. C.
Ogston, A. R.
Owen, R. M. S.
Perks, A. J.
Pink, E. P.
Pitkethly, R.
Porter, P. N. D.
Redgrove, E. R.
Richards, G. A.
Robathan, T.
Roger, A.
Sams, C. E. R.
Scott, L. D.
Scott, T. R.
Smallwood, W.
Smith, T. A.
Southwell, C. A. P.
Spielmann, P.
Taitt, G. S.
Taylor, J. F. M.
Thomas, H. C. H.
Tullett, G. V.
Tweed, R. R.
Underwood, A. J. V.
Walsh, D. M.
Walter, G.
Watson, A.
Webb, J. F. N.
Wigney, W. J.
Wilson, W. J.
Wray, A. T.
Young, R. H.
Staff of Shell Centra Laboratories.

ANNUAL GENERAL MEETING.

THURSDAY, 25TH NOVEMBER, 1943.

THE THIRTIETH ANNUAL GENERAL MEETING of the Institute was held at the Royal Society of Arts, John Adam Street, W.C. 2, on Thursday, 25th November, 1943, when Mr. C. DALLEY, PRESIDENT, occupied the Chair.

The SECRETARY (Mr. F. H. Coe) read the notice convening the meeting.

The Minutes of the Twenty-ninth Annual General Meeting, held on 29th May, 1942, were read, confirmed and signed.

ANNUAL ACCOUNTS.

The CHAIRMAN explained that the principal reason for the Annual Meeting being held in November instead of in May, when it was usually held, was that the Auditors were so short of staff that, although they had been asked to come in to audit the accounts last February, they had not been able to do so until June, and it was only by putting constant pressure upon them that they had produced the audited accounts in time for the present meeting. In effect, part of the Annual Meeting had been held earlier in the year, when the Vice-Presidents had been elected and, there being no nominations for members of Council, the Council had remained as before. Another reason for the delay in holding the present meeting was that the Institute's staff was new to the work, and the fact that the previous Secretary left at rather short notice had intensified the difficulty. The Auditors and the present staff of the Institute had now simplified the accounts so that those for the current year would almost certainly be audited and produced at the normal time.

Another war-time difficulty was that of printing the Report and Accounts, and as the printed copies were not yet available he would ask the Secretary to read the Report and Accounts, with the Auditors' report.

The SECRETARY then read the Report and Accounts, with the report of the Auditors.

The CHAIRMAN then moved the following resolution :—

> " That the Annual Report of the Council for the year 1942, together with the Accounts and Balance Sheet as at 31st December, 1942, be and are hereby adopted."

Mr. ASHLEY CARTER (Vice-Chairman, Finance Committee), in seconding the resolution, said that the Institute was continuing to make very healthy progress.

The resolution was carried unanimously.

ELECTION OF AUDITORS.

Mr. R. R. TWEED proposed that Messrs. Price, Waterhouse & Company be re-elected Auditors for the ensuing year.

The resolution was seconded by Mr. W. H. HUXLEY and carried unanimously.

NEW MEMBERS.

On the motion of the CHAIRMAN, it was agreed that the list of Fellows, Members, Associate Members and Students elected and transferred during 1942 should be laid on the table.

The SECRETARY read the names of Fellows, Members and Associate Members elected and transferred since the last General Meeting.

INSTITUTE ACTIVITIES.

The CHAIRMAN said that, as the meeting was being held so late in the year, he might refer to one or two of the matters which had arisen during the present year.

He would like to remind the members that, as they would have seen by the publications and the issue of *Standard Methods*, both the Publications Committee and the Standardization Committee had been very busy during the year.

Under the able chairmanship of Mr. T. Dewhurst, the revision of the By-laws, which was a long business and required great care, had been proceeding satisfactorily. That brought him to the question of the Branches, which was a subject to which the Council had recently been devoting a considerable amount of attention. A proceeding of which full advantage had not been taken in the past was the holding of joint meetings with other Institutions, which he himself and many others considered a very desirable thing to do. That should be extended to the Branches of the Institutions concerned, and it was therefore desirable that the Branches of the Institute should be on similar lines to the Branches of kindred Institutions, so that no difficulties would arise. The Council would shortly submit proposals to that effect, taking advantage of the experience gained by the older Institutions. The proposals would deal, amongst other things, with the subject of finance, to ensure that, when Branches drew money from the parent body, the parent body would have full control of the expenditure of the money.

Another subject to which he wished to refer was the housing of the Institute. The older members would recollect that the meetings had first been held in the offices of the late President, *i.e.*, in the offices of Messrs. Redwood & Eastlake. They had then been transferred to John Street, Adelphi, and after that the Institute had stepped to a great height and had its offices under the rafters of Aldine House for some years. Then it had been translated to the great Adelphi Building, and when it had had to leave there it had been lodged in Birmingham University, through the kindly offices of the authorities there. Its return to London had been, he thought, a very wise step, and it had been kindly given accommodation by the Imperial College of Science. Recently some quarters had been found which he hoped and trusted would prove satisfactory to the members for some time to come. The Institute would be the tenants of the Royal Society of Tropical Medicine and Hygiene at 26, Portland Place, and he thought the members would be very pleased with their premises at that address. The Council room was 32 feet by 23 feet and the Institute would, in addition, occupy the whole of the second floor. At the back of the premises, in the basement, there was a modern lecture theatre, which was

opened by the Duke of Windsor when he was Prince of Wales and which would accommodate 250 people. It had lobbies and rooms where light refreshments would be served, and it would be very convenient to hold the Council meetings upstairs and then go down to the basement for the general meetings. The Council had secured the premises for a period of five years at a very moderate rent. He did not think that the outgoings in the way of rent, rates if they had to be paid, and all the incidentals, would much exceed £500 a year, and he thought that when the members had an opportunity of examining the premises they would feel that the Council had done at least one good deed for them that year. It had not been possible to obtain a lease for longer than five years, owing to L.C.C. regulations, but he thought that the Institute would be able to occupy the premises for as long as it wished to do so. He was glad that, after all its sojournings, the Institute had at last got a home which was worthy of it. It would move into its new premises on the 30th November and he hoped it would be possible to have some kind of opening ceremony.

Mr. T. Dewhurst proposed a vote of thanks to the Chairman for the excellent account he had given of the activities of the Institute, which he thought were very satisfactory.

The resolution was seconded by Mr. W. H. Huxley and was carried unanimously.

The meeting then terminated.

JOURNAL OF THE INSTITUTE OF PETROLEUM

ABSTRACTS

VOLUME THIRTY

1944

Published by
THE INSTITUTE OF PETROLEUM
MANSON HOUSE,
26, PORTLAND PLACE,
LONDON, W. 1.

ABSTRACTORS.

D. Alexander, B.Sc.
K. T. Arter, B.Sc., A.M.I.A.E., M.Inst.Pet.
L. Aston, A.M.Inst.Pet.
C. J. Bassett, M.A.
J. Cantor, B.Sc., A.R.I.C., M. Inst.Pet.
S. E. Coomber, B.Sc., A.M.Inst.Pet.
W. H. Crouch.
R. A. Eldridge, F.Inst.Pet.
J. Firminger.
H. Gardner, B.Sc., A.R.I.C.
C. L. Gilbert, B.Sc., A.R.C.S., F.Inst.Pet.
C. G. Gray, B.Sc., A.H.W.C., F.R.I.C.
G. D. Hobson, Ph.D., A.M.Inst.Pet.
J. W. Hyde, B.Sc., A.M.Inst.Pet.
A. Lamont, Ph.D.
A. T. Langton.
C. F. McCue, B.Sc.
H. B. Milner, M.A., D.I.C., F.G.S., F.Inst.Pet.
A. H. Nissan, Ph.D., M.Inst.Pet.
C. H. Sprake, F.Inst.Pet.
T. C. G. Thorpe.
W. H. Walbridge.
E. H. Wild, B.Sc., A.R.I.C., A.M.Inst.Pet.
H. G. Williams, Ph.D., M.Sc., A.R.I.C.
J. G. Withers, A.M.Inst.Pet.

ABBREVIATED TITLES USED IN THE ABSTRACTS

Abbreviated Title.	*Journal.*
Aircr. Engng	Aircraft Engineering.
Ann. Min. Belg.	Annales des Mines de Belgique.
Ann. Min. Roumanie	Annales des Mines de Roumanie.
Ann. Off. Combust. liq.	Annales de l'Office National des Combustibles Liquides.
Asph. u. Teer	Asphalt und Teer.
Auto. Engr	Automobile Engineer.
Auto. Tech. Z. (Berlin)	Automobiltechnische Zeitschrift (Berlin).
Azerb. neft. Khoz.	Azerbaidzhanskoe Neftyanoe Khozyaistvo.
Beitr. angew. Geophys.	Beitrage angewandte Geophysik.
Beitr. Geophys.	Beitrage zur Geophysik.
Bitumen	Bitumen.
Bol. Geol. y Min. (Caracas)	Boletin de Geologia y Mineria (Caracas).
Bol. Inform. Petroleras (B.A.)	Boletin de Informaciones Petroleras (Buenos Aires).
Boll. Soc. geol. ital.	Bolletin de la Societa Geologica Italiana.
Bull. Acad. Sci. (U.S.S.R. Inst. Seismol.)	Bulletin of the Academy of Sciences (U.S.S.R. Institute of Seismology).
Bull. Amer. Ass. Petrol. Geol.	Bulletin of the American Association of Petroleum Geologists.
Bull. Amer. geol. Soc.	Bulletin of the American Geological Society.
Bull. Ass. franç. Tech. Pétrol.	Bulletin de l'Association Français des Techniciens du Pétrole.
Bull. Inst. Min. (metall.) Engrs	Bulletin of the American Institute of Mining and Metallurgical Engineers.
Bull. Math. Phys. Éc. polyt. Bucharest	Bulletin de Mathematique et de Physique, Bucharest (École-polytechnique).
Bull. roum. geol. Soc.	Bulletin of the Roumanian Geological Society.
Bull. seismol. Soc. Amer.	Bulletin of the Seismological Society of America.
Bull. Univ. Texas (Bur. econ. Geol. Techn.)	Bulletin of the University of Texas (Bureau of Economic Geology and Technology).
Bur. Stand. J. Res., Wash.	United States Bureau of Standards Journal of Research, Washington.
Calif. Oil World	California Oil World.
Canad. J. Res.	Canadian Journal of Research.
Canad. Min. J.	Canadian Mining Journal.
Canad. Min. metall. Bull.	Bulletin of the Canadian Institute of Mining and Metallurgy.
Chem. & Ind.	Chemistry and Industry.
Chem. Rev.	Chemical Reviews.
Chem. Tr. J.	Chemical Trade Journal.
Chem. Wkbld	Chemische Weekblad.
Chim. e Industria	La Chimica e l'Industria.
Chim. et Ind.	Chimie et Industrie.
C.R. Acad. Sci. (Paris)	Comptes Rendus hebdomadaires des Seances de l'Academie des Sciences (Paris).
C.R. Geol. Pétr. (Strasbourg)	Compte-Rendu des Seances du Groupe des Geologues Pétroliers de Strasbourg.
IIme Congrès Mond. Pétrole	IIme Congrès Mondial du Pétrole (Paris, 1937).
Diesel Eng. Us. Ass.	Diesel Engine Users Association.
Direccion Minas y Geol.	Publication of Direccion Minas y Geologicas (Argentine).
Econ. Geol.	Economic Geology.
Engineer	Engineer.
Engineering	Engineering.
E.P.	English Patent.
Fuel	Fuel in Science and Practice.
Gas Oil Pwr	Gas and Oil Power.
Geol. Mag. (Lond.)	Geological Magazine (London).
Geophys.	Geophysics.
Glückauf	Glückauf.
Groz. Neft.	Groznenskii Neftyanik.

Abbreviated Title.	*Journal.*
Industr. Engng Chem.	Industrial and Engineering Chemistry.
Industr. Engng Chem. Anal.	Industrial and Engineering Chemistry, Analytical Edition.
Industr. Pwr & Fuel Econ.	Industrial Power and The Fuel Economist.
Instruments	Instruments.
J. Amer. chem. Soc.	Journal of the American Chemical Society.
J. appl. Chem. (U.S.S.R.)	Journal of Applied Chemistry, U.S.S.R.
J. appl. Phys.	Journal of Applied Physics.
J. chem., metall. min. Soc. S. Africa	Journal of the Chemical, Metallurgical and Mining Society of South Africa.
J. chem. Soc.	Journal of the Chemical Society.
J. Fuel Soc. Japan	Journal of the Fuel Society of Japan.
J. Geol.	Journal of Geology.
J. Inst. Fuel	Journal of the Institute of Fuel.
J. Instn auto. Engrs	Journal of the Institution of Automobile Engineers.
J. Inst. Petrol.	Journal of the Institute of Petroleum.
J. org. Chem.	Journal of Organic Chemistry.
J. phys. Chem.	Journal of Physical Chemistry.
J. R. aero. Soc.	Journal of the Royal Aeronautical Society.
J. Soc. aut. Engrs	Journal of the Society of Automotive Engineers.
J. Soc. chem. Ind.	Journal of the Society of Chemical Industry.
Khim. Tverd. Topliva	Khimiya Tverdovo Topliva.
Kop. Naft. Polsce	Kopalnictwo Naftowe w Polsce.
Matières grasses	Matières Grasses.
Min. & Metall.	Mining and Metallurgy.
Min. Mag. (Lond.)	Mining Magazine (London).
Monit. Pétr. roum.	Moniteur du Pétrole Roumain.
Montan. Rdsch.	Montanistische Rundschau.
Nat. Petrol. News	National Petroleum News.
Nature	Nature.
Neft. Khoz.	Neftyanoe Khozyaistvo.
Nickel Ind.	Nickel Industry.
Nov. Neft.	Novosti Neftepererabotki.
Nov. Tekhn. Bur.	Novosti Tekhniki Bureniya.
Nov. Tekhn. Neft.	Novosti Tekhniki Neftedobvicki.
Oel u. Kohle	Oel und Kohle vereinigt mit Erdoel und Teer.
Oil Gas J.	Oil and Gas Journal.
Oil Wkly	Oil Weekly.
Ole, Fette, Wachse	Ole, Fette, Wachse, Seife, Kosmetik.
Olii min.	Olii Minerali.
Paint Mnfr.	Paint Manufacture.
Paint Technol.	Paint Technology.
Petroleum	Petroleum.
Petrol. Engr	Petroleum Engineer.
Petrol. Press Service	Petroleum Press Service.
Petrol. Tech. (A.I.M.M.E.)	Petroleum Technology (American Institute of Mining and Metallurgical Engineers).
Petrol. Times	Petroleum Times.
Petrol. World	Petroleum World.
Physics	Physics.
Pipe Line News	Pipe Line News.
Proc. Amer. Petrol. Inst.	Proceedings of the American Petroleum Institute.
Proc. Amer. Soc. Test. Mater.	Proceedings of the American Society for Testing Materials.
Proc. Ass. Asph. Pav. Technol.	Proceedings of the Association of Asphalt Paving Technologists.
Proc. Instn mech. Engrs	Proceedings of the Institution of Mechanical Engineers.
Proc. phys. Soc. (Lond.)	Proceedings of the Physical Society (London).
Proc. roy. Soc.	Proceedings of the Royal Society.
Przeg. Chem.	Przeglad Chemiczny.
Przem. Naft.	Przemysl Naftowy.
Quart. J. geol. Soc. Lond.	Quarterly Journal of the Geological Society of London.
Rds & Rd Constr.	Roads and Road Construction.
Rec .Trav. chim. Pays-Bas	Receuil des Travaux Chimiques des Pays-Bas.

Abbreviated Title.	*Journal.*
Refiner	Refiner and Natural Gasoline Manufacturer.
Rev. Comb. liq.	Revue des Combustibles Liquides.
Rev. sci. Instrum.	Review of Scientific Instruments.
Riv. ital. Petrol.	La Rivista Italiana del Petroleo.
S. Afr. Min. (Engng) J.	South African Mining and Engineering Journal.
Strade	Strade.
Sulz. tech. Rev.	Sulzer Technical Review.
Summ. Ops, Calif. Oil Flds	Summary of Operations, Californian Oil Fields.
Tech. Phys. U.S.S.R.	Technical Physics of the U.S.S.R.
Tekn. Tidskr.	Teknisk Tidskrift.
Terr. Magn.	Terrestrial Magnetism.
Trans. Amer. geophys. Un.	Transactions of the American Geophysical Union.
Trans. Amer. Inst. Min. & Metall.	Transactions of the American Institute of Mining and Metallurgy.
Trans. Faraday Soc.	Transactions of the Faraday Society.
Trans. Inst. mar. Engrs	Transactions of the Institute of Marine Engineers.
Trans. Instn min. Engrs	Transactions of the Institution of Mining Engineers.
U.S. Bur. Mines, Inf. Circ.	United States Bureau of Mines, Information Circular.
U.S. Bur. Mines, Rep. Invest.	United States Bureau of Mines, Report of Investigations.
U.S. Bur. Mines, Tech. Paper	United States Bureau of Mines, Technical Paper.
U.S. Geol. Surv. Bull.	United States Geological Survey Bulletin.
U.S.P.	United States Patent.
World Petrol.	World Petroleum.
Z. dtsch. geol. Ges.	Zeitschrift der Deutschen Geologischen Gesellschaft.
Z. Geophys.	Zeitschrift für Geophysik.
Z. prakt. Geol.	Zeitschrift zur Praktische Geologie.
Z. ver. dtsch. Chem.	Zeitschrift Vereins deutscher Chemiker.

(Certain periodicals listed above have not been available during 1944).

ABSTRACTS.

AUTHOR INDEX.

The numbers refer to the Abstract Number.

The original papers referred to in the abstracts marked with an asterisk may be borrowed by Members from the Institute Library.

Geology and Development.

1. Greeley Oil-Field. F. H. Updike. *Calif. Oil Fields*, 1941, **27**, 5.—There were, up to the time of this report, two productive horizons in the Greeley oil-field situated 6½ miles due west of Bakersfield, Kern County, California. The Stevens Zone (Santa Margarita-Miocene) occurs at approximately 7500 ft., and the Rio Bravo–Vedder zone (Vaqueros-Miocene) at 11,250 ft. Prospect well No. "KCL Lease" 11 was drilled in the Stevens Zone in 1936 by the Standard Oil Company of California, and had an initial production of 2456 brl./day of 36·3° gravity oil cutting 0·9% water.

Subsequently, drilling was continued and 25 wells were completed, 5 of which were failures. During 1937–38 the same company deepened well No. " KCL Lease " 11 to the Vedder horizon at 11,410 ft., and obtained an initial production of 14,022 brl./day of 35·2° gravity oil with a water cut of 0·2%. There was no further development of the Vedder Zone until November 1939, when the General Petroleum Corporation of California completed well No. " Sullivan " 1 with an initial production of 2578 brl./day of 39·3° gravity oil with 2,641,000 cu. ft. of gas.

Producing sands in the Stevens Zone are interbedded with greyish-brown shale, and are ill-defined because of rapid horizontal and vertical variations. They have an average thickness of about 175 ft.

In the second productive horizon, Rio Bravo sand overlies the Vedder with some 50 ft. between the two. Average thickness of Rio Bravo sand is approximately 25 ft., while that of the Vedder is 75 ft.

Total proved area in this field, including wells in both the Stevens and the Vedder Zones, was 1820 acres on 1st July, 1942.

Total production obtained to that date was : 3,008,963 brl. from the Stevens Zone and 4,749,820 brl. from Rio Bravo–Vedder Zone—*i.e.*, 7,758,783 brl. in all.

H. B. M.

2. Rio Bravo Oil-Field. F. E. Kasline. *Calif. Oil Fields*, 1941, **27**, 9.—This field is approximately 15 miles north-west of Bakersfield, Kern County, California, and adjacent to the Greeley oil-field in the south-east. In 1937, Union Oil Company of California drilled well No. " Kernco " 1–34, in an attempt to extend the productive zone (Stevens sand) found in the Greeley oil-field, and also to reach the Vedder sand, which was expected at about 11,250 ft. In November of that year an initial production of 2400 brl./day was obtained. After 30 days, production was recorded as 2588 brl./day of 38° A.P.I. gravity oil and 4,306,000 cu. ft. of gas. In point of fact, the well established the first commercial production of oil in California from a depth below 11,000 ft. Well No. " Kernco " 2–34 was started in December 1937, and an initial production of about 2500 brl. of oil/day was obtained between 11,205 and 11,465 ft. Before its completion, 18 wells, in addition to the discovery well, were drilled. The highest well in the field, structurally, encountered the Rio Bravo sand at 11,090 ft. The lowest well struck the top of the producing sand at 11,529 ft. and was finished at 11,550 ft. Two deep test-wells were drilled in the field, one in 1938, to a total depth of 14,018 ft. without finding any commercial production, and the other in 1941, to 13,642 ft. with an initial production from the interval 11,480–11,505 ft. of about 400 brl./day of 38·9° gravity oil. H. B. M.

3. Rincon Oil-Field. W. C. Bailey. *Calif. Oil Fields*, 1941, **27**, 13.—The Rincon oil-field includes approximately 850 acres of proved land, and lies in the north-west part of Ventura County, California. It consists of three distinct areas, known as San Miguelito, Padre Juan Canyon, and Rincon. The San Miguelito area is not described in this paper, as structurally it is more similar to the Ventura oil-field than to any other areas in the Rincon field.

There are three oil-zones in the Rincon area. The top zone occurs between 400 and 500 ft. above the Miley Shale, which extends over the entire field and varies in thickness from 50 ft. at the western end to about 150 ft. at the eastern end. This zone is in some places less than 50 ft. thick, and its maximum thickness is approximately 100 ft. The intermediate zone lies immediately above the Miley Shale and is between 100 and 400 ft. thick. The Miley Zone lies immediately below the Miley Shale and is approximately 800 ft. thick. Producing zones of the Padre Juan Canyon area are the same, except that some production is found about 500 ft. higher in the section than the uppermost production in the Rincon area.

Up to the time of this report, 150 wells, including those drilled in the San Miguelito area, but exclusive of validation holes, have been drilled in the Rincon field. Of these 28 were abandoned and 122 were potential producers.

Total production from the field, including the San Miguelito area, to June 1942, was 22,744,115 brl. Average daily production per well for the six months period ending 30th June, 1942, was 79·9 brl. of oil and 17·9 brl. of water. The average gas–oil ratio for the same period was 1220 cu. ft. of gas/brl. of oil. Average gravity of the oil is 32°.

The conclusion is reached that the Rincon and Padre Juan areas of the field offer little promise of new reserves by future drilling, unless new wells develop production between these two areas, or unless the deep test well being drilled by Chanslor–Canfield Midway Oil Company finds production in the Miocene. H. B. M.

4.* Some Factors Influencing the Declining Rate of Crude Oil Discoveries. L. F. McCollum. *Petrol. Engr*, Reference Number, **14** (10), 32. See Abstract No. 622 (1943). G. D. H.

5.* Discovery Thinking. A. I. Levorsen. *Bull. Amer. Assoc. Petrol. Geol.*, July 1943, **27** (7), 887. See Abstract No. 620 (1943). G. D. H.

6.* Maintaining an Adequate Level of Geophysical Prospecting. F. Goldstone. *Bull. Amer. Assoc. Petrol. Geol.*, July 1943, **27** (7), 948. See Abstract No. 623 (1943). G. D. H.

7.* Some Factors Influencing Declining Rate of Crude Oil Discoveries—the Geologist's Responsibility in the Present Situation. L. F. McCollum. *Bull. Amer. Assoc. Petrol. Geol.*, July 1943, **27** (7), 960. See Abstract No. 622 (1943). G. D. H.

8.* Factors Influencing Decline in Oil Discovery Rates. L. F. McCollum. *Oil Wkly*, 28.6.43, **110** (4), 18. See Abstract No. 622 (1943). G. D. H.

9.* Oil Zones of the United States : Eocene. Anon. *Oil Gas J.*, 30.9.43, **42** (21), 56-B.—While the Wilcox group, and particularly the Carrizo formation at the top, was known to bear oil, it was only in 1939 that good Wilcox production was obtained. Following the discovery of Wilcox production at Eola, Louisiana, in 1939, and at Ville Platte in 1940, a number of Wilcox discoveries were made in North-east Louisiana, starting a pay running from the Mississippi to La Salle County in South-west Texas. Numerous discoveries along this trend have shown that the whole Wilcox sand section may contain productive members. In the Claiborne group, the Queen City and Weches members of the Mount Selman give a little oil in East Texas, but the main production is from the Cockfield along the Gulf Coast. The Sparta is productive in Louisiana.

The Jackson is most important in South-west Texas, where seven distinct producing zones are found. It decreases in importance to the north.

In the Rocky Mountain area the only Eocene production comes from sand-lenses in the Wasatch at Hiawatha, Colorado, and LaBarge, Wyoming. Eocene production has been obtained in California at North-east Coalinga and Coalinganose, at Kettleman Hills, at Simi, and at Bardsdale.

New Eocene production may be expected along the Wilcox trend in coastal Texas and Louisiana. There oil may be found down-dip in distillate pools. Wilcox production has not been found east of the Mississippi. The likelihood of further development in the Claiborne and Jackson groups seems small in the coastal area.

The margins of the Uinta and Green River basins may be expected to produce additional Wasatch oil.

The great depth of the Eocene in the San Joaquin Valley has prevented its exploration over much of the area, but it is highly productive in a shore-line phase at Coalinga. It pinches out on the east side at Fruitvale. Oil may possibly be found in the Eocene of the coastal valleys of the Oregon and Washington.

A map shows the distribution of the Eocene outcrops, its approximate depth where buried, and the favourable areas. G. D. H.

10.* Completions Increase in August. Anon. *Oil Gas J.*, 30.9.43, **42** (21), 81.—1610 wells were completed in U.S.A. in August, 58 more than in July, but the 827 oil-wells were 29 fewer than the number completed in July, and 82 more than the oil-well completions in August 1942. Drilling activity was greater than a year ago, the increase being spread over the Appalachian area, Ohio, Kentucky, Oklahoma, and California. The various areas of Texas showed less activity than a year ago.

A table provides a summary of operations in August 1943 by States, with comparative totals for July 1943 and August 1942. G. D. H.

11.* Wildcats and Discoveries. Anon. *Oil Gas J.*, 30.9.43, **42** (21), 91.—In the week ended 25th September, 76 wildcats were completed in U.S.A., 14 finding oil, 1 finding distillate, and 2 finding gas. Two of the discoveries were east of the Mississippi.

A fair McClosky discovery well was completed in Richland County, Illinois, some 3 ml. north-east of Maplegrove. Near Clay in Webster County, Kentucky, the Palestine sand of Upper Chester age was found to be productive. The new Beeching pool of Ellis County, Kansas, may open a fairly large area. Two wells south-west of the Morel pool in Graham County, Kansas, found Arbuckle production, which may eventually connect with the Morel pool.

A pumping wildcat was completed near Meeker, Lincoln County, Oklahoma. Two new Marble Falls pools were opened in North Texas, and an Ellenburger pool in Wilbarger County. In the Permian Basin, the Clear Fork was found to be productive in the Keystone area. Two discoveries were made in south-western Louisiana, one being a distillate well 6 ml. south-east of the Bancroft field, and probably in the Cockfield, while the other was at Big Lake Cameron Parish, where a 13,084-ft. test was plugged back to 8591 ft. to make a producer.

Two gas-fields were found in Madera and Sacramento Counties, California, and there were two new oil-pools.

The results of wildcatting in the week ended 25th September are tabulated by States and districts, with cumulative totals for 1943. G. D. H.

12.* Crude Output Reached High Mark in July. Anon. *Oil Wkly*, 4.10.43, **111** (5), 46.—In July the U.S. oil output was 4,113,000 brl./day, the highest rate attained this year, and 136,000 brl./day above the June figure. Texas produced 1,626,000 brl./day, 127,000 brl./day more than in June. The Texas Gulf Coast produced 535,000 brl./day, 35% more than in January. In July the West Texas production rose by 47,000 brl./day, and that of East Texas by 35,000 brl./day.

856 wells were completed in July, 60 more than in June, and 23 more than in July 1942.

Total stocks of crude at the end of July were 238,346,000 brl., compared with 240,601,000 brl. at the end of June. In July an average of 3,893,000 brl./day of crude was run to stills. The gasoline yield was 36·7% and the yield of residual oil 30·3%.

7,487,000 brl. of natural gasoline was produced in July. G. D. H.

13.* Peace River Gas Output Estimated 35 Million Feet. Anon. *Oil Wkly*, 4.10.43, **111** (5), 53.—Gas-wells in the Peace River district near Pouce Coupe are reported to be capable of a flow of 35,000,000 cu. ft./day. East of Rolla, British Columbia, a well has flowed 5,000,000 cu. ft. of gas/day from 2168 ft. The old Guardian well flow is calculated at 20,000,000 cu. ft./day, and that of the Imperial well at 10,000,000 cu. ft./day.

14.* Independent Company Starts Tests in Taber Area. Anon. *Oil Wkly*, 4.10.43, **111** (5), 53.—Two wells are to be drilled in the Taber area of Southern Alberta. G. D. H.

15.* Vermilion Field in Western Canada Gains in Output. Anon. *Oil Wkly*, 4.10.43, **111** (5), 53.—More than 30 wells are now producing in the Vermilion field, and there may be 50 producers by the end of the year. All the wells are shallow pumpers. There may be production in the Devonian below 2500 ft.

42,000 brl. of crude have been shipped from the field this year, and there may be a rise to 15,000 brl./month. G. D. H.

16.* Alberta Oil Output Drops in Six Months. Anon. *Oil Wkly*, 4.10.43, **111** (5), 53.—In the first half of 1943 Alberta produced 4,867,491 brl. of oil, compared with 5,144,482 brl. in the same period of 1942. G. D. H.

17.* View Western Canada as Vast Oil Reserve. Anon. *Oil Wkly*, 4.10.43, **111** (5), 54.—Geologically and geographically Alberta offers the best production possibilities in Canada. The opening of the Alaska Highway has increased the incentive for developing Alberta's oil. The foothills belt contains formations which produce oil

in the Rocky Mountain and Mid-Continent areas of U.S.A., and in which oil indications have been found at shallow depths in widely scattered wells. G. D. H.

18.* Working Over Old Well in Vermilion Area. Anon. *Oil Wkly*, 4.10.43, **111** (5), 54.—12 ml. north of the producing area at Vermilion, the well, Vermilion Consolidated 3, is being reconditioned. This five-year-old well was one of the best until it developed water trouble. G. D. H.

19.* Production in Peru on Increase This Year. Anon. *Oil Wkly*, 4.10.43, **111** (5), 54.—In the first half of 1943 the Peruvian oil production is estimated to have been 7,816,160 brl. The 1942 output was 14,632,530 brl., 173,219 brl. more than in 1941. The 1942 figure included 1,003,972 brl. of natural gasoline.

Two wells are being drilled in the Pirin region, and preliminary geological work is being carried out in adjacent areas. G. D. H.

20.* Wildcats and Discoveries. Anon. *Oil Gas J.*, 7.10.43, **42** (22), 115.—In the week ended 9th October four of the five oil discoveries were in the McClosky in Illinois. Three of the Illinois finds were well separated from older production, and may represent considerable additions to reserves. A pumper was completed in North-east Clay County, 6 ml. from the nearest production at Noble. In Jefferson County, McClosky discoveries were made 1½ ml. west of Coil, and between Coil and Bluford. A 500-brl. McClosky well, south of the Bungay pool, Hamilton County, may prove to be an extension.

The fifth discovery well was in the Waltersburg sand near Uniontown, Union County, Kentucky.

The most important gas discovery was in Garvin County, Oklahoma, 6 ml. from Pauls Valley along the same trend, two dry wells intervening. A Clinton sand gas-well was completed in Hocking County, Ohio, and a small gas-well 1¼ ml. south-east of the Lockhart field, Starr County, Texas.

A table summarizes by States and districts the wildcat completions in the week ended 2nd October, 1943. G. D. H.

21.* Skyrocketing War Needs Presage Early U.S. Oil Shortage. W. L. Baker. *Oil Wkly*, 11.10.43, **111** (6), 18.—Heavy industrial and military oil demands have caused consumption to exceed production in U.S.A., although there have been sharp rises in production. Hence crude and product stocks have been seriously reduced. A consumption of 5,000,000 brl./day is predicted for the first quarter of 1944, compared with 4,500,000 brl./day in the third quarter of 1943. All districts in U.S.A. except West Texas are now thought to be producing at their maximum efficient rate. West Texas is estimated to have 250,000 brl./day of unused productive capacity.

In September the daily average production was 4,337,000 brl., 120,000 brl./day more than in August, and 200,000 brl./day above the pre-war record level. P.A.W. certifications for October amount to 4,638,700 brl./day, including 4,373,000 brl. of crude.

1,097,661,000 brl. of oil was produced in the first nine months of 1943, 69,000,000 brl. more than in the same period of 1942.

Since the end of May crude oil stocks have declined 12,000,000 brl., and they now stand at 233,000,000 brl., about the 1939 level.

Despite domestic rationing, the motor-fuel demand in September is estimated to have been 5% higher than in September 1942. The production of gas–oil and distillate-fuel has risen to an all-time peak.

Most of the recent crude-oil production increase has been due to gains in Texas, where the output has been boosted from the curtailed low points of 1942 with the completion of pipe-lines. In September Texas gave 1,829,000 brl./day, 330,000 brl./day more than in June, and nearly 750,000 brl./day more than in April 1942. In the first nine months of 1943 Texas gave 416,434,000 brl. of oil, 17·1% more than in the corresponding period of 1942.

At present the Californian production is about 780,000 brl./day, 143,000 brl./day more than in April 1942. In September, Louisiana gave 359,000 brl./day, 36,100 brl./day more than in January. Oklahoma, Illinois, and Kansas are giving less oil

now than in January, the declines being 14,000 brl./day, 20,000 brl./day, and 9000 brl./day, respectively.

Tables and graphs give data on production, stocks, etc. G. D. H.

22.* Crude Output Rises to 4,402,730 Barrel. Anon. *Oil Wkly*, 11.10.43, **111** (6), 52.—In the week ending 9th October the U.S. oil output averaged 4,402,730 brl./day, 66,445 brl./day more than the average for the previous week. G. D. H.

23.* September Completion Rate Slumps With Most Districts Declining to New Lows. Anon. *Oil Wkly*, 11.10.43, **111** (6), 53.—In September completions averaged 367 per week, compared with 397 per week in August. It appears that the 1943 total of completions will be several hundred below the 19,000 estimated earlier. Labour shortage and low oil prices are among the factors keeping the drilling rate low.

In the first nine months of 1943, 13,772 wells were completed in U.S.A., 3707 fewer than in the same period of 1942. Most areas show declines this year, but California, some districts of Texas, Colorado, Kentucky, and Montana have shown rises.

A recent change in the spacing regulations in South-west Michigan may lead to a slight drilling increase.

A table shows by States and districts details of the completions in September and the first nine months of 1943, with comparative totals for other months. G. D. H.

24.* Oil-Zones in the United States : Oligocene. Anon. *Oil Gas J.*, 14.10.43, **42** (23), 52-B.—Oligocene production is obtained in a number of sands in the Gulf Coast area, and also in some sectors of the coastal district of California. The Oligocene of the Gulf Coast region is generally non-marine at its outcrop, but the Vicksburg, the lowest member of the Oligocene, shows marine marls in the east, and becomes progressively more sandy towards the west, where it provides a number of important oil-pays in the Lower Gulf Coast and South Texas districts. In the same area the overlying Frio has important oil-zones, and the Frio production extends to the coast. In the Upper Oligocene the Marginula, Heterostegina, and Discorbis (some place the Discorbis in the Lower Miocene) provide pays of variable importance, and the pools are rather scattered.

The Sespe, of Oligocene age, produces in the Ventura–Newhall and Santa Barbara districts, forming the lowest pays at Capitan and Elwood, as well as the principal pay in several fields in Eastern Ventura County. The Oligocene has not generally been reached in fields in this area, so that it is a potential reservoir over the whole of the coastal district. In the Los Angeles Basin the Sespe has been barren or missing in some fields, but there is the possibility of wedge-edge production on the flanks of schist highs.

In the Gulf Coast region productive wedge edges may be found at almost any depth in the Oligocene until the section has become completely shaly.

In California the Oligocene seems to have good prospects for oil production only in the embayments and basins of the coastal district. There are thick marine sections in similar embayments in Oregon and Washington.

A map shows the Oligocene outcrops and the areas which are favourable for Oligocene oil-production. G. D. H.

25.* Wildcats and Discoveries. Anon. *Oil Gas J.*, 14.10.43, **42** (23), 107.—In the week ended 9th October three discoveries were made on the Sweetgrass Arch, Montana, all of them in the Sunburst sand. Oil-wells opened the Brady and Midway pools in the Pondera district, while a gas-well was completed south-west of the Kevin–Sunburst field. Three discoveries were also made in South-west Texas. A Loma Novia sand well was completed on the trend running south from Duval through Jim Hogg County ; a Wilcox well was opened in Live Oak County, 1½ ml. from the Goebel field, with which it may merge. The third find was ½ ml. east of the recent gas discovery at Blanconia, Bee County.

East of East Texas an important Pettit lime discovery was made in Rusk County. A new gas-producing area has been opened on the south-west flank of the Sabine uplift. A small well in Throckmorton County, North Texas, has revealed a new Caddo lime area.

Illinois and Indiana had one McClosky lime producer each, while a gas-sand was discovered in the West Raisin City field of California. Near Kansas City a small gas-pool was opened, and a small Wilcox well was completed in Pottawatomie County, Oklahoma, west of Wanette.

A table gives the results of wildcatting completions by States for the week ended 9th October 1943. G. D. H.

26.* September Wildcatting Results Fall Short of Expectations. D. L. Carroll. *Oil Wkly*, 18.10.43, **111** (7), 13.—Up to the end of September, 201 new oil-fields had been found in U.S.A. in 1943, 9·5% fewer than in the same period of 1942. There was a decline of 27·3% in the new oil-pay discoveries, an increase of 16·7% in the new distillate fields, an increase of 36·7% in the gas-field discoveries, and an increase of 25% in new gas-pay discoveries. 363 wildcat wells, exclusive of extensions and semi-wildcats, have proved successful in the first nine months of 1943, compared with 402 in the same period last year.

In September, 26 oil-fields, seven new oil-pays, 11 oil-field extensions, two distillate fields, one distillate extension, six gas-fields, two gas-pays and one gas extension were found among 275 wildcat completions. In August there were 61 successes among 384 wildcat completions.

Illinois had 15 successes out of 54 wildcat completions in September. Texas had 11 oil-fields, two new oil-pays, one oil-field extension, one distillate field, three gas-fields, two new gas-pays and one gas-field extension among its 21 discoveries. California had two new oil-fields, two oil-field extensions and one gas-field, while Kansas had two oil-fields, one oil-field extension and one gas-field.

The best discovery well was at South-east Moxel, Graham County, Kansas, where the Arbuckle, topped at 3764 ft., gave 1904 brl./day initially. In Young County, North Texas, a 1128-brl. well was completed in a shallow, thin Pennsylvanian pay. At Cameron in Starr County, South-east Texas, a 225-brl. well was completed at 4140–4150 ft. in the Frio. The five new Illinois pools were in the McClosky at depths not exceeding 3303 ft., with initial outputs of 155–517 brl./day.

The Willamar field of the Lower Texas Gulf Coast was extended 1 ml. to the north by a well which found 75 ft. of pay in the Frio above 7925 ft. This extension is believed to add 6,000,000 brl. to the reserves. 200 acres of production may have been added to the Pauls Valley field in Oklahoma by a Bromide well. A new small field has been opened near the Paloma field, California. A new pay has been opened in the Cook Mountain (Eocene) at 5811–5819 ft. on the east flank of the Humble salt dome, Texas. A reserve of 3,000,000 brl. may have been added. The discovery well of the South Shelby gas-field gave 3,000,000 cu. ft./day from the Sunburst sand, topped at 1308 ft. This may be a gas-cap field, and a well is to be drilled 1½ ml. down-dip to the south-west in search of oil.

Tables summarize the results of wildcatting in the first nine months of 1942 and 1943; they give by States and districts the results of wildcatting in September 1943, and a list of all the discovery wells completed in September 1943, with the name, location, depth, completion horizon, initial production, oil gravity, structure and method of discovery. G. D. H.

27.* Americans Control Big Share of World Oil Production. Anon. *Oil Wkly*, 18.10.43, **111** (7), 35.—Excluding the Far Eastern fields, now in Japanese hands, the oil production outside U.S.A. is estimated by P.A.W. to be about 1,276,720 brl./day. American interests control 47·39% of the present developed production, and the British control 38·73%. In the Eastern Hemisphere U.S.A. controls 15·3% and the British 79·5%, while in the Western Hemisphere the figures are 59·3% and 23·6%, respectively.

The present output of 200,000 brl./day in Iran is entirely British controlled, but of the 75,000 brl./day produced in Iraq, U.S.A. controls 23·75%, and the British 52·5%. There is 100% British control of the Egyptian (25,000 brl./day), Indian (7315 brl./day) and British (2700 brl./day) production. U.S.A. controls the 15,000 brl./day given by Saudi Arabia and the 20,000 brl./day given by Bahrein. The total output of the Eastern Hemisphere is estimated at 345,200 brl./day.

80% of the 585,000 brl./day produced in Venezuela is controlled by American interests, and 20% by the British, and the corresponding figures for Colombia are 85% and 15%, the output being 60,000 brl./day. Argentina yields 68,000 brl./day,

with U.S.A. controlling 7·5% and the British 21·5%. Trinidad's 60,000 brl./day is entirely British-controlled, as is Ecuador's 7500 brl./day. Peru gives 40,000 brl./day, 70·5% being American-controlled, and 29·5% British. The area gives 93,520 brl./day.
G. D. H.

28.* United States Crude Oil Production at New Peak. Anon. *Oil Wkly*, 18.10.43, **111** (7), 42.—In the week ended 16th October the U.S.A. daily average oil production was 4,413,221 brl., a new all-time high. Kansas produced 296,950 brl./day, 31,350 brl./day more than in the previous week. California produced 788,800 brl./day, in contrast with 780,100 brl./day in the preceding week. Apart from a decline of 26,300 brl./day in Illinois, there were only minor changes in other States. G. D. H.

29.* Barco Drilling Results More Encouraging. Anon. *Oil Wkly*, 18.10.43, **111** (7), 42.—Socuavo 4 has perforated 128 ft. of sand, and proved the best of seven wells drilled in the Tibu area to date. Due to lack of storage there has been only a short test. The reservoir is highly irregular, and the wells of variable quality. Socuavo 4 is bottomed in the Tertiary at about 4600 ft. A small amount of production has been developed in the Cretaceous at about 10,000 ft., but it is scarcely commercial in volume.
G. D. H.

30.* Outer Rings of Production Should Surround Salt Domes. D. L. Carroll. *Oil Wkly*, 1.11.43, **111** (9), 14.—It seems likely that salt domes formed by the static loading of deep-seated salt beds causing plastic flow of the salt, will have a "halo" or anticlinal ring separated from the central dome by a syncline of width approximating to the radius of the dome. The existence of a circular syncline produced by downward settling of the sediments is frequently noted in contour-mapping salt-dome structures. The inner limb of this syncline assists in creating oil accumulation around the salt dome, while the outer limb, if suitably related to other structures, may also cause oil accumulation. The injection of salt upwards through the strata will not only bend them to give the flank-structure, but will also exert lateral, outward pressure which might warp competent beds at some distance radially from the dome.

The known occurrence of the rim syncline makes it worth while exploring carefully, by careful correlation or geophysics, for the existence of closed anticlinal structure beyond the syncline. G. D. H.

31.* World Petroleum and its Availability. E. O. Thompson. *Oil Wkly*, 1.11.43, **111** (9), 19.—Authoritative statements indicate that U.S.A. will be 500,000 brl. of oil/day short in the third quarter of 1944, even with strict rationing.

In spite of the current production of 4,600,000 brl./day, an all-time high, stocks above ground are gradually decreasing.

It is believed that a 35-cents-a-barrel increase would immediately give a 50% increase in drilling. In California a 25-cents-a-barrel rise caused an immediate 52% rise in drilling.

The low oil prices affect stripper-well operators most seriously, for they cannot afford to spend money on secondary recovery methods in order to increase their production.

Texas alone has 136,000,000 brl. of empty steel storage space.

At present the only unused productive capacity in U.S.A. amounts to 200,000 brl./day in West Texas, and this will be absorbed by March 1944, when pipe-lines become available for shipping the oil.

The potential production of Bolivia, Colombia, Ecuador, Mexico, Peru, and Venezuela is 1,080,000 brl./day, of which about 630,000 brl. is now being produced. The potential of Bahrein, Egypt, India, Iran, Iraq, Saudi Arabia, and the United Kingdom is 777,000 brl./day, with the current production 362,000 brl./day.

In 1942 the world reserves were estimated at 54,882,600,000 brl., of which 20,000,000,000 brl. are in U.S.A. Many areas of U.S.A. have passed their peak in production.

The Axis controls 3% of the world oil production. The Japanese are reported to have reconditioned and re-drilled wells in the Dutch East Indies.

Tables give estimates of the current daily production in various countries which

can supply the Allies; the estimated reserves at the end of 1942 in all producing countries and their production in 1938; the production of crude oil and its substitutes in 1941 and 1942; and the distances by sea from world producing areas to consuming centres. G. D. H.

32.* Alberta Output Climbs Above Same Period of 1942. Anon. *Oil Wkly*, 1.11.43, **111** (9), 41.—In the first week in October the Alberta oil production averaged 26,870 brl./day, compared with 25,491 brl./day in the corresponding period of 1942. Turner Valley gave 24,853 brl. of crude and 1165 brl. of natural gasoline. The rise is influenced by the recent completion of six wells at Turner Valley, including Homo-Millerville 15, which gave 165 brl./hr. in a 10-hr. test. There are 18 wells drilling in Turner Valley, and 18 wells drilling in other fields. G. D. H.

33.* Production Upward Climb Halted Week of October 30th. Anon. *Oil Wkly*, 1.11.43, **111** (9), 46.—In the week ended 30th October the U.S.A. production was 4,394,646 brl./day, 24,820 brl./day below that of the preceding week. The Texas production was unchanged, that of Kansas rose by 2900 brl./day, while there were decreases of 10,150 brl./day in Kansas, 9850 brl./day in Illinois, and 4650 brl./day in California. G. D. H.

34.* October Completion Rate Shows Gain and Prospects Indicate Continued Strength. Anon. *Oil Wkly*, 15.11.43, **111** (11), 45.—In October the completion rate averaged 56·2 wells/day, compared with 55/day in September. Comparing succeeding four-week periods in September and October, the number of gas-well completions dropped from 117 to 112; dry holes rose from 461 to 517; input and disposal well completions rose from 135 to 151; total completions rose from 1540 to 1616, and 76 more oil-wells were completed in the October period than in the September period.

It is possible that the 1943 completions may total nearly 19,000. For the first ten months of 1943 there were 15,814 completions, compared with 18,140 in the same period of 1942.

A table gives by States and districts a summary of the completions in October 1943, with comparative totals for September 1943 and October 1942; and a summary of the completions in the first ten months of 1943, with comparative totals for the corresponding period of 1942. G. D. H.

35.* Wells Completed in United States in Week Ended November 13th, 1943. Anon. *Oil Wkly*, 15.11.43, **111** (11), 53.—A preliminary tabulation of the field and wildcat completions in the week ended 13th November, 1943, is given by States and districts. G. D. H.

Geophysics.

36.* The S.P. Dipmeter. H. G. Doll. *Petrol. Engr*, Reference Number, 1943, **14** (10), 17. See Abstract No. 437 (1943). G. D. H.

37.* The Use of Electrode Spacing in Well-Logging. R. H. Zinszer. *Petrol. Engr*, Reference Number, 1943, **14** (10), 25. See Abstract No. 539 (1943). G. D. H.

38. Natural Potentials in Sedimentary Rocks. P. A. Dickey. *Petrol. Tech.*, Sept. 1943, **6** (5); *A.I.M.M.E. Tech. Pub. No.* 1625, 1–10.—The existence of potential differences in the surface of the earth has long been known. Measurements in oil-wells have shown that the potential of shales with respect to some arbitrary reference is almost constant in any well, at least below the zone to which meteoric water has gained access. Sandstones and some other sedimentary rocks have a negative potential with respect to shale. While the potentials have usually been measured with water in the drill-hole, potentials have also been recorded without water in the hole.

Potential measurements were made in an exploratory well, first with water in the hole and then some days after it had been bailed dry. Owing to the absence of the short-circuiting effect of water, the curve for the dry hole showed more detail than

that for the water-filled hole, but the range of potential differences was smaller. Comparison of the curves with cores showed that most of the sandstone layers gave high negative values, and that in a dry hole beds as thin as 0·1 ft. may be detected.

Potential measurements were also made in a shaft, and this showed that most of the potential drop at a sandstone–shale boundary occurred within a few inches in the sandstone, the sandstone being more negative. Sandstone in loose sandstone and shale blocks also proved more negative than the shale. Fresh cores have also shown potential differences between sandstone and shale.

It appears that potential differences exist at the contacts of sandstones and shales in sub-surface strata that contain strong connate water. When satisfactory electrodes are available potential measurements in oil-wells empty of water may be of great practical importance where the top or bottom of a formation must be located with extreme accuracy. The potential differences may be related to the selective absorption of ions in the connate water by clay particles.

Electro-endosmosis and solution-concentration potential may modify the natural potentials. The effect of the latter potential cannot be predicted in a well. Potential differences are greater in a well with fresh than with salt water, but they diminish with time even with fresh water unless there is circulation of the well-fluid.

It is doubtful whether the potential due to electro-endosmosis can be estimated for an oil-well. In some instances the potential difference was not found to be affected by the pressure of the water.

Altogether it appears that the amount of clay material in a sandstone, and not its permeability, controls the potential differences observed. G. D. H.

39. Natural Potentials in Well-Logging. W. D. Mounce and W. M. Rust. *Petrol. Tech.*, Sept. 1943, **6** (5); *A.I.M.M.E. Tech. Pub. No.* 1626, 1–6.—The natural potential log is extremely simple to record precisely enough for all present-day uses. The customary interpretation is equally simple, the potential log consisting of a rather irregular base line from which there are occasional deflections of varying amplitudes, often with fairly steep sides and flat tops. Commonly the "base line" is found opposite the shale sections with the deflections opposite the sand sections. Not infrequently some deflections do not represent sands, and at times there is no deflection opposite to an oil-sand. The natural potentials are attributed to electro-filtration and to electrochemical potentials. Some features associated with electro-filtration could be erroneously interpreted as making the permeability proportional to the potentials. The properties of the filter chiefly determining the electro-filtration potential are its chemical nature and the condition of its surface; its permeability has little or no effect. There is poor correlation between potential logs in oil-wells and the measured permeability of cores. Moreover, the filter-cake in a well dominates the permeability of the combination of filter-cake and sand. Nevertheless, the filter-cake is more permeable than a shale, so that the presence of sand might be shown by electro-filtration potentials even though the sand permeability is not actually measured. Laboratory and field observations in which the pressure was changed did not show potential changes of the same magnitude, and it seems probable that less than 10% of the observed potential is due to electro-filtration. Conventionally, the remaining 90% of the potential would be explained as due to electrochemical potentials, but the salinities commonly present are unlikely to give potentials as high as those logged.

A circular trough was divided into three sections by unglazed porcelain partitions. A pair of non-polarizing electrodes placed in one section failed to show any potential difference whatever the combinations of electrolytes used in the different sections. Small potentials were observed when clean sand-cores were used as partitions, and quite large potentials when shale partitions were used. If one section is filled with shale and the other two sections with fresh and salt water separated by a permeable membrane, potentials were again measured; and this condition is analogous to a well with fresh-water mud in contact with shale and sand containing salt water. If the mud is more saline than the water in the sand the potential is reversed, and such a reversal has been observed in a well when a tannate mud has been replaced by silicate mud.

The potentials have been observed to change with time, and when the potentials measured for a series of cores were compared with the electrical log for the same well, a striking resemblance was found.

It appears that when fresh-water mud is used, the potential log may be largely a measure of the absence of argillaceous material in the formation. The admixture of shale particles in a sand may cause the log, according to the usual simple interpretation, to suggest the presence of a tight zone, not a sand. G. D. H.

Drilling.

40.* Accurate Depth Measurements Vital to Well Completions. A. C. H. Cooke. *Oil Wkly*, 9.8.43, **110** (10), 20.—Records of measurements should be kept accurately, both in the daily drilling reports and the engineers' well-log. A definite bench-mark or reference point at the surface should be used at all times. Where the ground level is used as a depth reference this level should be permanently established by reference to some substantial reference point. A concrete derrick corner may have a bolt-head set in it as a bench-mark; a permanent derrick may be marked at the level of the rotary table; or all measurements may refer to the level of the final casing braden head. The customary procedure in rotary drilling is to use the top of the rotary drive-bushing as the zero point. However, in the final record of the well all measurements must tie in to the same reference points, and should include: (1) Elevation of well location. (2) Distance from ground level to top of rotary drive-bushings: (*a*) Record all depth measurements made from this point. (*b*) Note any changes in this measurement due to changes in rotary, casing spider, or sub-structure. (*c*) Note distances from original floor to top of original drive-bushings. (3) Distance from rotary drive-bushings to: (*a*) Surface casing braden head. (*b*) Final casing braden head. (*c*) Companion flange of master gate. (*d*) Companion flange of tubing head.

The second bench-mark in a well is the final total depth, which is more closely related to the zones or depths of vital interest. Discrepancies, due to use of different yard-sticks, often arise from the use of this second mark. Depth measurements by means of drill-pipes in a horizontal position, and eventual correction to more nearly correct values, are described. Measurements of drill-pipe, tubing, or casing in strain are discussed. Several sources of errors are traced and discussed for the different methods. Use of bailing and other wire lines and the source of errors introduced in measuring well-depths are discussed in some detail.

The various well-service companies employ mechanical measuring devices and accurately calibrated flagged cables. It is possible in some cases to rely fully on the measurements made by service companies; but even with accurate measurements it is often impossible for a service company to overcome inaccurate well data completely. For example, an electrical log made before setting casing may be used as a basis for perforating an old well. At the time the log was made the measurements were zeroed at the rotary drive-bushings. Forgetting this point may result in using a much lower elevation on the workover derrick as the zero for the perforator.

One of the causes of ineffective service company measurements is the placing of full reliance on the fact that a certain line should duplicate its performance on subsequent runs. This fact is well founded, but it provides no permanence. As with bailing and coring lines, the cables used by service companies are subject to service accidents which affect their accuracy. Therefore, a cable should not be relied on entirely to determine the results to be obtained from a well. Prior to any perforating of casing, the well should be cleaned with the largest possible size of rock-bit and then thoroughly washed. Cement cuttings frequently settle back to bottom when the well is washed with water. Rubber, belting, and other plug materials may remain in the well to prevent the perforator from reaching bottom. In some cases the pump-suction is lowered in the pit to permit a "dry trip," and the heavy viscous mud is pumped down the well. The result may be a false bottom or bridge through which the gun perforator may not pass. A. H. N.

41.* Deep West Texas Drilling Presents Many Problems. F. Briggs. *Oil Wkly*, 6.9.43, **111** (1), 48.—Drilling to the Ordovician formation of West Texas is meeting with difficulties, due to depth, high pressures, and lack of water. All three types of rotary rig prime movers—steam, internal combustion, and electric—have been used in drilling these deep wells. Electric rigs have been powered with 750-horse-power motors in drilling wells in the Barnhart area of Reagan County. Steam rigs have

predominated in drilling deep tests in Winkler County, with some of the rigs using separate steam-engine drives for both rotary and draw-works. In Ward County the predominating rig is the diesel. There are tandem-drive units of 350 horse-power each. In most areas the preliminary problem is water. This usually determines the type of motive power for the rig, but not necessarily so. For instance, in the Monahans area of Ward County it was thought at first that water would be scarce and that diesel rigs would be desirable. One of the greatest problems encountered in drilling deep wells in West Texas is the necessity of penetrating very hard chert sections, which are interspersed just below the Permian formations within the Devonian zones. In these formations rock-bits seldom succeed in drilling more than 5 ft. before being rendered unfit for further use. The first problem is maintaining gauge; the second, tooth wear. Seldom does the total chert section encountered exceed 800 ft., but no other section is as slow and expensive to drill.

In the present deep-well-drilling programme the factors that determine the type of mud to use are location and casing programme. It is general practice in the Permian Basin to spud the wells with fresh-water mud or clay. After setting the surface pipe, no particular attention to the mud is required, for the red beds underlying the surface for a good depth make sufficient and good mud for this zone-drilling. However, after the red beds are passed, the underlying salt section requires careful consideration of the mud. In drilling this section, the mud becomes highly concentrated with salt, which it retains until completion of the well—unless an intermediate string of pipe is set through the salt section. If this is so, fresh-water mud usually is used to completion. Thus, on wells having the salt zone, the casing point determines the mud type.

The control of water loss (filtration), viscosity, weight, and settling properties of mud, is an important phase of drilling. In facilitating this control, a daily chart of these factors gives the operator a very clear overall picture of the mud condition at all times. Salt-water mud is discussed in some detail. The average cost of mud to drill a well to completion in the Barnhart area is $1500. This is relatively easy digging as deep drilling in West Texas goes. Spudding is done with a clay or the bentonite material, and, as with the usual drilling in the Basin, the mud requires but little attention while drilling through the red beds. At approximately 3800 ft. the mud begins to require care. A 10·2-lb. mud with a 43-second viscosity and a 10–15 c.c. water loss is carefully maintained. From 4000 to 4800 ft. water in a shale section that tends to cave is responsible for lost returns and sticking-pipe tendency. After passing this shale section no particular treatment is needed for the mud, and it is allowed to develop a water loss of around 70–80 c.c., a weight of about 9·8 lb., and a viscosity of 34 seconds. Nearing completion at 8800 ft., the hole again requires that careful attention be given the mud. The addition of inorganic or starchy compounds or quebracho caustic bring the water loss down to the very low filtration of 4 c.c. This is necessary to prevent stuck pipe. The weight of the mud reaches 10 lb. and the viscosity is raised to around 38 or 40 seconds. The usual pipe programme in this area is to set 7⅝-in. at 2200 ft., and 5½-in. to bottom at 9200 ft. A. H. N.

42.* Coring with Reverse Circulation. H. F. Simons. *Oil Gas J.*, 9.9.43, **42** (18), 47.—The paper deals with a method of coring the pay-zone with reverse circulation which is practically satisfactory and adds nothing to the expense of the completion. In addition, cores have been obtained of some sections where formerly conventional coring did not produce results. The new method requires practically no additional equipment, does not require any additional trips in and out of the hole with the drill-string, and actually delivers the cores to the surface for examination much quicker than any present method of coring. For instance, a 1-ft. core taken of a producing section may be examined on the ground from 9 to 15 minutes after the actual cutting in wells down to 4500 ft.

The method devised by Shell uses a slightly remodelled hard-formation core-head, but does not use the inner barrel in which cores are ordinarily caught; the core-catcher is also eliminated. Instead, the core is washed to the surface by the fluid stream pumped down the annulus and up through the drill-string. After the core is started to the surface, drilling may proceed or not, as the engineer and geologist supervising the job may direct. Sections of the core thus may come from the hole in small sections as the drilling progresses.

The only limitation on reverse-circulation completions is the pressure in the pay-zone, or its ability to withstand the column of oil on it without appreciable loss into the formation. In some wells completed with reverse circulation, low-pressure, permeable zones which take fluid very rapidly (faster than the pump can handle the fluid) are sometimes encountered. In such cases, however, the difficulty may be overcome by the use of an oil-base mud which has excellent plastering properties and prevents entry of the drilling fluid into the formation. Use of this material makes it possible to complete wells with reverse circulation where the reservoir pressure is quite low. The samples of the formation obtained while completing with reverse circulation are excellent compared with other samples. In addition, a gauge of the well can be taken at any time simply by stopping circulation and letting the well flow. However, cores of the formation are also desired for analytical purposes.

Slim-hole drilling and coring is detailed in the paper. Recoveries run up to 80% or 90%. One of the early difficulties in reverse-circulation coring was the development of abnormal pump pressure due to the blocking of the fluid passage by the core. The clearance between the core-head and the core is very small, and very little fluid can pass through. The high pump pressures were eliminated by drilling four ⅜-in. holes adjacent to the cutters. These holes are directed upwards into the water-courses which connect with the tubing above. Consequently, part of the fluid by-passes the core, and pump pressures are kept down. Occasionally, a core of the formation of other material will lodge in a tubing collar and cause a pressure build-up. A measuring line with a weight on it can be used to knock such obstructions loose, after which they can be pumped out. A. H. N.

Production.

43. Some Tools and Methods Used in Cleaning Oil-Wells in California. G. B. Shea. *U.S. Bur. Mines. Report of Investigations No.* 3706, May 1943.—The incidence of war has focused attention on the necessity of obtaining increased production from old wells without undue expenditure of essential materials such as steel. It is pointed out in this report that in California efficient well-cleaning methods have been responsible to a large extent for improved performance ever since the system of voluntary curtailment of production came to an end. Information included is based on a field survey and on data obtained from technical and patent literature, manufacturers' catalogues, etc. Much of it is not new, and letters patent have precluded detailed description of certain methods regularly practised by operators, but this collection of facts, ideas, and suggestions relevant to oil-well cleaning is designed to stimulate further research into the urgent problem of economic rehabilitation of oil-wells and fields.

Before starting to clean out a well, careful study must be made of specific causes of impeded flow of oil and gas into the hole. Gradual accumulation of detrital material and consequent obstruction in the critical region surrounding the well, clogging of the sand-face or liner, pump troubles, etc., are all potential causes of reduced production, but cleaning out is not always the solution to the problem. A sub-surface pressure survey may indicate that replacement or relocation of the pump or gas-lift equipment is all that is required. Fluid-level tests will usually determine whether falling off in production is due to pump troubles or clogged perforations.

Final decision as to whether or not a well should be cleaned out is largely determined by economic considerations of the value of the expected increase in production, costs, amount of recoverable oil remaining in the reservoir, and probable duration of effectiveness of reconditioning.

Once the necessity for a clean-out is established, careful analysis must be made of the particular cause or causes of subnormal production, to ascertain which method will give the best results having regard to the type and location of accumulations in the well.

In the removal of sand from wells, standard bailing tools, hydraulic suction-type or pump-type bailers are used, depending on the particular type of accumulation. In addition, hydraulicking with oil is sometimes useful in removing sand, silt, or fragmentary shale accumulations.

Swabbing is a common and simple method of cleaning perforations in Californian fields, though with certain wells it proves effective only when combined with an alternate bailing operation. Washing methods involving the use of high-pressure

or suction perforation washers have been considerably improved during recent years, and a great variety of ingenious tools is now available.

Carbonate scale is removed from liners and sand-faces by chemical treatment, and it has been found that an aqueous solution of 10–15% hydrogen chloride is the most satisfactory concentration of acid to use. If the scale deposits are oil-soaked it is usually necessary to add penetrating or wetting agents to facilitate penetration of the acid.

In some Californian wells the principal causes of subnormal production are due to accumulations of paraffin, asphalts, and gums which separate out from the crude oil. Present tendency is to utilize paraffin solvents and heat-generating chemicals to facilitate their removal. The solvents are properly selected for each type of paraffin found.

Methods of prevention and removal of mud-sheaths deposited from drilling fluids on the face of oil-bearing sands have been carefully studied over a number of years, and their success is largely dependent on the chemical and physical characteristics of the fluid used. Oil-base mud fluids are fast gaining popularity as drilling fluids.

Removal of mud-sheaths may involve washing-in methods, wall-scraping, or chemical treatment with calcium carbonate and acid, mud acid, etc.

In conclusion, operators are advised to study the possibility of a combination of methods for cleaning out and to avoid misapplication of tools having regard to existing well conditions. H. B. M.

44.* The Effect of Casing Perforations on Well Productivity. M. Muskat. *Petrol. Engr*, Reference Number, 1943, **14** (10), 124. See Abstract No. 297 (1943). G. D. H.

45.* Determination of Oil-Well Capacities from Liquid-Level Data. C. C. Rodd. *Petrol. Engr*, Reference Number, 1943, **14** (10), 117. See Abstract No. 1057 (1942). G. D. H.

46.* Analysis of Reservoir Performance. R. E. Old. *Petrol. Engr*, Reference Number, 1943, **14** (10), 139. See Abstract No. 298 (1943). G. D. H.

47.* Remedial Work in Oil-Fields of the Eastern Area of the United States. W. N. Little. *Petrol. Engr*, Reference Number, 1943, **14** (10), 153. See Abstract No. 806 (1943). G. D. H.

48. Bottom-Hole Water Shut-Off. V. E. Baum. *Oil Gas J.*, 29.7.43, **42** (12), 219.—A qualitative analysis of water-coning is made. From this analysis it would appear that the prime problem is that of equalizing the unit pressure over a given area so as to compensate for the difference between the surface tension of oil and water. Since water flows with greater ease, we have to increase the resistance to the flow of water. This can be acomplished by putting out a disc, so that when the water attempts to flow in over the top of the disc, it has a greater distance to travel than the oil (which is floating upon the water) and is immediately adjacent to the bore-hole. It would be ideal if one could insert a flat disc at the water-hole contact level when the well was first completed, but since any treatment applied from the surface must be assumed to take a spherical form, we can merely supply an artificial dividing line by running a formation packer.

It is not wholly sufficient to supply an artificial dividing line by merely running a formation packer, because the placing of the cement underneath the packer must be controlled. It must be realized that the point of lowest pressure is still in the casing, and any uncontrolled attempt to place cement would simply have the effect of by-passing the packer, as the pressure of the hydrostatic head of cement would overcome the tendency of this heavier fluid to go out and down in the formation. With a tubing control valve placed at the bottom of the tubing string and immediately above the packer, it is possible to place the cement at the face of the pay at low pressure, ranging from zero to any desired pressure. The tubing control valve is merely a piston-type valve with a logarithmic curve metering-pin backed by a heavy coil-spring, which is set so that the bottom-hole pressure, plus the force of the spring, will keep the valve closed when the tubing is filled with cement and displacing fluid. It will be immediately seen that to meter cement at low pressure through the valve and under the

packer, one need only exert a low pressure on the tubing at the surface. If the engineers' figures are carefully worked out from predetermined bottom-hole pressure data, the pressure applied on the cement ejected through the valve will be exactly that which is applied to the tubing at the surface, calculating, of course, the change in the fluid column as displacement takes place.

An actual case is quoted with favourable results. Cases where such a method of shut-off will not work are enumerated. A. H. N.

49. Fatigue of Sucker-Rods. J. Zaba. *Oil Gas J.*, 29.7.43, **42** (12), 229.—The simple formulæ for elastic stress–strain in relationships are briefly discussed, followed by a discussion of endurance under fatigue. The endurance limit of materials is determined on a testing machine by subjecting the test specimens to reverse loadings from maximum tension to maximum compression. Several specimens are tested to failure under gradually decreasing stresses until the stress is found under which the specimen can withstand an indefinite number of cycles of reversals. In the case of steel, it has been found that a stress which permits 10,000,000 reversals without failure can be safely assumed as the endurance limit. The results of endurance-limit tests are plotted, as the so-called S–N curves (stress–number-of-cycles curves) on semi-logarithmic paper with axis of ordinates as stresses and axis of abscissa as number of cycles of reversals.

Typical curves are given. The endurance limit of a material is decreased by the so-called "stress-raisers." Dents, pits, scratches, or holes on the surface of a bar result in concentration of stresses leading to fatigue failure. The mechanism of this failure is generally interpreted as follows: the failure usually starts on the outside, at the base of a pit or dent—that is, at the point of stress concentration. A minute crack is formed which results in further stress concentration and further spreading of the crack. This process continues, reducing the working area of the bar until the area is reduced to the point at which the elastic limit of the material is reached and a single application of load results in a failure. The cross-sectional area of a fatigue break is very characteristic. The part of the progressive damage, because of the rubbing of the two parts against each other, is smooth. The part of the final, elastic failure is coarse and granular. Different materials exhibit different resistances to progressive failure. Stress, range of stresses, and number of reversals are three main factors affecting the progress to fatigue failure.

Oil-well sucker-rods work under conditions of repeated cyclic loadings; their service, therefore, is a problem of fatigue. In case of sucker-rods, however, there is one additional factor which affects their service, and that is the effect of the surrounding medium. The sucker-rods often work in highly corrosive fluids. Air-endurance limits of steels cannot be used satisfactorily in designing sucker-rods for given working stresses. The effect of corrosion on service of a sucker-rod string may be two-fold. Sucker-rods working under conditions of light stresses may be eventually destroyed by corrosion, or highly stressed sucker-rods may fail because of corrosion fatigue. The corrosion-fatigue failure occurs in two stages. During the first stage the electrochemical action of the corrosion results in the formation of pits on the outside surface of the rods. These pits cause stress concentration, and the second stage of the corrosion fatigue failure proceeds along the line of the fatigue failure already described. Therefore, the resistance of material to corrosion fatigue is determined, primarily, by its resistance to corrosion.

Methods of determining endurance limits under corrosive conditions are given in some detail. Causes of differences appearing between laboratory testing results and actual practice are given. A. H. N.

50. Rapid Extraction Methods May Yield More Oil in Fields Producing Much Water. S. F. Shaw. *Oil Gas J.*, 5.8.43, **42** (13), 39.—The paper develops the theme that not in all fields controlled does production result in greater ultimate recoveries; but, on the contrary, in certain fields, ultimate recovery is increased by rapid withdrawals. A number of such fields are cited. The reasons for this increase in ultimate recovery are discussed. In the first place, with higher withdrawal rates the gas expands through a longer range of pressure, and thus will do more work in pushing the oil. Thus, if a well has a static bottom-hole pressure of 400 lb./sq. in. and is produced at a slow rate such that the producing bottom-hole pressure falls to 200 lb./sq. in., each cubic foot

of gas will perform 1393- ft.-lb. of work in moving oil towards the well. If this same well is produced at a high rate such that the producing bottom-hole pressure falls to 50-lb./sq. in., each cubic foot of gas produced will perform 3932 ft.-lb. of work in moving oil towards the well. Thus, unless the gas–oil ratio at the slow rate of production is less than one-third that at the high rate of production, a net loss of total gas energy is being suffered by employing the slow production rate. In all fields in which gas is a motive force this could easily result in lower total recovery of oil.

Another reason that may be suggested is that oil trapped in upper inequalities in the formation is forced by its dissolved gas out of its trap into the stream of fluid moving towards the well when the pressure is reduced. This may account not only for the increase in total oil content lifted, but also for the increase in the percentage of oil. An instance is cited of a well in a limestone reservoir that had been making 350 brl. of fluid, of which 50 brl. was oil. A centrifugal pump was installed and the withdrawal was increased to 1600 brl./day, of which 800 brl., or 50%, was oil, and this rate of production continued for a considerable time. Limestone formations have openings, some large, some small, and a large cavern in the upper part of a reservoir might easily contain a large quantity of oil which would never be recovered unless either a well happens to be drilled into this cavern, or unless the pressure is lowered in the reservoir by high withdrawals from the surrounding wells to the point where this cavern can be emptied of its oil contents.

Again, it is stated that many reservoir rocks contain from 10% to 30%, or even more, of connate water. If there is connate water present in the sand to this extent that was not displaced by the oil which originally collected in the reservoir, it would seem that the connate water must be the fluid originally wetting the sand-grains, in which case the oil is not adhering to the grains of sand, and has only to be washed out of the pores in the sand, and the quicker this is done, the greater is the profit, and the cleaner is the sand afterwards, because of the rapid flow. A. H. N.

51. Failure of Sucker-Rods. J. Zaba. *Oil Gas J.*, 5.8.43, **42** (13), 49.—Principal cause of sucker-rod body failures is overstressing. Stresses normally safe may be increased in intensity by "stress raisers," or additional stresses may be superimposed on the safe stresses, the total exceeding the endurance limit of sucker-rods and leading to failure. The mechanism of failure is fatigue, if corrosion is known to be absent, corrosion fatigue, hydrogen embrittlement, or combination of the last two. Causes of over-stressing rods are discussed.

An instrument is now available for testing the fatigue of sucker-rods. The operation of the instrument is based on the fact that physical characteristics of steel affect the steel's magnetic characteristics. A field test unit consists of a coil through which the sucker-rods pass when pulled out or run into the well. The coil is excited with an alternating current, inducing magnetic flux in the rod, which generates an electromotive force in another coil. The voltage of this electromotive force is function of the flux, and what follows also the function of the physical characteristics of sucker-rod steel. Both the presence and the magnitude of the fatigue are recorded. A string of sucker-rods tested for fatigue in such a manner can be classified from the standpoint of service it is still capable of performing. Good rods can be re-run in the same well, slightly fatigued rods can be used in lighter wells, while badly fatigued rods are discarded. Elimination in one run of a number of rods which would eventually cause a number of separate breaks resulting in a number of separate pulling jobs is a distinct contribution towards economy of operations.

Prime requirements of sucker-rod material capable of performing satisfactory service are sufficient tensile strength and inherent resistance to corrosion and embrittlement. Other requirements are ductility, uniformity of composition, and resistance to stress concentration. Attempts to apply, in the manufacture of sucker-rod, materials satisfying these requirements can be seen in evolution of the sucker-rod, from the standpoint of material used, from wrought iron to soft steels, to steels with higher carbon content and increased manganese, and to steels with addition of nickel, molybdenum, and chromium. At the same time, methods of manufacture were improved, various forms of heat treatment tending to improve the physical properties of rods. As manufactured now, a sucker-rod should give economically satisfactory service if used under conditions for which it is designed and if given proper care in normal oil-field operations. A. H. N.

52.* Salt-Water-Disposal Injection Systems. I. W. Alcorn. *Oil Wkly*, 30.8.43, **110** (13), 20.—The open and closed systems are compared, and a particular field is discussed. The results to date, after one year and seven months' operation, indicate that, where practicable, the closed system for salt-water disposal is desirable from the standpoint of low initial cost, minimum maintenance cost, due primarily to elimination of current chemical treatment of salt water to hasten precipitation and destroy algæ, and apparent minimizing of corrosion. Any injection system, whether open or closed, depends largely for its success on the sand available for disposal. Obviously, a coarse, highly permeable, porous sand with low pressure-head is to be desired. Sands of Miocene age, such as those generally occurring in coastal Louisiana, seem to be ideally suited to injection disposal of salt water. In the Louisiana installation, some 1,950,000 brl. of salt water have been disposed of by gravity. Currently, 4000 brl./day, which represents approximately the capacity of the central oil-treating and salt-water-disposal unit, is being cared for in this fashion.

The installation of any salt-water injection disposal system requires careful consideration of all the factors relating to it if best results are to be achieved. The closed system involves more than the usual number of mechanical problems, but these are susceptible of solution. About the only difficulty so far encountered is chemical in nature. Shortly after the filter was put in operation, a black deposit was noted on the inside of the gauge glass. At the same time the backwash water began to carry some black, finely divided material. This material was identified as iron sulphide by settling and treating the residue with hydrochloric acid. The original of this iron sulphide was believed to be the by-product of an anærobic microbiological organism tentatively identified as *Sporovibro. Desulfuricans*, one of the sulphur splitting group. Backwash water increased in coloration and the filter required more frequent washing. Thus far no chemicals have been used to kill the anærobic bacteria. The ordinary chemicals containing chlorine used for this purpose cannot be used, as they would precipitate other solids. Other chemicals are unavailable or too costly at this time. The only solution of this problem to date is a periodic injection of 15% inhibited acid into the injection well. Over a period of one year and seven months one such injection has been made.

It is not to be presumed that the closed system should be used under all conditions, but where it is applicable considerable advantages may be gained. A. H. N.

53. Surface Tension of Crude Oils Containing Dissolved Gases. D. L. Katz, R. R. Monroe, and R. P. Trainer. *Petrol. Tech.*, Sept. 1943, **6** (5); *A.I.M.M.E. Tech. Pub. No.* 1624, 1–10.—The difficulties associated with the making of reliable surface-tension measurements at high pressures make it desirable to have a method by which the surface tension of crude oils containing dissolved gases may be computed from the fractional analysis of the liquid.

Experimental data on the surface tension of the equilibrium liquids for the methane–propane system have been obtained at pressures up to 1230 lb./in.^{2}. These data have been used to derive an equation from which the surface tension under pressure can be predicted from the composition of the mixture.

$$\gamma^{\frac{1}{4}} = P_1\left(x_1 \cdot \frac{d_L}{M_L} - y_1 \cdot \frac{d_V}{M_V}\right) + P_2\left(x_2 \cdot \frac{d_L}{M_L} - y_2 \cdot \frac{d_V}{M_V}\right) + \text{etc.},$$

in which P = parachor for any constituent or mixture; x = mol fraction in liquid phase; d_L = density of liquid phase; M_L = molecular weight of liquid; y = mol fraction in vapour phase; d_V = density of vapour phase; M_V = molecular weight of vapour phase; γ = surface tension. Subscripts 1, 2, 3, etc., refer to individual constituents or mixtures. This formula reproduced the data on the methane–propane system with an average deviation of less than 0·1 dyne/cm., and it is believed that it will apply to complex mixtures such as crude oils and gasoline. The data for methane–propane indicate that the parachor for the hydrocarbon remains substantially constant for all temperatures and pressures, but such may not be true for non-hydrocarbon gases. The parachor for a complex mixture will change with vaporization of a portion of the mixture, while the parachor for a compound is constant.

The above relationship has been tested on several butane–gasoline mixtures with

good agreement, showing that the parachor for a complex mixture may be used in a similar manner to that for pure compounds, and that the equation is not restricted to binary systems.

A calculation is given which shows the dependence of surface tension on the vapour-phase composition and properties, as well as on the composition of the liquid phase. Studies on systems equivalent to naturally occurring crude-oil systems show that the calculated surface tension becomes very low as the saturation pressure of the gas in the liquid becomes high. It is likely that reservoir liquids, such as crude oils or precipitated condensates containing dissolved gases, will have surface tensions under 2–3 dynes/cm., at pressures above 3000 lb./in.^{2}, and may easily be below 0·1 dyne/cm.^{2} under these conditions. G. D. H.

54.* First Triple Completion in Texas at Lake Creek. F. Briggs. *Oil Wkly*, 6.9.43, **111** (1), 100.—The geology of the field is briefly discussed. Lenticular sands are prevalent. Triple-completion involves setting 7⅝-in. casing through all the sands; perforations are made in the pipe at the pays desired to be produced. Although the pays are definitely known, each formation to be produced is tested by the usual drill-stem procedure. At the completion of these tests a double-slip-type casing packer, composed of drillable material, is run in on tubing. This packer is set between the lower pay and the two upper sands to be produced. After setting, the tubing is released from this packer and withdrawn from the well. Next, another packer is run in on the 5-in. string of inner casing and set between the two upper sands. This pipe contains a circulatory port just above the packer. This port is closed at installation and is opened by a predetermined number of turns of the pipe. As soon as this port is opened, washing action is instituted through the 5-in. pipe, and continues until enough mud has been unloaded from the upper sand to allow this formation to produce, and the port is closed again.

After the topmost pay has been brought in, the 2½-in. tubing string is run inside the 5-in. inner casing. This tubing contains a special arrangement involving a side-door choke and a removable plug. It is seated, or bottomed, in the previously set double-slip-type casing packer. The plug and side-door choke are placed just above this packer in the tubing. In order to bring in the middle sand, the tubing is first plugged, and washing action is permitted by means of the side-door choke. As soon as sufficient mud has been removed, this sand begins to produce, the tubing is closed off, and the tubing plug is pulled by wire line. This closes in the middle sand through the annulus between the tubing and the 5-in. strings, and opens the tubing to the lowest pay. After bringing this lower sand in, all three are ready to produce. The well is completed so that production from the lowest pay flows through the tubing, that from the middle through the annular space between the tubing and inner casing strings, and the upper sand through the inner and outer casing annulus.

A. H. N.

55.* Distillate Well-Production Problems Studied with Testing Equipment. E. Sterrett. *Oil Wkly*, 6.9.43, **111** (1), 109.—Test apparatus for distillate wells are described. The tests now under way include the determination of a simple and practical method for sampling a two-phase gas-stream so as to obtain samples which are truly characteristic of the entire output of the well. To prevent possible gravity separation of fluid particles in the stream, the sampling devices are installed on the riser side of the inverted U-shaped sampling loop, with provision to ensure centring of the tube with respect to the walls of the flow-line. Varying the known liquid content of the stream, by reintroducing fluid previously separated from the gas, will make it possible to determine the effective operating limits of different types of sampling devices, and to set up comparative data from which their results may be calibrated and converted.

The pressure range at the new set-up is variable from a low of 1000 to a high of 2500 lb./sq. in. or field producing top. Fluid range in the gas tested will grade upwards from that of the stripped gas after its pass through the test separator to about 10% liquid phase by volume. The storage provided for the liquid phase at the separator is ample to provide full stabilizing runs and permit extended sampling and metering runs on a flow of predetermined content. A. H. N.

56.* Selection of the Pump-Plunger. J. Zaba. *Oil Gas J.*, 9.9.43, **42** (18), 60.—Formulæ for selecting plunger size are given. Coberley's formula is :—

$$A = \frac{S_p E}{10{\cdot}39 g L^2 \left(\frac{1}{A_r} + \frac{1}{A_t}\right)}$$

where A = plunger area for maximum production (sq. in.), S_p = polished-rod stroke (in.), E = modulus of elasticity, g = specific gravity of fluid lifted, L = setting depth of pump (ft.), A_r = area of rods (sq. in.), A_t = area of tubing (sq. in.).

The formula applies to free tubing. In case of anchored tubing :—

$$A = \frac{S_p E A_r}{10{\cdot}39 g},$$

where the symbols are the same as in preceding formula.

These formulæ consider only the stretch of rods and tubing as factors affecting the plunger stroke. To correct for over-travel, Coberly suggests following correction factor by which the results of the preceding formulæ should be multiplied :—

$$F = 1 + \frac{2{\cdot}4(LN)^2}{100{,}000}$$

where F = correction factor, L = length of rods in thousands of feet, N = number of strokes/minute.

Kemler's formula is :—

$$d = \left[\frac{KQ}{210se}\right]^{\frac{1}{2}}$$

where d = plunger diameter for minimum peak load, K = weight/ft. of sucker-rods (average weight/ft. for tapered strings), Q = rate of production, s = specific gravity of fluid pumped, e = volumetric efficiency of the pump.

Mill's formula is :—

$$d = \left[\frac{KQN}{2750es}\right]^{\frac{1}{2}}$$

where N = number of strokes/minute, and other symbols are as in preceding formula.

The characteristics of wells, fluids, pumps, and of pumping operations are briefly discussed. A. H. N.

57.* Slow and Economical Water-Flood Proving Profitable. Anon. *Oil Wkly*, 20.9.43, **111** (3), 16.—The paper deals with a small water-flooding project that is being developed to pay for itself in a short time. Development was started by drilling four water input wells. Cores were analysed to determine if the reservoir sand contained sufficient oil and satisfactory conditions suitable for flooding. Average permeability was found to be around 80 m.d., and oil content to be approximately 14,600 brl./acre with a possible recovery of 40–50%. Average depth of oil sand was 300 ft. Gradual development through 1941 was on a well spacing of 330 ft. water to water. Abandoned oil-wells have been reclaimed as producers where they fit the pattern. 200 lb. pressure was required at the initial water injection of 1 brl./ft. of sand. Pressure was gradually increased to 300 lb. in order to inject 2 brl./ft. of sand, which pressure is safely below the over-burden strata.

Economics of this flood is at a figure lower than most operators are able to maintain, due to elimination of all non-essentials and the use of good used equipment instead of the usual new material on most floods. Drilling has been the major item of expense. Installation of necessary machinery and lines has been accomplished at a low cost. Total average cost of development has been less than $350 acre. Low initial and maintenance costs have allowed the project to pay its way and show an early profit. It is proposed to change from pumping to flowing wells.

A. H. N.

58.* Efficient Plunger Travel in Oil-Well Pumping. F. Briggs. *Oil Wkly*, 20.9.43, **111** (3), 22.—Perhaps the most simple method of determining the general performance

of the pump is that involving the application of a dynamometer to the polished rod. This gives a polished-rod-load curve from which such plunger characteristics as under-travel, over-travel, fluid pounds, frictional restriction, and others may be recognized. Working in combination in these studies is the apparent volumetric efficiency; it is an indicator of trouble if the computed figure is low, but does not put the finger on the specific cause. For instance, from the amount of fluid produced by the normal operation of the surface unit for 24 hours, say, the apparent volumetric efficiency was found to be only 35%. Good operation is usually indicated by at least 70%; thus, it is known by this low figure that sufficient fluid to fill the barrel each stroke is not available, or that the length of the plunger stroke is much less than the surface stroke. It is then a process of elimination, trial and error. If the fluid is not in the hole in sufficient quantity to fill the working barrel, or is restricted from entering because of gas-lock or other impediments, a fluid pound (felt in the polished rod or easily seen in the dynamometer load curve) is the simple indication of this condition. If it is established that the inefficiency is not due to lack of fluid, some restriction to sucker-rod travel may be the cause. Thus, by a process of elimination the real cause may be discovered.

Langer's formula for calculating plunger stroke is compared with actual determination and found acceptable. The formula, in an approximate form, is :—

$$\text{Plunger travel} = \frac{S}{\text{Cos}(0{\cdot}0004LN)^0} - \frac{W_{od}}{2(10)^6}\left(\frac{1}{A_r} - \frac{1}{A_t}\right)$$

where S = polished rod stroke in inches, W_{od} = weight of net fluid column on total area of plunger, L = length of rod string in feet, A_r = cross-sectional area of sucker-rods in square inches, A_t = cross-sectional area of tubing in square inches, N = number of operating strokes/minute.

The first term is the only difficult expression. It is found by this sequence :—

$$\text{Cos}(0{\cdot}0004LN)^0 = 1 - x^2/2 + x^4/24.$$

where

$$x = \frac{0{\cdot}0004LN}{57{\cdot}3}.$$

A. H. N.

59.* Preventing Pressure Leakage from Abandoned Wells. F. R. Cozzens. *Oil Wkly*, 27.9.43, **111** (4), 34.—Different means of sealing off abandoned wells are described. The main objective in the treatment of old wells is to effect a closure as near as possible to the top of the pay-sand. In wells containing large quantities of water the most favoured method of making a sand closure is to induce caving by means of carbide or explosives. Certain portions, soft formations, along the walls of a well generally start to slough off, or cave immediately following the temporary removal of water. In the carbide treatment 100 lb. of commercial carbide are usually needed for wells 1000 ft. or less in depth, and to simplify handling, the carbide is broken into chunks, 1 or 2 in. in length. After the top of the hole has been cleared of debris, the broken-up carbide is shovelled in, due care being taken that the worker does not inhale the fumes, or have lights, except electric, or fires within the immediate area. On reaching water within the well, carbide creates violent agitation through chemical action. Temperature of the water rises 20–40° F., causing the water-level to rise several feet up along the walls of the hole. As agitation ceases, the water recedes, and a very favourable caving reaction is made upon the walls along which the water has stood. The heated water likewise encourages caving action. In most wells 1–20 ft. of cavings can be expected to fall within a few hours, and this burden, combined with the carbide-sludge which settles to the bottom, generally makes a pressure-tight seal. One treatment is usually sufficient, although in wells exceeding 1000 ft. in depth, and which contain water one-half to two-thirds the length of the hole, more carbide is required, sometimes as much as 300 lb. In localities where formations do not cave, explosives are used. Other means of plugging wells are also briefly described.

A. H. N.

Transport and Storage.

60. A Study of Gasoline Evaporation Losses. J. Happel and D. P. Heath. *Oil Gas J.*, 25.3.43, **41** (46), 160.—A detailed study is presented, with experimental data,

of the factors controlling the loss by evaporation of gasoline from tanks, the mechanism of evaporation loss and methods of testing rates of evaporation loss. The variables controlling loss are: (1) average atmospheric temperature, (2) daily temperature variation, (3) colour and condition of paint on tank, (4) condition of tank and ventilating equipment, (5) average wind velocity, (6) vapour pressure of the gasoline, (7) number of turnovers of the gasoline in a given time, and (8) average product inventory. The relative importance of these will depend on the type of tank, viz. (*a*) vertical cylindrical tanks with fixed roofs, (*b*) vertical cylindrical tanks with variable roofs, (*c*) pressure storage tanks, and (*d*) floating-roof tanks. For fixed-roof tanks loss occurs by breathing and during filling, published formulæ being available for the calculation of loss. For variable-roof tanks, which may be of the gasometer, breather (flexible diaphragm), or balloon (large diameter diaphragm) type, no vapour will be lost by breathing if the vapour volume is large enough, though from the breather type loss generally occurs unless the tank is two-thirds full. Owing to prevention of breathing, loss from these tanks during withdrawal is lower than for fixed-roof types, and can be calculated from formulæ provided. For pressure tanks, the pressure required to prevent breathing can be calculated, a storage pressure of 2·5 lb./in.^{2} being generally regarded as sufficient for motor gasoline. Particular care must be taken to avoid pin-holes, it being shown that 23 gal. of gasoline of 4 lb. vapour pressure can be lost per day through an $\frac{1}{8}$-in. hole in a pressure tank at 1·5 lb. pressure. Formulæ have been evolved for withdrawal losses from pressure tanks, taking into account the evaporation of gasoline which saturates the additional vapour space on withdrawal and the corresponding condensation when filling. For floating-roof tanks there are theoretically no breathing or filling losses, but there is some loss of vapour between the shoes of the tank-shell and of gasoline by capillary action up the tank wall past the shoes and secondary seal. The four possible methods of measuring evaporation losses are: (1) gauging, (2) metering of vented vapour, (3) adsorption of vented vapour, and (4) Chenicek and Whitman method. Of these, (4) is the most widely used and the most reliable, giving results accurate to 0·05% with motor gasoline. It is based on determinations before and after loss of the variations of vapour pressure with percentages evaporated. Evaporation loss data have been determined by this method over a 10-year period with the following results: cone-proof tanks, conservation vents, 1·0 gal./yr./sq. ft./lb. abs. vapour pressure; spheroid and hemispheroid tanks (2·5 lb./sq. in. gauge) 15 gal./day; balloon and gasometer-roof tanks 2·5 gal./day

Pontoon-roof tanks: (*a*) riveted-shell single-seal roof, 60 gal./hr./ft. diam./lb. abs. vapour pressure; (*b*) riveted-shell double-seal roof, 31 gal./hr./ft. diam./lb. abs. vapour pressure; (*c*) welded-shell single- or double-seal roof, 23 gal./hr./ft. diam./lb. abs. vapour pressure.

Similar data are presented for the loss in filling tanks from 40% to 60% capacity, with gasoline of 5 lb. vapour pressure—viz., cone-roof tank 0·22% throughput, balloon and gasometer-roof tanks 0·15%, pressure storage tank at 16·0 lb. abs. pressure, 2·5 lb. venting pressure, 0·10%, and floating-roof tanks nil. From the economic aspect, a floating-roof tank is preferable if the tank is filled more than eight times a year, and if under severe winter conditions a spheroid is recommended. Where a tank is to be worked slowly, a balloon-roof, gasometer-roof, or a pressure-type tank will be the most economical, depending on local conditions. For low-vapour-pressure tanks, cone-roof tanks are almost invariably used. C. L. G.

61. New Type Rustproof Lining for Drums. A. Wachter and N. Stillman. *Oil Gas J.*, 25.3.43, **41** (46), 202.—A product, Nidex, has been developed for preventing the corrosion of drums by water deposited from gasoline. It meets the following requirements: (1) Highly effective rust inhibition and stability with petroleum products, (2) insolubility in petroleum, (3) without effect on petroleum products, (4) good adhesion to the drum-wall and flexibility to withstand rough handling, (5) permanence after prolonged storage in contact with petroleum products, and (6) low cost. Nidex is a solution containing sodium nitrite, a mucilaginous film-forming vehicle, a plasticizer, a wetting agent, and a dye to facilitate inspection. Moderately dirty, rusty, or oily drums can be coated, but returned Nidex-lined drums should be cleaned and re-lined. The coating is applied by spraying an excess of the solution, allowing this excess to drain to the bottom for 4–5 minutes and then pumping it out and drying the drum

at not more than 350° F. for 10–15 minutes. 20–25 drums can be coated with 1 gal. of Nidex solution. Results are given of laboratory tests carried out to determine the behaviour of the lining in practice in the following directions: corrosion prevention, gasoline contamination, shock resistance, abrasion resistance, gasoline resistance, and temperature effects. Field storage and handling tests have been carried out with satisfactory results. A warning is given that Nidex is not suitable for galvanized containers or for use with acidic solutions or products which hydrolyse to acids, and will not withstand exposure to large volumes of water. It should, however, be suitable (in addition to drum lining) for corrosion protection of stored iron and steel. A modified quick-drying product is available for use as a rust preventive coating.

C. L. G.

62.* Solution of Flow Equations for Natural Gas Lines. P. McD. Biddison and G. H. McKay. *Petrol. Engr*, June 1943, **14** (9), 63.—The exact equation, given in U.S. Bureau of Mines monograph No. 6, connecting quantity of gas delivered by a given pipe-line in a 24-hour period, with the dimensions of pipe, pressure and density of gas, etc., does not permit of slide-rule solution for quantity. The quantity calculation is rather tedious, hence the Weymouth equation, giving an approximate value only, is generally employed, as it may be solved by slide-rule.

The authors show that the values given by the approximate equation may be corrected by means of simple charts, thus permitting accurate computation by slide-rule and chart operations only. C. G. G.

63.* Corrosive Effect of Alternating Currents on Pipe-Lines. Starr Thayer. *Petrol. Engr*, July 1943, **14** (11), 82.—It has previously been assumed and stated that corrosion of pipes due to alternating currents (which may use the line, for example, as a return path) is negligible, but recent observations discount this view to some extent.

It is suggested that exposed portions of the pipe may become coated with iron oxide, which acts as a rectifying layer, permitting the flow of direct current at such points, with resulting loss of metal. An experimental cell was set up, and behaved in a manner which lends support to this hypothesis. C. G. G.

64.* Control of Pipe-Line Corrosion. G. R. Olson. *Petrol. Engr*, Aug. 1943, **14** (12), 96.—The electrical basis of the soil corrosion of pipe-lines is simply explained and the cathodic method of protection discussed. Galvanic action resulting in corrosion of pipe-lines can be set up by contact of dissimilar metals, by variations in the composition of metal at different points (due to mill-scale, stresses, etc.), by adjacent variations in the nature of the electrolyte (composition and moisture content of soil), and by contact between old and new pipes. Corrosion takes place at the points where the current leaves the pipe, which may be at holidays in the coating, over water-filled voids in the soil adjacent to the pipe, or at points shielded by soil clods or tree roots from access of oxygen. Stray currents picked up from electric trolley, etc., systems, or generating equipment, may also cause corrosion of nearby lines Cathodic protection is based on the use of an external source of power, greater than that of the corrosion currents, to cause current to flow from the soil to the pipe. The positive side of a d.c. generator is connected to a ground-bed, generally consisting of old pipe, and the negative to the pipe-line to be protected, the current from the pipe being collected and removed through a drain-cable.

Some improvements in ground-bed design have been made, but it is still a source of excessive loss of electrical energy. In some cases rods of zinc are used as anode, and the possibility of using magnesium when cheap enough is being considered. Windmills are the cheapest power producers, but output is irregular, while gas-engine generators are relatively expensive, though their cost is outweighed by the reduction in corrosion. In 5 years protection of 35·8 miles of pipe by 16 cathodic units operating at 0·8 volt pipe-to-soil potential, the number of corrosion leaks has been reduced from 13 to 6. While complete protection can be obtained by the use of sufficient well-distributed current, the cost may be prohibitive, so that it has generally been applied only on bare and poorly coated sections that have suffered severe corrosion and would shortly require reconditioning or replacing, or on coated and bare sections of lines in locations (*e.g.*, river crossings) where leaks would be very expensive.

The economics of any proposed installation should be studied, taking into account the corrosion leak and replacement history of the line and estimating the cost of (*a*) continuous repair of leaks and short replacements as and when necessary, (*b*) complete reconditioning or replacement of the line combined with leak repairs as they occur, (*c*) complete reconditioning or replacement with coating, supplemented by cathodic protection, and (*d*) application of cathodic protection with no reconditioning or coating. C. L. G.

Crude Petroleum.

65.* Crude Oils Produced in New Mexico Analysed by Bureau of Mines. Anon. *Petrol. Engr*, Oct. 1942, **14** (1), 140.—A short summary is given of a report, issued through the Bartlesville, Oklahoma, station of the U.S. Bureau of Mines, dealing with the analysis of the various crudes and giving production data of what is now a major producing state. J. C.

66.* Evaluating Aviation Gasoline Content of Crude Oil. W. L. Nelson. *Oil Gas J.*, 13.5.43, **42** (1), 52.—The properties of aviation gasolines which are principally concerned in delimiting the available yield from a given crude oil are O.N., vapour pressure, and sum of 10% and 50% temperatures.

The total straight-run gasoline (F.B.P. 400° F.) from a sample crude was separated by means of a batch still and 3-ft. packed column into 18 cuts of 5%, and 13 blends of these were made in aliquot parts, giving the cuts 0–5, 5–10, 10–15, etc., and a selection such as 0–15%, 5–15%, 0–25%, 15–25%, etc.

These cuts were plotted with their percentage limits as abscissæ and ordinates respectively, and O. Nos. and Reid V.P.'s marked beside the appropriate points. A "contour map" of O.N.'s and V.P.'s was thus constructed, from which it was possible to read off the maximum yield and composition of an aviation base stock of any desired O.N. and V.P. which could be obtained from the crude under examination. C. G. G.

Gas.

67.* High-Pressure Gas Measurement. D. L. Katz, T. A. Matthews, and C. H. Roland. *Petrol. Engr*, Part 1, Sept. 1942, **13** (13), 82; Part 2, Oct. 1942, **14** (1), 54.—Calculation of the quantity of gas flowing through meters requires the gas density, which involves the compressibility factor to account for deviation from the ideal gas laws. Part 1 compares experimental and calculated compressibility factors for a number of natural gases, and demonstrates the use of this factor for computing the density of high-pressure gas containing small amounts of liquid. The liquid phase may be present through the reduction in pressure accompanying flow, and the resultant problems are discussed in Part 2, which also recommends standard procedures for obtaining orifice correction factors.

Data for a number of natural gases are presented in the form of tables and charts. J. C.

68.* The Value of Raw Gasoline for Gas-Making Purposes. W. H. Ganley and R. W. Stafford. *Petrol. Engr*, Oct. 1942, **14** (1), 134.—A preliminary study has been made of the possibilities of substituting gasoline for gas oil or fuel oil as a gas enricher. The conclusions were that gasoline, properly handled, could be successfully used and, whilst price factors prevent its use to-day, future conditions may arise to make it of interest.

Tests with a laboratory gas machine indicated that superheater temperatures may have to be raised slightly for gasoline, and that all joints and connections would have to be made absolutely tight. Comparative data for gasoline, gas oil, and fuel oil are tabulated.

It is intended to carry out operating trials in the near future. J. C.

69.* Storage of Liquefied Petroleum Gases. H. E. Chambers. *Petrol. Engr*, Jan. 1943, **14** (4), 60.—Advice is given on the purchasing, maintenance, use and gauging of storage and transport tanks for liquefied petroleum gases. Specifications for such tanks have been laid down by the Bureau of Explosives and regulations recommended by the National Board of Fire Underwriters, the A.S.M.E. and the A.S.M.E.—A.P.I.

code for unfired pressure vessels, and the Bureau of Marine Inspection and Navigation. Tanks are available in size from the 2½-lb. container for propane heating a single burner hotplate to special 600,000-gal. tanks for storing natural gas at less than 10 lb. pressure and at about − 250° F. Special steel and special welding-rods are required at this temperature, owing to the brittleness of normal steel, but for normal butane and propane storage the temperature ranges from 30° to −50° F. Regulations control the maximum quantity of liquefied petroleum gas which can be loaded into tanks on one car structure, and the capacity of gas motor-fuel containers. The location of tanks is specified and recommendations are made for the tank supports, fireproofing equipment, and maintenance and type of fittings. The regulations for safe loading of trucks do not appear to be well known, and many unnecessary hazards are run. It is recommended that tanks should be loaded so as to be full only when the temperature reaches 130° F. Thus, propane should be loaded to maximum 84% at 60° F. and butane to maximum 88% at 60° F. Tables are available for calculating deliveries and receipts. C. L. G.

70.* Dehydration of Natural Gas. R. W. Parker. *Petrol. Engr*, Jan. 1943, **14** (4), 110.—The rapid increase in the sales of natural gas (which amounted to 931,814,400,000 cu. ft. in the 12 months ended 3rd June, 1942) has necessitated the use of higher operating pressures in transmission lines, requiring more attention to be paid to the prevention of ice or hydrate formation. The advantages of gas dehydration include: (1) increased line capacity by preventing clogging with condensed water, (2) reduction of internal corrosion, (3) alleviation of dust problems in distribution systems, and (4) elimination of drips, and thus the expense and waste of gas by blowing. The methods in use for dehydrating gas include (*a*) absorption by calcium chloride, with or without additives, glycerine, zinc chloride, and ethylene glycol, (*b*) refrigeration, and (*c*) adsorption, using *e.g.*, activated alumina. With regard to (*a*) diethylene glycol is the most satisfactory from the point of view of absence of corrosion and provision of a high dew-point depression. (The operation, construction, and processing costs and glycol requirements of plants are discussed.) Solid adsorption-type plants are coming into greater use, being particularly suited for high-pressure operations, owing to high dew-point depression, ready availability of adsorbent, simplified process of reactivation, absence of solidification at high pressures, low operating cost, and apparent freedom from entrained losses. (Details are given of the operation of two plants of this type.) Much information is being collected on the chemical and physical properties of hydrocarbon hydrates and on the conditions under which they are formed. It is difficult to predict the hydrate formation characteristics of a gas from the analysis, but it has been concluded that the higher the thermal value of the gas the more readily will it form hydrates. C. L. G.

71.* Liquefied Petroleum Gas Vital to War Production. G. G. Oberfell. *Oil Gas J.*, 14.1.43, **41** (36), 10.—Developments in the liquefied petroleum gas industry during 1942 are discussed. U.S. marketed production during the year was 548,000,000 gal., representing an increase of 19% over 1941. This, the smallest increase since 1938, was undoubtedly caused by war restrictions. Supply increased and is increasing at existing refineries and at specially built new plants which produce unsaturates and other components of aviation gasoline and synthetic rubber.

A table is given comparing major types of use during 1942 with the preceding 20 years. Utilization for aviation gasoline increased rapidly, butane going to isomerization plants and *iso*butane being segregated for alkylation. Propane supplies were affected by the separation of propene for cumene manufacture, whilst some propane has been used for blending with motor gasoline when butane has not been available. As the synthetic rubber programme gets into full swing, taking more of the C_4 cuts, greater emphasis will be placed on propane. Use of propane for lubricating-oil refining and metal cutting, and of liquefied petroleum gas for metal heating during shell and bomb manufacture, has increased. Propane and butane are being used for mining machinery, for army cooking, etc., and for testing and running-in aeroplane engines.

Stand-by storage and other equipment has been put up according to Government requests. Transportation, especially to the East Coast, has been a major difficulty, but has been alleviated by the use of trucks. J. C.

72. Analysis of Natural Gas by Slow Combustion Method. Anon. *Oil Gas J.*, 14.1.43, **41** (36), 59.—The slow-combustion method gives satisfactory results if the gas contains no constituents other than carbon dioxide, carbon monoxide, oxygen, methane, ethane, and nitrogen, and will be applicable to most natural gas used for fuel, since this is usually scrubbed free of hydrocarbons heavier than ethane. In this method carbon dioxide is absorbed in potash, oxygen in alkaline pyrogallol, carbon monoxide in cuprous chloride, after which an excess of oxygen is introduced into the apparatus and the residual gas ignited by means of an electrically heated filament. Hydrogen sulphide is measured separately.

A typical apparatus and procedure are described. J. C.

73. Combustion of Excess Gas. R. A. Fon. *Oil Gas J.*, 25.3.43, **41** (46), 109.—The increasing utilization of refinery waste gases for the manufacture of valuable products has led to the refinery boiler plants being supplied with variable fuels of less suitable quality. Details are given of the way in which a refinery at Lemont, Ill., has applied automatic combustion control to the solution of this problem. C. L. G.

74.* The Production and Uses of Sewage Sludge Gas. S. H. Jenkins. *Petrol.*, 6.7.43, **6** (7), 100; 3.8.43, **6** (8), 115.—Under proper conditions of controlled "digestion," town sewage may be made to yield 3–12 cu. ft. of gas/lb. of dry organic matter, the result of anærobic fermentation. The potential production of sludge gas in England is $12{,}600 \times 10^6$ cu. ft./annum, equivalent to 60×10^6 gal. of petrol. 58×10^3 tons of phosphate (half that present in the raw sewage) would be conserved in the digested sludge which is available as a fertilizer. At present not many sewage disposal schemes use the activated sludge process. The largest in this country are those at Birmingham and Mogden (Middlesex C.C.). The composition of the gas is remarkably constant: CH_4 60–70%, CO_2 25–35%, H up to 5%, and H_2S up to 0·3%. It is used, normally, as the motive power in the works, the surplus, if any, going to the town gas-mains. Washed free from CO_2 and H_2S, the resulting CH_4 is a potential source of I.C. engine fuel and raw material for the chemical industry. H. G.

75. Chart for Calculation of Pressure Drop in Gas Lines. E. N. Kemler. *Refiner*, Sept. 1943, **22** (9), 297–302.—Weymouth's formula is given, together with an approximate equation for calculating the pressure drop in gas lines. Charts based both on the approximate as well as on the Weymouth formula are presented, together with worked examples and a discussion of errors involved. A. H. N.

Cracking.

76. Catalytic Reforming of Straight-Run Gasoline Increases Aromatic Content. V. I. Komaresky and C. H. Reisz. *Oil Gas J.*, 24.6.43, **42** (7), 90.—Briefly outlining the catalytic reforming reactions of pure hydrocarbons, generalizations are made on the reforming of straight-run gasoline fractions. A process for aromatization of gasoline has been developed, and is described. The results are given of laboratory test-runs on catalytic reforming of Pennsylvanian fractions under varying conditions—viz., (*a*) a two-stage, two catalyst ($Pt–Al_2O_3$) or ($Ni–Al_2O_3$) and (Cr_2O_3-Al_2O_3), (*b*) a two-stage, one catalyst ($Ni–Cr_2O_3–Al_2O_3$), (*c*) a two-stage, one catalyst ($Cr_2O_3–Al_2O_3$); and for aviation-gasoline: (*d*) a two-stage, two catalyst ($Pt–Al_2O_3$) and ($Cr_2O_3–Al_2O_3$), and (*e*) a one-stage, one catalyst ($Ni–Cr_2O_3–Al_2O_3$).

The fractions used had the following properties:—

Fraction No.	2	3	2 and 3 combined.
Boiling range	70–100° C.	100–150° C.	70–150° C.
Octane No. A.S.T.M. (M.M.)	58	43	49
Liquid analysis, %:			
Olefins	0	0	0
Aromatics	11	8	6
Naphthenes	18	22	20
Paraffins	78	70	74

(*a*) In two-stage, two catalyst reforming of fraction 100–150° C. after the first stage with Pt–Al_2O_3 or Ni–Al_2O_3 at 310° C., the aromatics increased from 8% to 36%, and the octane value increased from 43 to 51. After the second stage, with Cr_2O_3–Al_2O_3 at 450° C., the aromatics increased from 36% to 54%, the octane value increased from 51 to 75. From the analyses it is observed that in the first stage the Pt or Ni catalyst gave maximum conversion of naphthenes by dehydrogenation into aromatics. The decrease in naphthene content of the original fraction (18%) indicated that the remaining 10% of aromatics were produced by direct dehydrocyclization of the paraffins. No olefins were formed. In the second stage (Cr_2O_3 catalyst) 14% of the aromatics were formed by the dehydrocyclization of paraffins, and the remainder (4%) by the dehydrogenation of naphthenes; in addition, 23% of olefins were formed by dehydrogenation of paraffins.

(*b*) In two-stage, one catalyst (Ni–Cr_2O_3–Al_2O_3) reforming of fraction 100–150° C., with the second stage at 450° C., the aromatics increased from 8% to 60%, the octane value increased from 43 to 75 with a yield of 88·8%. From the graph showing yield–octane relationships, it is seen that for the same yield (88·8%) in a one-stage reforming the product would have an octane value of 71.

(*c*) A two-stage, one catalyst (Cr_2O_3–Al_2O_3) reforming of fraction 100–150° C. gave a yield of 91·6% with an octane value of 65. It is shown that a one-stage process would give a product yield of 61·5% for an equivalent octane value.

Aviation base gasoline. Two fractions, 70–100° C. and 100–150° C., were combined and processed :—

(*d*) The two-stage process with Pt–Al_2O_3 at 310° C. and Cr_2O_3–Al_2O_3 at 475° C. gave 82·6% of product containing 57% of aromatics with an octane value of 80. From the graph it is seen that in a one-stage process an 82·6% yield would have an octane value of 71·5.

(*e*) In a series of reforming tests on the same fraction at 550° C. with Ni–Cr_2O_3–Al_2O_3 in a one-stage process, the highest octane value obtained was 90, when the liquid recovery by volume was 67% (75% by weight). The aromatic content was 76%.

The importance of a nickel containing catalyst is observed in either one- or two-stage processes, better yield–octane relationships being obtained. The nickel promotes the dehydrogenation of hexahydro-aromatics at relatively low temperatures in the first stage, while the chromia catalyst produces the dehydrocyclization of the paraffins in the second stage.

Graphs and tabulated data and a detailed bibliography are given. W. H. C.

77.* Houdry Catalytic Operations at Marcus Hook. Anon. *World Petrol.*, Ann. Ref. Issue, 15.7.43, **14** (8), 52.—The original Houdry catalytic cracking unit at Marcus Hook was the first Houdry plant to come into full-scale commercial operation about 1937. It was a 6-case unit known as plant 11–4, and was designed to work mainly on heavy reduced crude by the "one-pass" system, to produce high-octane motor gasoline, two cases being on process, two on regeneration, and two on purging at any given time. Later, plant 12–3, a 12-case unit, was erected to run on the same feedstock, but operating as a "2-pass" unit, the initial cracked gasoline being revaporized and retreated in a 2-case unit to improve quality. The next addition was a 3-case reforming unit in which high-octane motor gasoline could be produced from coastal naphtha.

The next plant erected, known as 10–3, is the largest unit of all, and is a 12-case unit to which the reforming unit was attached as a second pass treater. Its function was to produce motor gasoline from gas oil.

Early in 1942, as a result of the need for aviation gasoline, a new production programme was drawn up. Instead of motor spirit it was arranged to produce maximum quantities of finished aviation gasoline and of components, involving the production of alkylates, *iso*pentane, etc. With this object in view, plant 15 was designed, and has recently come into operation. It comprises (1) a gas compression and fractionation unit capable of handling all refinery gases and unstabilized gasolines produced in the refinery, (2) an alkylation unit, using HF as catalyst, producing aviation alkylate of about 93 octane number from suitable fractions from the plant, (3) a 6-case Houdry catalytic unit, treating one-pass aviation gasoline from the other Houdry plants at Marcus Hook and also Toledo Refinery. The total cost of plant and auxiliary equipment installed to operate Plant 15 was approximately $9 million.

In the meantime improvements have been made in the type of catalyst used in the process. Instead of a treated natural clay, synthetic catalysts of improved performance are now utilized. Modifications of the process have also been developed whereby aviation fuels of octane number greater than 100 can be produced. Two such methods are known as the "adiabatic process" and the C.T.C., a 3-pass system involving both thermal and catalytic cracking. The "adiabatic process" has been developed to the pilot-plant stage. Full descriptions of the two processes are not available for publication, but the bare outlines are given. Views of sections of plant 15 are also provided. R. A. E.

78.* The Fluid Catalytic Cracking Process. Anon. *World Petrol.*, Ann. Ref. Issue, 15.7.43, **14** (8), 62.—The Fluid Catalytic Cracking Process is similar in principle and in general operating results to the Houdry and Thermofor processes, but differs in practical details, particularly in respect of catalyst and its application. The Fluid process was developed by the Standard Oil Co. of New Jersey, which has three plants in operation and five under construction, each costing approximately $6 million. The catalyst used is in the form of a fine dust, and is moved throughout the circuit by gas velocity or by gravity. Vaporized oil from the furnace picks up finely divided catalyst from a standpipe attached to the catalyst hopper, and carries it along to the bottom of the reactor. Entering the reactor, velocity is lost, increasing the density of the catalyst–gas mixture at that point, and thus increasing both the time and intimacy of contact of the catalyst with the reacting gases. Vapours leave the top of the reactor carrying with them the catalyst powder, which is then separated in a series of cyclone separators. The catalyst-free vapours then pass to the fractionating system. The spent catalyst is collected in a hopper, and is maintained in a "fluidized" condition by admission of steam into the hopper and its standpipe. Passing down the standpipe, the spent catalyst is admitted at a controlled rate into an air-stream from a blower, and is carried to the regenerating chamber, maintained at relatively high temperature, where carbon deposits are burned off. Catalyst and combustion gases pass overhead to regeneration cyclones, which remove the catalyst, which passes to the catalyst hopper. Final traces of catalyst are removed from the combustion gases, before they are vented, by means of an electrostatic precipitator. Both catalyst and spent catalyst hoppers must be placed at such a height that the static pressure developed at the base of the standpipe is sufficient to ensure entry of catalyst into the vapour or air-stream.

Temperature in the reactor normally ranges from 800° to 1000° F., and pressure at the top can be varied, but is normally about 10 lb./sq. in. when operating on gas oil. Reaction temperature can be varied by the heat applied to the furnace or the amount of hot catalyst circulated. Depth of cracking is controlled by the amount of catalyst in the reaction zone and by the ratio of catalyst to oil-flow.

For production of aviation base-stock and increased yields of C_4 fractions, required as raw material for blending agent manufacture, more severe cracking at a higher temperature is needed than is the case for motor gasoline production. A different type of catalyst is also required. Alternatively, a two-stage process may be used for aviation gasoline production, and the improvement in quality obtained is of particular merit where there is a shortage of blending agent.

A flow-sheet and photographs of plant are provided and other operating details given. R. A. E.

79. Cracking Technology. No. 1. Reactions in Cracking Process. C. R. Wagner. *Oil Gas J.*, 2.9.43, **42** (7), 27.—Cracking of petroleum from the earliest days is discussed. Shock-chilling allowed higher temperatures to be employed in vapour-phase operations than in the earlier processes and produced higher octane products without loss of capacity by dropping pressures.

Cracking reactions of ethane and propane are considered, and the possible splitting of the molecule is shown by formulæ. With butane the possibilities are more complex, and as the lengths of the molecules of hydrocarbons increase, the complexity of reaction increases in a geometrical ratio. If time and temperature are set for propane cracking and some *iso*butane is introduced, cracking conditions are too severe, therefore either time or temperature must be reduced. If ethane is present with the propane, conditions are too mild. *n*-Butane with the propane would necessitate

lower time or temperature than would be required for *iso*butane and propane. If *n*-pentane or *n*-hexane were introduced, under the correct operative conditions for cracking a mixture of *iso*butane and *n*-butane, the conditions would be far too severe, and coke formation would proceed rapidly.

From the literature on the subject, it appears that cracking rates are doubled for each 18 to 30–35° F. rise in reaction temperature, the rate depending on the charging stock, temperature range, and other factors. W. H. C.

80.* Cracking Technology. No. 3. Viscosity-Breaker Coil Operation. C. R. Wagner. *Oil Gas J.*, 16.9.43, **42** (19), 53.—Two types of recycle oil that caused trouble in liquid-phase cracking operations are discussed. One type was a very high-boiling-range waxy material which had an A.P.I. gravity of 8–16°, which would produce a small amount of gas and a large amount of coke, when cracked. The second type was found in the light fractions, and had a distillation range of about 400–475° F. To overcome the difficulty they were passed through a viscosity-breaking coil in which lighter gas-oil fractions were produced for recycling. Temperatures of 890–915° C. at 200–500 p.s.i. with relatively high velocity accomplished this without coke formation, and gave a fuel oil of low viscosity.

Generalizations are made on pressure, time, and charging stocks under cracking and polymerization conditions, and some thermokinetics are briefly recorded.

As the hydrogen content, or paraffinicity, of the charge is increased the cracking temperature is lowered, decomposition per pass is greater, and secondary reactions are greater per pound of gasoline made than for a charge of lower hydrogen content.

A flow-sheet of the plant is shown. W. H. C.

Polymerization and Alkylation.

81. Alkylation and Isomerization Combined in Aviation-Gasoline Plant. F. M. Simpson. *Oil Gas J.*, 24.6.43, **42** (7), 89.—As the ratio of *iso*butane to olefins in thermally cracked gases at the Cities Services Co.'s refinery is considerably lower than the requirements of 1 : 1 for alkylation purposes, a plant was designed to offset the shortage by combining an alkylation unit with an isomerizing unit for the production of *iso*butane from *n*-butane.

All gases and distillates from existing thermal cracking and reforming units are stabilized and passed through a fractionator, from which a cut is taken containing the butenes, butylenes, *iso*butane, and *n*-butane, this after debutanization, (1) is used as the principal feed for the alkylator. From depropanized straight-run gasoline, *n*- and *iso*butane are separated in a straight-run debutanizer column. The debutanized stream passes to a de*iso*pentanizing tower for separation of *iso*pentane and *iso*butane, (2).

In the alkylation process (1) is caustic washed and passes to the reactors. The straight-run fraction (2) and the butane–*iso*butane from the isomerization unit with the effluent from the alkylator are charged to the *iso*butane tower. The overhead *iso*butane is mixed with H_2SO_4 catalyst and passes to the reactor, in which the olefins and *iso*butane form an alkylate. Unreacted material and propane go overhead to a column to be depropanized, and the bottoms are recycled to the reactor. The alkylate effluent from the reactor is caustic washed and passes through a tower for de*iso*butanizing; from this tower it passes to the debutanizer, and then to a re-run column in which aviation alkylate is stripped of any heavy alkylates. The butanes from the debutanizers are heat-dried and charged to the isomerization unit, passing through a catalyst bed of $AlCl_3$ on Porocel, in contact with HCl gas, about 40% conversion of the butane takes place. The HCl butane–*iso*butane mixture is stripped of its HCl, and the hydrocarbons are caustic washed and returned to the *iso*butane tower for separation. W. H. C.

Refining and Refinery Plant.

82.* Refinery Applications of Rotary Pumps. Part 1. R. G. Lovell. *Petrol. Engr*, Oct. 1942, **14** (1), 38.—In a discussion of the characteristics of rotary displacement pumps in general use the following types are dealt with : the lobe, the spur and herring-bone gear, the screw, the internal gear, and the swinging-vane type. No one design

is considered superior to all others in all respects, but each possesses certain advantages for particular applications. J. C.

83. How to Double Your Heat-Exchanger Surface. W. L. Nelson. *Oil Gas J.*, 14.1.43, **41** (36), 34.—A method is described by which existent heat-exchanger equipment can be made to go further. For example, in a usual set-up of six exchanger units it is possible to remove two without decreasing the efficiency of the remaining four by a proportional amount. The remaining four may recover over 90% as much heat as the six units, instead of the 67% which might be expected. The heat recovered by four units in the old service plus two in a new service will be greater than when all the units are used in a single service. The penalty is a decrease in thermal efficiency, which is not considered too great a price to pay in view of the critical scarcity of heat-exchangers.

Examples are given of the methods of computing the performance of the abbreviated systems. J. C.

84. Contact Filtration as an Aid to War-Time Production. R. C. Davidson. *Oil Gas J.*, 25.3.43, **41** (46), 87.—A review is presented of a number of systems which can be used for the contact filtration of motor oils, depending on available equipment, with a discussion of the effects of time and temperature, nature of adsorbent, and of the equipment requirements and costs. The systems described are: (1) the recommended procedure for finishing motor oils, in which the mixed oil and clay are heated, passed to a steam-vacuum stripper to remove light volatiles, cooled, and passed to a continuous vacuum precoat filter; (2) an intermittent process in which the oil and clay are circulated between heater or exchanger and an insulated tank until the correct temperature is reached and the slurry pumped to a filter-press; (3) a similar process to (2) in which the heated oil and clay are passed to a stripper and then to a filter-press; (4) a system for continuous moderate temperature contacting in which part of the oil only is mixed with the clay, this heavy slurry being then passed into the main stream; (5) a batch-operation process using a shell-still in which part of the oil is heated, the remainder of the oil mixed with the clay being run into it slowly; the still can be tilted slightly to facilitate removal of the oil and clay; (6) a method of contacting, utilizing the residual heat from the bottoms of a fractionating column to heat the oil; (7) a similar method to (6), in which the oil and clay are added to the oil in the bottom of the column; and (8) the Filtrol process, in which the raw stock is mixed with clay and charged to the still and fractionation column.

An investigation into the effects of contacting time and temperature revealed that on stable stocks a slight temperature rise will cause a greater increase in the relative decolorizing efficiency of the clay than will an enormous increase in length of contact time. Laboratory tests must be carried out with the oils in question to evaluate the conditions required for optimum improvement in characteristics such as oxidation values or steam emulsion numbers. The chemically activated clays are dearer than the natural clays, but much more efficient, so that handling costs and loss of oil are reduced. The main items in the cost of a contact filtration unit are the heater and the filter presses. A new 1000-brl./day heater will cost about $5000, whereas Sweetland filter presses will cost about $9–19, secondhand to new, per sq. ft. of filter area.

C. L. G.

85. Heat Transfer Coefficients for Condensers. G. T. Atkins. *Oil Gas J.*, 25.3.43, **41** (46), 180.—There is little or no published information on the subject of heat-transfer coefficients for condensing vapours suitable for rating commercial shell and tube condensers handling vapour mixtures condensing through a fairly wide temperature range. It is hardly possible to take account of the many complex phenomena obtaining, but by selecting and correlating the factors of greater importance, a good working solution has been obtained. Data have been collected on a variety of condensers and condensable mixtures, and the overall heat-transfer coefficients measured, the various factors being adjusted so that calculated and measured coefficients are in agreement. Theories of heat transfer are fully discussed, and the method of calculating the heat-transfer coefficients explained. Test data on ten installations expressed in terms of the derived results illustrate the range and magnitude of the variables. It is concluded that cross-baffling within limits can aid in improved performance,

and thus in economy of heat-transfer surface and in conservation of the materials used in the construction of heat-transfer apparatus. C. L. G.

86. Water Treating. C. E. Erb. *Oil Gas J.*, 25.3.43, **41** (46), 198.—An extensive review is given of methods of treating water from the point of view of reducing corrosion, priming, foaming, caustic embrittlement, and scaling. The factors giving rise to these difficulties are also discussed. Attention is directed to the possibilities of vapour-phase treatment with solutions of inhibitors—*e.g.*, chrom-glucosates—to reduce corrosion on the condensing side of the boiler system. C. L. G.

87. Chemical Treatment of Boiler Water. J. D. Betz. *Oil Gas J.*, 25.3.43, **41** (46), 223.—The problems confronting the water-treatment engineer in the prevention of scale, corrosion, carry-over, and embrittlement of boilers are discussed, and the general methods used for water treatment outlined. C. L. G.

88. Refineries Operating in the United States, Canada, and Mexico. Anon. *Oil Gas J.*, 25.3.43, **41** (46), 231.—Lists are given showing the location, crude-oil capacity, cracked-gasoline capacity, and type of the refineries operated by different companies in each State of the United States and Canada and in Mexico. A further list gives similar data on shut-down plants in the U.S. C. L. G.

89. Sulphur Removal from Sour Crudes Reduces Corrosion, Improves Product Quality. Arch L. Foster. *Oil Gas J.*, 24.6.43, **42** (7), 111.—The paper presents information on the methods for the removal of sulphur and sulphur compounds in crudes and distillates, particularly gasolines. Processing treatment is divided into two groups, (1) those which sweeten, or change the corrosiveness of kerosines, etc., without necessarily reducing or eliminating sulphur, (2) those which remove sulphur as their primary purpose. Group 1 includes Doctor treatment, lead sulphide, hypochlorite, and copper chloride treatments. Group 2 includes desulphurizing methods by caustic scrubbing, H_2SO_4 treatment, solutizer (potassium *iso*butyrate and hydroxide), Unisol (caustic methanol), and for gases the Koppers (sodium phenolate), Shell (potassium triphosphate) or the Girbotol (amine) processes, and the catalytic methods of the Gray, Schultz or Perco, and Houdry processes. Brief notes are made, on the Lachman $ZnCl_2$ process, the work of Mustaov and Krymova using $ZnCl_2$ and $Zn(OH)_2$, and on two important advances in acid treating by the Haloran and Stratcold methods.

Under each group each section is discussed, and, where possible, equations and data relating to T.E.L. response are included. W. H. C.

90.* Treatment of Liquid Phase Cracked Gasolines with Zinc Chloride. M. M. Gerasimov, V. E. Glushnev, S. F. Vasil'ev and S. N. Solodov. *Petrol. Engr*, Aug. 1943, **14** (12), 151.—The results are given of plant-scale tests on the refining of liquid-phase (Winkler Koch) cracked-pressure distillate with zinc chloride. The pressure distillate, heated in a pipe-still to 225° C., is charged into a tower containing $ZnCl_2$ precipitated on pieces of coke 2–12 mm. in size, from which gasoline of required boiling range is taken off overhead. Light gasoline of O.N. 75·5–76·5 is produced, a corresponding clay-treated gasoline having an O.N. of 72 only. Motor spirit of 73 O.N. can also be produced, both products having satisfactory gum stability and other properties. During the production of light gasoline a naphtha of 68 O.N. is produced. Refining losses and polymers amount to 3·5% when producing light gasoline and 7·7% when producing motor gasoline. C. L. G.

91. A Graphical Method Useful to the Piping Detailer. Anon. *Refiner*, Aug, 1943, **22** (8), 238.—A nomograph is given for determining the distance between the intersection of the tangents to the two limbs of a pipe-bend at the centre line and the corresponding intersection point taken on the outside of the pipe. A. H. N.

92. The Design of Foundations for Stacks and Towers. V. O. Marshall. *Refiner*, Aug. 1943, **22** (8), 251–268.—A similar paper appeared in the *Refiner* of December 1939. In this paper a more detailed account is given of the design problems met and

method used to solve them. From the viewpoint of the foundation designer, stacks and towers may be divided into two general classifications, depending on the method utilized to maintain them in a vertical position : (*a*) self-supporting, which resist the overturning forces by the size, shape, and weight of the foundation, (*b*) guyed, in which the overturning forces are resisted by guy-wires. It is obvious that the conditions affecting the design of foundations for these two types will not be the same, and that it is necessary to treat them separately. The same principles apply to foundation design for either stacks or towers. In the case of stacks, the brick lining is a variable load, corresponding to, and requiring the same treatment as the liquid, insulation, etc., in a tower. The paper deals with foundations of towers of both classifications, but, of course, applies equally well to foundations of stacks.

A. H. N.

93. Tube Cleaners—Their Application and Maintenance. L. A. Kunzler. *Refiner*, Aug. 1943, **22** (8), 245–250.—Practically all refinery cleaners are air-driven, although some are steam-driven. Therefore it seems logical to start an investigation at the source of power, or at the compressors. Assuming the compressors are in good operating condition, it will require very little time to check the maximum air volume required through each air-line against the pressure drop. For example, a 2-in. air line 1000 ft. long with 100 lb. pressure at the compressor end will have a pressure drop of approximately 9·95 lb. while passing 300 cu. ft. a minute, and if the pressure is raised to 125 lb. the drop will be only 8·18 lb. Any handbook will supply data for the condition, but it must be remembered that numerous valves, elbows, and leaky connections increase the pressure drop. Undoubtedly some pressure drop can be eliminated by streamlining the air lines, removing old lines in use, and correcting leaky valves.

It is a very simple matter to put a pressure gauge on the air-supply line at the still platform and check the actual pressure drop. A medium-size motor requires 150 cu. ft. a minute when 80-lb. pressure is supplied at the motor. Therefore, reducing the pressure drop will pay in many cases. It is also preferable to reduce the number of cleaners operating on one supply line, thus increasing the pressure to the remaining motors. A motor operating at low air pressure will not be effective in hard coke, and will require more time to clean a tube, while the maintenance will be practically the same.

The paper details methods of correct maintenance of hose and couplings of the motor and of the cutters. Suggestions for correct operation of cleaners are appended.

A. H. N.

94. Maintenance of Electronic Controls. W. D. Cockrell. *Refiner*, Aug. 1943, **22** (8), 269–272.—This article is not intended to be an exhaustive step-by-step treatment of the maintenance of particular electronic controls, but rather a " highlight " discussion of good maintenance, trouble-finding, and trouble-correcting practices on electronic controls generally. Photo-electric and other electronic controls involving mechanical components should be checked frequently to assure that the mechanical adjustments have not been disturbed. Common causes of such disturbances are bolts loosening under vibration or chain hoists and other shop equipment hitting against the equipment. Very rarely does a modern electronic tube fail suddenly. Usually the failure is the result of a gradual loss of emission that takes place as the active cathode material is used up or flakes off. Overloading, mechanical abuse, operation at high or low filament or cathode heater voltage, and operation outside of required temperature limits all tend to shorten tube life. Among the most prevalent causes of poor operation and short tube life are the operation of electronic panels on line voltages differing too greatly from the panel name-plate voltage, and the use of the wrong tap when a tapped-input transformer is provided. Panels are usually designed to operate satisfactorily on line voltages varying plus or minus 5% of the panel rating. If the voltage at the installation point is consistently high or low, a small auto, or booster, transformer may be used. If the line voltage fluctuates widely, a special voltage-regulating transformer may be required. Faulty heater transformers, loose connections, and corroded socket connections also may limit the low-voltage, high-current power required for the tube cathode heater.

Gas-filled tubes and high vacuum tubes can tolerate wider ranges of ambient

temperatures than those filled with mercury vapour. After the discussion of general causes of trouble, the paper deals with failures and their cures under three headings: (1) first starting a new equipment; (2) when starting after a normal shut-down; and (3) during operation. A. H. N.

95.* Selecting Rotary Pumps for the Refinery. L. G. Lovell. *Petrol. Engr*, Sept. 1942, **13** (13), 58.—To assist in the selection of the most suitable type of pump for oil-refinery duty, a review is given of the development, uses, and performance of rotary pumps. Methods of determining capacity ratings, mechanical, and volumetric efficiency, and actual and theoretical output are outlined, and a table is given of friction loss in pipes of different sizes handling oils of varying viscosity. C. L. G.

96. Production of Hydrocarbons for Aviation Motor Fuels. M. Van Winkle. *Refiner*, Sept. 1943, **22** (9), 273–278.—The rapid growth in the demand for 100-octane fuels is discussed. A table gives specifications for 100-octane aviation gasoline. A study of the specifications for the 100-octane-grade aviation gasoline indicates that such a fuel can rarely be made by following ordinary refining procedures. The narrow boiling range, high stability requirements, and high octane number in conjunction with a low permissible tetraethyl lead content of the finished product prohibit the use of simple fractionation of straight-run and cracked gasolines to the desired boiling range and "leading" to the required octane number. Therefore, it is necessary to use blending materials having suitable characteristics, particularly high-blending octane numbers and lead susceptibles, to produce the high qualities necessary in 100-octane aviation gasoline. The first fuel of this grade was composed of a blend of straight-run naphtha, *iso*-octane, *iso*pentane, and tetraethyl lead. As new processes were developed, different types of base stocks, as well as high-octane blending components, came into use, and the composition of 100-octane aviation gasoline varied greatly from that of the first type produced. Several of the possible compositions are shown in a table.

The high-octane blending components are *iso*pentane, *neo*hexane, *iso*-octanes, substituted benzenes, and benzene. These are compounds or relatively pure mixtures of compounds which are not all available in the necessary quantities from physical separation methods applied to petroleum. *iso*Pentane is recoverable from fractionation of natural gasolines and crude oils and benzene, and some benzene derivatives are available from the destructive distillation of coal. Most of the high-octane blending components, however, must be produced synthetically by means of hydrocarbon-conversion processes in order to ensure their availability in the quantities needed. There are two principal methods used in the manufacture of high-octane hydrocarbons. One involves the combination of suitable small hydrocarbon molecules to form larger ones having satisfactory fuel characteristics, and the other involves the rearrangement of the structure of larger hydrocarbon molecules without changing their size. Polymerization and alkylation are examples of the first method, and isomerization, aromatization, and cyclization are examples of the second. The various methods used are tabulated, together with their chief characteristics. The paraffins, with the exception of *iso*butane, are available from crude oil and natural gasoline in sufficient quantity for process demands; the olefins are available from cracking processes, although in some plants the necessary amounts of the right kind of olefins are lacking; and benzene is available in large quantities from destructive distillation of coal. The charge materials, of which there are insufficient quantities, are produced by means of conversion processes. For example, catalytic isomerization of butane produces *iso*butane, catalytic dehydrogenation of butane and *iso*butane produces butenes and *iso*butene, and aromatization of hexane, heptane, etc., produces benzene and other aromatics. In addition to the processes necessary for the production of suitable charge materials, it is further necessary to process the olefinic product obtained from polymerization to convert it into a saturated *iso*-paraffin. This is accomplished by hydrogenation.

The processes which are being utilized commercially in the manufacture of high-octane hydrocarbons are: (1) alkylation, (2) isomerization, and (3) polymerization. Accessory processes for the preparation of charge-stocks or the treatment of products from the conversion are: (1) dehydrogenation, (2) isomerization, and (3) hydrogenation. Each process is discussed separately. A. H. N.

97. Reviving Small Gate Valves. Anon. *Refiner*, Sept. 1943, **22** (9), 295–296.—By rebuilding valves a certain refinery has extended their useful life considerably. The system of rehabilitation involves the customary segregation at plants and periodic delivery to the salvage depot. After dismantling each valve, its parts are strung together on a wire, and as many as 50 dismantled valves are immersed in a cleaning solution, then steam-rinsed. This is followed by an acid bath, another rinse, and then immersion in a "brass dip," a chemical solution which restores original bright colour. This is an aid to visual inspection. The valves are segregated on the basis of type and manufacture as an aid to re-assembly. First comes inspection of stems. Those only bent are repaired. Broken stems are replaced from new stock or from new stems made by turning down stems from larger valves. Then all parts are subjected to a wire brush to remove any remaining foreign matter. Special tools have been designed for regrinding bodies and seats. If the valve has a ground joint fitting to the body, two tools are required for re-surfacing, a concave device with a sheet of abrasive cloth to smooth the body, and a convex device for the body. A few turns with grinding compound are sufficient to lap parts together and assure leak-proof assembly. Re-facing is accomplished with the seat in place. Re-grinding and the use of special tools is described, together with final refitting. A. H. N.

98.* Superfractionation's Place in Refining. Anon. *World Petrol.*, Sept. 1943, **14** (10), 41.—During recent years, especially with the advent of chemical processes in the refining industry, the application of good fractionation has become of increasing importance. Not only must the raw material for the process be of closely controlled quality in order to obtain the best results in processing, but often the finished material, being the raw material for other manufacturing processes, must also be of a high degree of purity. Instances are butadiene for synthetic rubber manufacture and toluene for T.N.T.; without equipment for superfractionation it would be difficult and costly to meet required specifications for these materials.

It was chiefly the need for separating butanes from natural gasoline for *iso*-octane manufacture that prompted efforts to make superfractionation commercially workable in the oil-refining industry. In most installations designed for this work use is made of bubble towers operated with high reflux ratios. Towers containing 40 trays each have been used as standard and connected in series as occasion demands. One commercial installation now in routine service utilizes 80 plates and operates with a reflux ratio of 25 to 1.

Products having an overall boiling range of 18° F. are commonly prepared, and for specific applications this can be reduced to 4·5° F. or even less. Recently azeotropic methods and selective solvents have to be used to supplement the work of the fractionating towers where products of exceptional purity are required. R. A. E.

99.* Correct Stabilizing Treatment Plus Tailored Control Eliminate Scale in Cooling Systems. W. H. Thompson and J. W. Ryznar. *Oil Gas J.*, 16.9.43, **42** (19), 43.—The subject of water softening is discussed from the following aspects :—

(*a*) The concentration ratio as affected by composition and quantity of make-up water.
(*b*) Effectiveness of stabilizing chemicals.
(*c*) The p_H value of circulating water, including effect of temperature, design of system, and composition of make-up water.
(*d*) Pretreatment.
(*e*) Auxiliary treatment for corrosion prevention.
(*f*) Direct treatment with stabilizing chemicals.

(*a*) A close estimate for make-up water is obtained by the formula :—

$$\text{Total quantity of make-up water, gallons per hour} = \frac{\text{Concentration ratio}}{\text{Concentration ratio} - 1} \times \text{Evaporation loss in spray per 24 hours.}$$

Evaporation loss of sprays is usually taken as 1% of the water sprayed for each 10° F. drop across the sprays.

(*b*) Each type of stabilizing chemical has its optimum dosage above or below which increased scale is obtained. Their action is different from that of other softening

or acidification processes. Inorganic and organic agents are discussed; combinations of the types are more efficient than one type alone.

(*c*) The p_H value is important for (1) the prediction of results, (2) in the control required for scale and corrosion prevention. (1) Depends on composition of make-up water, ratio of concentration being carried, on temperature and efficiency of the equipment; and affords information governing the selection of proper combination of pretreatment and stabilizing treatment. (2) Actual conditions governing corrosion prevention or scale deposition, at any specific p_H value in the water, are the combination of a number of factors—*e.g.*, Ca, Mg, Fe content, temperature, dissolved salts, etc.

(*d*) Pretreatment methods are discussed: (1) removal of objectionable solids by filtration, etc., (2) by base exchange (zeolite), (3) by conversion of bicarbonates to sulphites (acidification).

(*e*) Auxiliary treatment for corrosion prevention includes deæration, use of anodic inhibitors (chromates, silicates, phosphates), and cathodic inhibitors (Ca or Na bases).

(*f*) Direct treatment with stabilizing chemicals includes the use of different types, the selection of which depends on the composition of the make-up water and conditions of the cooling system. W. H. C.

Metering.

100. New Processes Require More Powerful Automatic Control Equipment. J. B. McMahon. *Oil Gas J.*, 25.3.43, **41** (46), 90.—Processes such as catalytic cracking present difficulties in automatic control owing to the considerable pressure resistance offered to moving valves, etc. The ordinary air-operated diaphragm motor is limited as to its stroke and the available power it can exert, particularly over the large butterfly valves used in modern large-scale units. Piston-operated power units have been developed to move and position the large dampers and butterfly valves used in automatic combustion control regulators for large boilers and steel mills, and it is suggested that they should be used in the petroleum industry. The principles and mode of operation of automatic controllers of this type are fully discussed. C. L. G.

Chemistry and Physics of Hydrocarbons.

101. Vapour-Pressure Chart for Volatile Hydrocarbons. R. Vincent Smith. *Petrol. Engr*, Jan, 1943, **14** (4), 145; Feb. 1943, **14** (5), 88.—The integrated Clapeyron–Clausius equation, $\log p = -A/T + B$, predicts a linear relationship between absolute temperature and log of vapour pressure. Experimental data on hydrocarbons, however, yield lines with slight curvature.

The present chart is constructed by plotting collected data on paraffins up to *n*-dodecane on semi-logarithmic paper, ordinates and abscissæ being log p and $1/T$, respectively, scales of p and T being shown for convenience.

The chart has been useful in fixing cut points in distillation procedures at various pressures. A survey of known data for the paraffins in this range is included, with 48 references. C. G. G.

102.* Hydrocarbons in Petroleum. Frederick D. Rossini. *Petrol. Engr*, Feb. 1943, **14** (5), 41.—A review of A.P.I. Research Project No. 6 on Hydrocarbons in Petroleum, with reference to the foundation, terms of reference, organization, working methods, and results so far attained by the Project.

Subjects discussed in some detail are: General method of operation; Fractionation processes (straight, alternate pressure, and azeotropic distillation; extraction; adsorption; crystallization): Property determination and assessment of purity: Hydrocarbons isolated from gas, gasoline and kerosine fractions of Mid-Continent crude (table of 69 hydrocarbons listed): Separation of the lubricant fraction: General classification of types of hydrocarbons present in the lubricant fraction: List of 80 publications of Project 6. C. G. G.

103. Transparent Water-in-Oil Dispersions: the Oleopathic Hydro-Micelle. T. P. Hoar and J. H. Schulman. *Nature*, 24.7.43, **152** (3847), 102.—The production of transparent soluble oils with continuous oil phase requires (1) high soap/water ratio,

and (2) the presence of an alcohol, fatty acid, amine, or other amphipathic substance in molar fraction approximately equal to that of the soap.

The properties of such systems may be explained by the hypothesis that the disperse phase consists of submicroscopic micelles with a core of soap-in-water solution and an orientated surface monolayer of soap ion-pairs separated laterally by undissociated molecules of the amphipathic substance.

Values of the diameters of the micelles and the thicknesses of the monolayers predicted for specific systems on the basis of this hypothesis agree well with the optical properties (Tyndall effect) of the systems and with known values of soap monolayer thicknesses.

The properties of such systems on dilution with water are explained. C. G. G.

104. The Bloom of Petroleum Oils. J. de Ment. *Refiner*, Aug. 1943, **22** (8), 233–235.—In the market of lubricating oils, fluorescence or bloom is associated with quality—green with good and blue with bad quality. The green fluorescence or bloom is most often associated with quality in lubricating-oil stock, and certain lubricating-oil stocks not having this green fluorescence may acquire a blue fluorescence. This happens generally when the lubricating stock is an oil which has been obtained from a crude petroleum oil by distillation, and is called "overhead stock." In the manufacture of lubricating oil from crude oil which is asphalt-free, a green fluorescence is observed in the residue left after removal of the lower-boiling-point oils, even when the residue has had a light cracking to crystallize its amorphous wax. Lubricating oil produced from this kind of stock generally shows the green fluorescence. Commercial production of lubricating oil showing a green fluorescence has been accomplished by light cracking a lubricating-oil distillate obtained from a California asphalt-mixed-base petroleum oil containing about 4% paraffin wax.

Many organic substances which possess a closed ring or aromatic structure or one or more unsaturated bonds will show a bright and characteristic fluorescence or glow if placed under ultra-violet light or other radiations. Certain substances may be so markedly luminescent that they will show this property in strong visible light. This is exactly the case in the bloom of petroleum oils. Resonating structures, covalent linkages, and certain of the more complicated types of bondings may so respond to radiation striking them that, in terms of the physicist, they may have their energy raised to an upper level. This increase in total internal energy may arise essentially in additions to the energy of electrons, and to the energy of the vibrational and rotational movements of the molecules in the system. When this energy state is destroyed the energy is released as light, and the system drops back into its original configuration.

Should a number of like molecules be closely neighbouring, the absorption of energy may be insufficient to cause fluorescence, as an equal distribution to all occurs before any one can build to a stage where the release of light is permissible. This is seen in many solids and in concentrated or pure liquids. Cases where the particles are well dispersed frequently luminesce strongly, and this view is basic in the explanation of the luminescence mechanism. In liquids, however, there is one region where an appreciable fluorescence can occur without interference from near-by particles.

Methods of imparting green fluorescence by polymerization of aromatic or olefinic compounds are discussed. The use of substances extracted from coal tar or other coal products is also discussed. Finally, methods of testing or inspecting oils for fluorescence are given. In the absence of any auxiliary equipment, and for a quick study in daylight, fluorescence is best appreciated if the oil is smeared or poured in thin layers on to a dark or not brightly coloured plate and inspected in bright daylight from an oblique angle. The bloom will be seen at the surface and at the edges of the spot better than at any other part of the oil. Oil emitting from a fine jet may also be inspected for bloom, but this method is not as satisfactory. A. H. N.

105. Nomograph for Finding k in Smoker's Equation for Binary Distillation. C. H. Bisesi. *Refiner*, Aug. 1943, **22** (8), 236–237.—Smoker has developed a mathematical expression in place of the step-wise procedure of McCabe–Thiele for the determination of the number of theoretical plates required in the separation of binary mixtures. The Smoker equation assumes Raoult's law and an essentially constant relative volatility. The original article should be consulted for a description of Smoker's

method. However, use of the method involves the solution of the following quadratic equation in order to obtain a value which has been called k :—

(1) $m(a - 1)k^2 + [m + b(a - 1) - a]k + b = 0$

where k is the root between 0 and 1, and

(2) $m = R/(R + 1)$ (for rectifying section).
(2a) $m = [Rx_f + x_p - (R + 1)x_w]/(R + 1)(x_f - x_w)$ (for stripping section).
(3) $b = x_p/(R + 1)$ (for rectifying section).
(3a) $b = x_w(x_f - x_p)/(R + 1)(x_f - x_w)$ (for stripping section).

This k value is needed to calculate several quantities which appear in the final form of Smoker's equation. Once k is obtained, the equation can be solved readily. The nomograph gives the values of k from knowledge of m, b, and a the relative volatility.

A. H. N.

106. Butane and Pentane Content of Petroleum Products. W. L. Nelson. *Oil Gas J.*, 12.8.43, **42** (14), 58.—Data are presented on the content of normal and *iso*butanes and pentanes, and the ratios of *iso* to normal hydrocarbons in a variety of light petroleum products. An approximate indication of the composition of relatively pure mixed butanes or pentanes can be obtained from the specific gravity or vapour pressure from charts (reproduced) showing the variation of these properties with the composition of mixtures of (*a*) normal and *iso*butane and (*b*) normal and *iso*pentane. Evaporation tests, such as the weather test specified by the California Natural Gas Association, will also indicate, *e.g.*, the purity of *iso*butane or the *iso*pentane content of a butane mixture. The temperature at which the vapour pressure of a hydrocarbon mixture is equal to atmospheric pressure (obtained by plotting on a vapour-pressure chart) is an indication of the composition of the mixture. It is also suggested, as a very rough approximation, that the butane content of common light petroleum products is equivalent to the vapour pressure in lb./sq. inch. C. L. G.

Analysis and Testing.

107.* Significance of Ignition Temperature Test of Fuels. A. W. Trusty. *Petrol. Engr*, Jan. 1943, **14** (4), 78.—The ignition temperature of a particular mixture of a fuel and air is defined as the temperature at which heat lost by the system is more than counterbalanced by the rate at which it is evolved by the reaction, resulting in a temperature rise until ignition occurs and a flame appears. There is thus a variable lag between the ignition temperature and the appearance of flame. The extent of this lag is shown by a series of curves for ethane and air mixtures at various ignition temperatures and pressures. The A.S.T.M. have standardized a method of determining the spontaneous ignition temperature (A.S.T.M. D. 286—30, briefly described). It is emphasized that the considerable variation in experimental values found in the literature is due to difference in testing methods. The important variables are: material of ignition vessel, concentration of oxygen in the mixture, volume of the ignition chamber, time-lag before ignition, and pressure. Ignition in oxygen generally gives a more violent explosion and a lower ignition temperature than in air. (A table showing this difference for hydrocarbons, etc., is given.) In all crucible methods the volume of the ignition chamber does not allow of sufficient oxygen for theoretically complete combustion. The time-lag has a large effect, as it allows of decomposition to products of different ignition characteristics. In general, increases in pressure reduce the ignition temperature, a sudden drop occurring at a definite critical pressure. There is no relationship between the flash-point of an oil and its ability to ignite spontaneously inside an engine cylinder. The following conclusions are reached concerning the effect of chemical composition: (1) simple molecules have higher S.I.T. than similar complex molecules; (2) open-chain paraffins have low S.I.T. which decreases with increasing molecular weight; (3) branched-chain paraffins have much higher S.I.T. than straight-chain paraffins; (4) olefins have variable S.I.T., but generally higher than the corresponding paraffins; (5) naphthenes have higher S.I.T. and aromatics higher still than normal paraffins and olefins, though less than some branched paraffins; (6) alcohols have higher and aldehydes much lower S.I.T.

than the corresponding hydrocarbons; (7) amino-groups cause a marked increase, and bromine or chlorine atoms or nitro-groups a decrease, in S.I.T. when introduced into hydrocarbon molecules. C. L. G.

108. Viscosimetry and New Graphical Viscosity Classifications. C. M. Larson and W. C. Schwaderer. *Oil Gas J.*, 15.7.43, **42** (10), 49.—This article, although not fulfilling its ambitious claim to be "a complete treatise on everything worthwhile on the subject of viscosimetry," nevertheless represents a valuable compilation of useful data, most of which is presented graphically.

It deals chiefly with the application of viscosity and viscosity–temperature relationship to the selection of lubricating oils for specific purposes. So that the user may avoid the computations, interpolations, numerical conversions, etc., necessary when using most of the existent scattered data, four new viscosity classification charts have been designed, and these show by simple inspection :—

(1) Viscosity index, derived from kinematic or Saybolt viscosities at 210° F. and either 100° F. or 130° F.

(2) Conversion of kinematic to Saybolt viscosity and vice versa.

(3) S.A.E. numbers—crankcase oil-viscosity classification.

(4) Automotive manufacturers' viscosity classification.

(5) S.A.E. numbers—transmission and axle lubricant classification.

(6) Viscosity–temperature relationship.

The upper and lower limits of the S.A.E. and automotive manufacturers' oils are also indicated by red lines, etc., on the V.I. charts. Detailed explanation, with examples, is given of the numerous methods of using the charts for the deduction of viscosity characteristics.

The relationship of absolute to conventional units and the limitations of the V.I. function are explained. The authors suggest that V.I. should be stated to the nearest unit division of 5, thus implying an accuracy of $\pm 2\frac{1}{2}$ units in any specified V.I. number. The so-called V.I. improvers (additives) are considered to create a "false viscosity" and to give a V.I. not representing the true rating of the oil.

In a discussion of viscosity requirements for practice, minimum viscosities at the working temperatures for safety are quoted for lubricants for turbines, automotive bearings, heavy duty automotive engines, aircraft engines, reduction gears, transmission gearing, and exposed gears. Some of these limiting figures are marked on the charts.

A novel feature provided is a combined viscosity blending and dilution chart for fuels and lubricants. This provides, *inter alia*, a means for rapidly estimating the proportion of gasoline, kerosine, or diesel fuel diluent in a used lubricant from a knowledge of the viscosities of the unused and used oils. Similarly, the viscosity of a prediluted oil may be predicted.

The necessity for a system of viscosity classification is shown and, since in most applications there is a wider margin of viscosity than is usually supposed, a case is made for rationalization, leading from multiplicity of oil grades to "multi-purpose lubricants." J. C.

109.* Oxidation-Corrosion of Lubricating Oils. C. L. Pope and D. A. Hall. *Petroleum*, Nov. 1943, **6** (11), 168.—It is claimed that the method described for accelerated oxidation-corrosion testing of lubricating oils can be used to predict the useful life of an oil; to study the blending of new and used oil; to determine an oil's ability to protect ferrous materials from corrosion in the presence of nominal amounts of moisture; to determine at what point, during the life of an oil, corrosion products are formed; and to detect changes in refining that affect the stability of an oil. The following is a description of the apparatus and method used :—

The rim of a beaker was ground and fire-polished until it was flat. A glass hook, welded to the inside of the beaker near the top, served to hold the metal test-strip. A 250-ml. sample of the oil to be tested was placed in a beaker and mounted in the constant-temperature oil-bath. The samples were stirred at 850 r.p.m. and the oil-bath at 600 r.p.m. by stainless-steel paddles mounted on stainless-steel rods. A reflux condenser protruding through the tight-fitting Koroseal cover served to return most of the volatile oxidation products to the reaction. Oxygen, after saturation with moisture by passing through a Milligan gas-washing bottle, was admitted at a

constant rate of 3 litres/hour through a tube inside the condenser. A tight-fitting cover was assured by a coiled-wire spring under the rim of the beaker, and by a layer of sponge rubber backing the Koroseal cover. The cover, condensers, stirring-rods, and driving motor were all mounted on a brass plate which could be raised or lowered on three vertical supporting rods.

The reaction temperature of 100° C. was maintained constant within plus or minus 0·5° C. by means of a 500-watt Lolag heating unit and a mercury thermo-regulator. The type of test-strip depended on the use to which the oil under test was to be put, since the test-strip was to be representative of the materials used in machine construction. For turbine oils, a strip of S.A.E. 1020 steel, $\frac{1}{16}$ in. × $\frac{5}{8}$ in. × $3\frac{1}{2}$ in., wound with three turns of No. 18 copper wire, was used.

In testing diesel oils, silver–cadmium or lead–copper metal assemblies were employed. Before any test was made, all surfaces which would be in contact with the oil were first cleaned with a solution of equal parts by volume of acetone and solvent naphtha, and then dried. Interfacial tension is the chief criterion used in evaluating and correlating the oils. A. H. N.

Synthetic Products.

110. War Needs Bring Many Changes in Processing. C. R. Wagner. *Oil Gas J.*, 25.3.43, **41** (46), 82.—A review is given of the processes that have been introduced to provide the war-time requirements of aviation gasoline and synthetic rubber. Aviation gasoline generally consists of (1) a blending agent (alkylate, *iso*-octane, hydrocodimer, *neo*hexane, etc.), (2) a base stock (cut from selected straight-run or catalytically cracked or alkylated gasoline), *iso*pentane and tetraethyl lead. The following processes are now available to provide the requirements of (1) and (2): hydrofluoric acid alkylation, catalytic cracking by fluid, Houdry, and Thermofor processes, cycloversion, hydroforming, and several aromatization processes. (Simplified flow-sheets of the more important processes are given.) In particular, the production of large quantities of aromatics may present a challenge in post-war years to the coal-tar industry, and it is doubtful whether they could be absorbed by the resin and plastics industry. Processes have been evolved for the alkylation of benzene with ethyl alcohol or ethylene to produce ethyl benzene for styrene, and with propylene to produce cumene, for which existing catalytic polymerization equipment can be used. Another important process is catalytic isomerization, necessary owing to the shortage of *iso*butane. This is also used for the production of *iso*pentane and *iso*hexanes, and isomerization of higher paraffins is possible. Similarly, aromatization of the naphthenes is possible. For the preparation of butadiene the chief processes are: (1) catalytic dehydrogenation in two stages of butane, and (2) catalytic dehydrogenation of *n*-butylenes. The refinery conversion processes utilize (*a*) Houdry catalytic dehydrogenation of *n*-butane–*n*-butylenes, (*b*) tubular cracking at 1250°–1350° of naphtha and gas-oil, and (*c*) the T.V.P. process. The synthetic rubber industry is also revolutionizing the carbon-black industry, it being found that the furnace blacks are better for compounding than the channel blacks preferred for natural rubber. Success has recently been achieved in the production of acetylene from petroleum fractions (ethane to kerosine) by the Wulf process, a plant producing 150,000 lb. acetylene/day having been installed, but its economic success will depend on its being able to compete with acetylene produced by cheap electrical processes. The technique evolved for the production of special hydrocarbons will be of great value for the production of chemical products for the industry of the future. C. L. G.

111.* Isomerizing—A New Tool for Making Aviation Gasoline. Anon. *Petrol. World*, Ann. Ref. Issue, 15.7.43, **14** (8), 65.—Whilst the isomerization of C_6 and C_7 normal hydrocarbons, and mixtures containing them, holds considerable promise for the future, the main interest in the process at present is centred in the isomerization of *n*-butane to *iso*butane. The principal reason for this is that there is insufficient natural *iso*butane to balance the butylene available for conversion into aviation blending agent by established processes.

Isomerization of *n*-butane is best carried out with the aid of a catalyst, that preferred being anhydrous $AlCl_3$ with HCl as a promoter. Vapour-phase operation was first

developed, butane being passed in gaseous form with some HCl gas into the reaction chamber, which has a fixed catalyst bed. Vapours from the reactor pass through a trap to recover suspended particles of catalyst (the temperature being such that some is sublimed). The gaseous mixture then passes to a tower, where the mixed butanes are condensed and HCl gas passes overhead and back into the process. The mixed butanes are distilled and the *n*-butane returned to process. The percentage conversion per pass is of the order of 40%. Vapour-phase isomerization was first put into operation by the Shell Oil Co., and their process has been licensed to other companies. Since then other inventors and companies have brought out variants of this process, but all employ the same catalyst and promotor. Some disadvantages of the vapour-phase process are that some cracking is likely to occur, especially if C_5 or higher hydrocarbons are present in the feed. The olefins formed may polymerize and react with the catalyst, thereby reducing efficiency and shortening catalyst life. Rate of corrosion of equipment is said to be fairly heavy.

Attention has therefore been given to development of liquid-phase processes. One, due to Shell Development Co., has been in commercial operation since February. The process is said to be made possible by the use of a non-aqueous solvent for the catalyst. The solution is pumpable, and the solvent will absorb the charge of *n*-butane and HCl, so that an entirely homogeneous liquid phase system is obtained in the reactor. This gives a continuous method of operation, since fresh catalyst can be introduced, whilst some of the used material can be bled away for rejuvenation. Other advantages over the vapour-phase operation claimed are less corrosion, higher percentage conversion per pass, and longer catalyst life. Careful supervision of the feed, which must be as free as possible from C_5 and higher hydrocarbons, olefins, water and sulphur, is essential. Cost of production of *iso*butane by this process, including royalty, is less than 1 c. per gal. The process is applicable to isomerization of *n*-pentane. Full details of this and other processes which have been developed will not be available until after the war. R. A. E.

112. Composition of Paraffin Waxes from the Fischer–Tropsch Water–Gas Synthesis. H. Koch and G. Ibing. *Refiner*, Sept. 1943, **22** (9), 279–286.—About 5–10% of the paraffins, which are formed in the water–gas reaction process to make gasoline, possess a melting point above room temperature. Part of these so-called hard paraffin waxes is in solution in very high-boiling synthetic oils which are also produced, and this hard, waxy portion can be easily separated in a chilling operation. Paraffin obtained in this manner shows a melting point of about 50° C., and consists of the paraffin hydrocarbons from about $C_{17}H_{36}$ to $C_{25}H_{52}$. The much higher melting point paraffin concentrates itself in increasing quantities in the catalyst itself. Investigations by Fischer and Koch have shown that a contact catalyst will become saturated with paraffin equal to about one and a half times its own weight, especially during long reaction periods. This occurs without any appreciable loss in catalyst activity. The paraffin wax isolated from the catalyst by extraction with light naphtha or benzol shows a melting point of 70–80° C. A part of this hard paraffin is insoluble in ether, and the latter shows a melting point of 92° C. A similar product has been made in earlier work by Fischer and Koch by the catalytic reduction of carbon monoxide at 15 atmospheres pressure. From this synthetic material there was fractionated by means of crystallizing from xylol an intermediate portion melting between 104° and 117°. The molecular weight of this fraction was approximately 1000.

As these separations were only approximate, more accurate methods were attempted. The use of chemical reagents was early found unsuccessful, and thus only separation in which definite physical properties could be accurately determined were used. The results that have been presented, together with previous research work, have shown that the Fischer–Tropsch synthesis to produce gasoline builds up hydrocarbons of the paraffin series from methane to hydrocarbons of over 150 carbon atoms—quite remarkable, since the starting material, carbon monoxide, contains only one atom of carbon. It has been found that these high-melting-point paraffin hydrocarbons show well over 2000 mol. wt. and about 117° C. melting point. It has also been shown that an increase in the melting point beyond that stage cannot be obtained even with an increase in the chain length of the molecule. It is worthy of note that the synthesis in this manner of paraffin hydrocarbons by way of carbon monoxide will form hydrocarbons never before isolated in petroleum paraffin waxes. A. H. N.

Motor Fuels.

113. Plant Modifications to Make Aviation Gasoline. W. L. Nelson. *Oil Gas J.*, 1.7.43, **42** (8), 50.—The manufacture of 100 O.N. aviation gasoline requires special processes and equipment, but lower grades can in general be produced with relatively simple plant modifications. Aviation naphtha of correct boiling range can be obtained without using a special re-run fractionating column, by withdrawing it as a side-cut, necessitating an effective instrument-control system and the use of more cooling water and condenser surface, but the exceedingly low top temperature causes troublesome condensation of water. Alternatively, if a gas-recovery system is available it can be taken overhead by operating the receiver at 115–125° F., but this is wasteful of light hydrocarbons unless an absorption-recovery system is installed. Desulphurization to improve octane number and lead susceptibility can be carried out with caustic soda, solutizer solutions, or by catalytic methods. The solutizer process is, however, rather complicated, and not well suited for temporary production of aviation naphthas. For stocks of naphtha of only fair octane number removal of pentane and substitution of *iso*pentane will improve the octane value by, *e.g.*, 2·1 for 67 octane stock and 2·6 for 70 octane stock. This requires the use of three fractionating towers, one for the removal of butanes, another for *iso*pentane, and the third for *n*-pentane. Each of these must be operated at a reflux ratio of 5–10, and a pressure of at least 60 lb./sq. in. abs. must be used for the debutanizer. C. L. G.

Gas, Diesel, and Fuel Oils.

114. Improved Penn State Smokemeter. P. N. Schweitzer. *Oil Gas J.*, 28.1.43, **41** (38), 182.—A description is given of the Penn State smokemeter developed in 1938, and some improved models, used for measuring the completeness of combustion of fuel in diesel engines, and also, in modified form, of fuel in oil-burners.

The original model consists of an 18-in. tube with glass windows at each end, an electric lamp being mounted at one end and a light meter at the other. A three-way cock in the middle of the tube admits exhaust from the engine, the smoke intensity being measured by the percentage drop in light intensity. Improvements made to the instrument include the incorporation of a rheostat (instead of a light shutter) to adjust the light setting to a standard value, and of hinged windows to facilitate cleaning, the replacement of the high-wattage projection lamp by an automobile headlight-type lamp with reflector, and the design of a separate box for controls and indicator. The instrument is of particular value in assessing the validity of manufacturers' ratings of diesel engines based on maximum horse-power delivered with clear exhaust.

C. L. G.

Lubricants and Lubrication.

115.* Industrial Lubrication Problems. E. W. Steinitz. *Petroleum*, May 1943, **6** (5), 69.—The types of bearings and gears used in machinery employed in the pulp, paper, and cardboard industry are described and illustrated, and special references made to the working conditions imposed and the type of lubricant considered most suitable for application. A chart is presented showing the type of machine, the part or device to be lubricated, any special conditions of work, and the type of lubricant recommended.

In the case of oils the approximate viscosity R.I. at 140° F. or 200° F. is shown, and indications of any special requirement, such as water resistance, extreme pressure characteristics, etc., are given. R. A. E.

116. Pour-Point Stability of Treated Oils Under Winter Storage Conditions. C. E. Hodges and A. B. Boehm. *Oil Gas J.*, 24.6.43, **42** (7), 103.—The knowledge that some pour-depressant-treated oils when stored during the winter months become solid at temperatures higher than the A.S.T.M. test indicated, influenced the Paraflow laboratories to investigate the phenomena they designate "pour reversion."

Over some years field tests were made in districts where different temperature conditions prevailed. In each location the temperatures of 100 different blends in test-racks were chart-recorded over each 24 hours and the samples tested daily for fluidity. Correlated data revealed that for a given unstable oil the pour instability

generally occurred under a definite pattern of temperature stability. The highest solid point took place where the temperature cycle rose from below the cloud point in a steep warming curve, followed by a sharp drop in temperature. The range of temperatures covered in the tests was from − 30° F. to + 30° F. The selective adsorption characteristics of Paraflow blends are discussed. In a Paraflow blend the adsorption film excludes the oil from the wax particles, but if some force disturbs the film, the particles are free to absorb oil and form a gel. An example is given of a + 30° F. cloud-point oil blended with Paraflow at 100° F. and 25° F., respectively, the former having a pour point of − 20° F. and the latter + 20° F. (A.S.T.M.). This indicates that the wax at 25° F. is already out of solution and has absorbed oil, which apparently blocks the adsorption of Paraflow. A force to remove the Paraflow from the wax particles may be found in the temperature fluctuations; under these conditions the blend is at a temperature well below its cloud point and the wax is well inhibited by the Paraflow. When subjected to sudden warming the equilibrium between the adsorbed Paraflow and the Paraflow in solution is altered, and some Paraflow leaves the wax particles and is absorbed by the oil, in order to reach equilibrium conditions at the new higher temperature. Some of the wax is then free to absorb oil, which, as the blend is again cooled, prevents the Paraflow returning to the wax; the resulting solid point is consequently higher than it was before going through a temperature cycle.

As a field test requires 3 months to complete, a method was developed based on the field-temperature cycles. The apparatus consists of an insulated chamber containing a cooling system and automatic temperature controls. It holds 16 quart samples in a movable rack, which allows individual samples to be tilted to 45° to examine fluidities.

A large number of pour stability studies are given, embracing those of neutral oils plus Paraflow; bright stock in neutral oil Paraflow blends, and the effects of dewaxing on pour stability. The results are given in tables and 15 charts.

The method has afforded some information on predicting the performance of pour-point depressants under winter conditions, and appears to promise important data on the subject by a continuation of the studies. W. H. C.

117.* Graphite as a Lubricant. A. Neustatter. *Petroleum*, Aug. 1943, **6** (8), 124; Sept. 1943, **6** (9), 132.—Natural graphite is very widely distributed, and all the Continents possess a number of deposits of different types, different degrees of purity, and of different economic values. The natural deposits are of two types—viz., "crystalline" and "amorphous." These are trade designations, and the second a misnomer, since all graphite is crystalline. The "amorphous" variety is microcrystalline, the other macrocrystalline. Japan controls the biggest single source in the deposits in Chosen (Korea). Ceylon is the principal British source. Important European deposits are in Norway, the Danube Valley, Styria, Czecho-Slovakia, and Italy. Large quantities of graphite are manufactured from petroleum coke and anthracite, this variety possessing advantages of uniformity of composition over the natural article. All artificial graphite is "amorphous." Graphite of all types possesses a laminated structure, the atoms forming hexagonal patterns in parallel sheets which are able to slide relative to each other under the influence of small shearing stresses. The lubricating effect of graphite is thus explained. Apart from its numerous uses in the manufacture of pencils, refractories, pigments, etc., its unique characteristics make it an indispensable lubricant for many special purposes. Under conditions where conventional lubricants would be burnt or frozen or attacked by chemicals, or where their inflammability represents a fire hazard, graphite may be used. Other lubricant applications named are in the polishing of shot and the glazing of black and smokeless powder, the treatment of steel plates to prevent sticking during annealing, lubrication of wooden machine parts, treatment of yacht bottoms to reduce water friction. The addition of graphite to lubricating oils provokes much discussion. The arguments put forth in favour of the procedure are that graphite fills the surface irregularities in the bearing and/or coats the surface with a film of greater adsorptive power than that of the metal. H. G.

118. External Friction of Solids. A. Gemant. *J. Appl. Phys.*, Sept. 1943, **14** (9), 456–464.—This paper forms the fifteenth chapter of the works by the author

dealing with frictional phenomena. In this chapter external friction between sliding solids is discussed. The fundamental mechanism, which is based on the geometric irregularity of macroscopically plane surfaces, is discussed first. A review of the experimental facts on the dependence of the friction coefficient on pressure, speed, and temperature reveals the plastic deformation of the surface irregularities as a complicating factor during sliding. Further experimental material on the so-called slip-stick motion, and on observations of traces of soft metals left upon harder metals sliding against them, indicate abrasion as another complicating factor in external friction. A. H. N.

119. Physical Properties of Lubricating Oils at Low Temperatures. A. Bondi. *Refiner*, Sept. 1943, **22** (9), 287–294.—The paper is a report on experimental study of the behaviour of lubricating oil at very low temperatures. In the first part of this study a number of methods were described which allow us to find out whether, and in which temperature range, a phase separation occurs in mineral lubricating oils. Some of the phenomena observed closely resemble phenomena peculiar to solidifying paraffin waxes, such as melting-point contraction, heat of solidification, and maxima in electrical conductivity temperature curves. These similarities, however, can only serve to prove that the observed phase separation in lubricating oils is due to partial crystallization, but they did not prove that the crystallizing phase is paraffin wax. The viscosity effect of added paraffin wax exceeded the effect of the naturally occurring crystallizing material by one order of magnitude. The second part of this study, concerning itself with the mechanical behaviour of lubricating oils at low temperatures, was introduced by a discussion of the kinetics of solidification. The velocity of solidification was found to consist of several velocity components. Of these, only the velocity of crystal growth was observed to be of practical significance. Its extremely low values at low temperatures could be held responsible for the occurrence of plastic solidification of lubricating oils under conditions of rapid chilling. Based on this knowledge, rigid standards for the rate of cooling for low-temperature-viscosity measurement were adopted in order to obtain reproducible results. As the apparent viscosity of two-phase systems is known to be a function of the applied shearing stress, all viscosity measurements were conducted under application of shearing stresses comparable to those in motor bearings, in order to obtain viscosity values of practical significance. A new method of graphical presentation of low-temperature-viscosity data permitted the study of the effects of refining, dewaxing, and pour-point depressants in detail. Such a close investigation revealed that the addition of pour-point depressants is of much greater importance for the low-temperature performance of lubricating oils than has been generally known heretofore. In many instances the effect of pour-point depressants surpasses the improvement wrought by dewaxing, and it has been found highly recommendable to mix additives even to dewaxed oils.

An interesting diagram shows the shape of the meniscus of chilled oil flowing in a capillary. A. H. N.

120.* Pour-Point Stability of Lubricating Oils. L. M. Henderson and W. G. Annabel. *Oil Gas J.*, 9.9.43, **42** (18), 54.—The paper presents the results of a lengthy investigation to elucidate the irregularities in pour points found on storage in cold weather. Differences in pour point may be from 30° to 50° F. above the original A.S.T.M. figure.

The influences of quantity and melting point of waxes, found in the oil, upon pour-point stability has been studied. A neutral oil which gave bad pour stability was extracted with M.E.K. to obtain information as to the range of melting points of the waxes. A further quantity was similarly extracted to give a 25° F. pour-point neutral. The extracted wax was fractionally crystallized from M.E.K. into cuts of 130°, 88°, and 55° F. melting points. To determine which fraction or fractions of the wax were the cause of bad pour stability, S.A.E.-10W blends were made up from the 25° F. neutral, some bright stock and pour depressant. The wax fractions were then blended with the S.A.E.-10W blends and tested. The tabulated results afford evidence that a small amount of high-melting-point wax had an adverse effect upon the pour stability, whereas a larger amount of the lower-melting-point wax had little or no effect.

Results are given showing the pour stability of an oil containing comparable and varying amounts of two types of pour depressants. From these it is seen that instability may be due to insufficient depressant and that the type of pour depressant may greatly influence stability.

The influence of additives, other than pour depressants, in conjunction with a pour depressant is discussed and the results of tests are tabulated. These show an adverse influence on the pour stability.

In the investigations on cooling cycles, the authors find that the temperature cycle 65–25° F. showed oils at their worst. With oils having cloud points above 20° F. a cooling cycle of 25° to − 25° F. failed to indicate unstable pour points. Results of pour-stability tests indicate that a method utilizing one cycle could not be devised to give satisfactory results with all the types studied. It is necessary to include two tests—a slow cycle and a rapid cycle—for the evaluation of pour stability, and the oil must be fluid at the specific temperature in both tests to give good correlation with field storage.

The pour-stability method of test adopted is fully described. W. H. C.

121. Vegetable Oil for Diesel Locomotives. Anon. *Gas Oil Pwr*, Oct. 1943, **38** (457), 217.—A test lasting five days has been made on a diesel-electric locomotive in the works of the Tata Iron and Steel Co. to compare performance on vegetable oil with that on mineral oil. The power unit is an Ingersoll Rand 6-cyl. engine of 300 B.H.P., and the locomotive is used to haul iron ladles from the blast-furnaces to the melting-shops and foundries and also to perform shunting operations.

The main properties of the two oils used were :—

	Mineral Oil.	Vegetable Oil.
S.G.	0·906	0·916
Cal. Val. (B.Th.U.'s per lb.)	19,164	17,895
S content	0·069%	0·015%
Visc. R.I. and 100° F.	42 secs.	192 secs.

Complete work records were obtained, and are detailed. The general traffic performance of the locomotive was in no way inferior on vegetable oil. The average work performed per shift when using the two oils was not quite identical, the ladle mileage being less and the shunting time greater for vegetable than for mineral oil. Consumption per shift was approximately the same for both oils. Ladle mileage per gal. of fuel was 1·6 for mineral and 1·42 for vegetable oil. It is proposed to try out the locomotive for a period of eight months on vegetable oil to ascertain whether this oil has any adverse effects on the engine, maintenance costs, etc. R. A. E.

122. Oil Engine Lubricant Control. Anon. *Gas Oil Pwr*, Nov. 1943, **38** (458), 265.—A description is given of an arrangement devised by Tanway, Ltd., of Doncaster, to increase the pressure in the oil system, and hence the flow of oil to the engine, during starting periods, with a view to reducing cylinder wear.

The device includes an additional engine-driven pilot pump and a special hydraulically-operated oil release valve, or pressure monitor, connected to the main pressure rail and fitted with cold and hot oil controls.

Suitable adjustment of these controls enables the pressure within the system to fall by an amount corresponding with the reduced viscosity of the oil during subsequent operation of the engine, and thus permit a steady rate of flow of oil to the bearings at all times. The controls can then be locked in position.

The method of operation of the pressure monitor is described and the system illustrated. R. A. E.

123.* Rock Drill Lubricants. Anon. *Petroleum*, Nov. 1943, **6** (11), 177.—This short article is one of a series on special oils. One of the functions of the film of oil on the drill working parts is its sealing effect, which prevents by-pass of the air and consequent loss of efficiency, an effect particularly desirable in the valve assembly. A second function is the prevention of rust and corrosion on the machine. The formation and maintenance of such a film also depend on the use of an oil of the correct viscosity, and if there is any possible doubt, an oil of lower viscosity should be selected.

Viscosity, film strength, and emulsifying ability are three of the more important properties which affect the behaviour of the oil. Methods of tests are briefly described.
A. H. N.

Asphaltic Bitumen.

124. Modifiers Aid Manufacture of Asphalt Products. Anon. *Oil Gas J.*, 15.7.43, **42** (10), 44.—It is claimed that the addition of 1% of "Abalyn" or "Hercolyn," proprietary products of the Hercules Powder Co., reduces asphalt viscosity at high temperatures by about 15%, whilst reducing the softening point by only 1–2%. The effect on blown bitumens is to alter the softening point and penetration in the direction of the figures prior to blowing. Other alterations in properties may be achieved by using, in addition to one of the above agents, a co-modifier such as "Belro resin" (a trade name). It is also claimed for these materials that they improve low-temperature properties and are a help in processing—*e.g.*, saturating felt. J. C.

Special Products.

125.* Houdry Process as Applied to Manufacture of Butadiene. C. H. Thayer, R. C. Lassiat, and E. R. Lederer. *Petrol. Engr*, Oct. 1942, **14** (1), 29.—The process is a two-stage dehydrogenation, and can be used wherever butane is available. A plant is described which is now being built and is suitable for smaller refineries. The design permits the use of existent, or of easily obtainable, second-hand equipment, is economical of priority material, and the plant can be completed within six months.

Butane or butane–butylene (eliminating the first stage of the process) can be used as charge stock, but butane is preferred owing to its greater availability and to the demand for butylene for aviation gasoline. Estimates, based on Bureau of Mines figures for 1941 and 1942, are given of probable butane production of the U.S.A. for 1943 and 1944. It is claimed that 44 plants of this type taking 30,000 brl. daily of butane would yield 660,000 tons of butadiene annually.

The equipment is similar to that used in existent Houdry catalytic plants, but the reactors are of simpler design. The plant operates on short on-stream periods, followed by regeneration steps whereby carbon deposited on the catalyst is removed. The first stage of the process yields butane–butylene, which is concentrated and converted into butadiene in a second stage. The heat required for the dehydrogenation reactions is provided by burning the carbon deposit on the catalyst being regenerated. Catalyst life is expected to be in excess of six months.

Tables are given of material and utility requirements and costs, and of production costs. J. C.

126.* Plastic Pipe and Tubing One Solution of Metal Shortage Problem. Anon. *Petrol. Engr*, Oct. 1942, **14** (1), 142.—Saran plastic pipe, tough, durable, flexible, non-scaling, resistant to the solvent and corrosive actions of oils, soaps, chemicals, and moisture, is said to have a wide application in the oil industry. The material withstands freezing and heat up to 170° F., can be used for high or low pressure, whilst a table is given of its chemical resistance. Sizes from ½ to 2 in. are available in piping, and also standard flanges and other fittings. Saran pipe can be threaded by sharp standard pipe dies, whilst welding is simple and rapid at 350–400° F. Threading and welding (by two methods) are clearly illustrated by photographs. Saran tubing, with similar properties, is available in sizes from ⅛ to ¾ in. Pipe and tubing are manufactured by a modified extrusion process giving smooth products. J. C.

127.* Vistanex—An *iso*Butene Polymer. C. C. Pryor. *Petrol. Engr*, Jan. 1943. **14** (4), 84.—Vistanex is a rubber-like product produced by low-temperature polymerization of *iso*butene in the presence of boron fluoride or aluminium chloride. It is almost completely unsaturated, and can be produced in different degrees of polymerization, depending on the temperature reaction. The product, when filled, is used for gaskets, packings, and caulking compounds, which remain flexible and do not oxidize. It improves the low-temperature flexibility, moisture resistance, and adhesion to metals of asphalts and resins, and is useful as a plasticizer for waxes and resins. Solutions in aliphatic hydrocarbons are used as adhesives, particularly after

addition of resins or low-molecular-weight Vistanex to impart thickness. Its excellent electrical characteristics improve the properties of natural rubber products. It undergoes cold flow, but when compounded with fillers and vulcanizable rubber possesses useful properties. Alone it has superior impermeability to gases and moisture than rubber. Vistanex is soluble in hydrocarbons but insoluble in alcohols, ketones, esters, etc. By mechanical working or heating products of lower molecular weight are formed, and on chlorination a dry, colourless resin is produced. At 100° C. it has rebound properties close to those of natural rubber. The low-molecular-weight grades are used to improve the viscosity index of lubricating oils, to produce plastic paraffin waxes. Compounds with rubber show improved resistance to ozone cracking, sulphuric acid, heat, and oxidation, rendering them useful for insulation and acid linings, steam hose, belt coverings, etc. C. L. G.

128. Refinery-Conversion Phase of Rubber Plans Explained. H. D. Ralph. *Oil Gas J.*, 14.1.43, **41** (36), 14.—The article consists mainly of quotations from a statement by the Assistant Deputy Petroleum Administrator for War to a sub-committee of the Senate Committee of Agriculture. The factors which led to the choice of either new construction or of refinery-conversion for butadiene manufacture are discussed, but from a commercial angle, and details as to company involved, location, capacity, etc., are given of the refinery-conversion projects authorized. J. C.

129. Synthetic Rubber Development Smoothing Out Some Serious Problems. A. L. Foster. *Oil Gas J.*, 25.3.43, **41** (46), 87.—A review is given of the progress in the U.S. Government synthetic rubber programme, and of its effect on the requirements of petroleum raw materials for other purposes. Basic data on the operation of the large units, particularly operating capacity, are not available, but it is hoped that they will correlate with pilot-plant production. Similarly, widely different yields of butadiene from alcohol have been quoted. Much research is being carried out on other dienes—*iso*prene, piperylene, etc.—the production of which will lead to a wider range of synthetic rubber products. C. L. G.

130. Refining of High Melting Point Waxes. V. N. Jenkins. *Oil Gas J.*, 25.3.43, **41** (46), 223.—So far few processes have been designed to produce fully refined waxes from the crude waxes obtained by solvent dewaxing of lubricating oils. A commercial process has now been designed and put into operation at a refinery at Oleum, Calif., at which 10–12 tons/day of 145–150° F. and 160–165° F. melting point full refined waxes are now produced. The process is based on an observation that, regardless of melting point, a straight-chain paraffin wax separates in an oil-free condition when crystallized from the oil with which it is normally associated. If the molten crude wax is stirred during cooling, a semi-fluid slurry or stiff plastic mix, instead of a rigid structure, is given, the fluidity being controllable by the addition of oil. Laboratory investigation showed that practically all the high-melting wax separated at above 95–100° F. and could be recovered by extraction of the oil with a suitable solvent, methyl ethyl ketone being found the most satisfactory for use with crude waxes containing low or medium V.I. oils. The addition of 10% of a light hydrocarbon is necessary where processing crude waxes containing high V.I. oils. Following a thorough study of the conditions for extraction, rate of crystallization of the wax, temperature and quantity of solvent, a pilot plant was constructed from which the commercial plant was eventually designed. Full details of the operation of both plants and data on pilot-plant waxes are given. C. L. G.

131. Plant Manufacture of HCl for Use in Isomerization. Anon. *Oil Gas J.*, 25.3.43, **41** (46).—Details are given, with flow-sheet, of a process for the manufacture of anhydrous hydrogen chloride, used for the isomerization of *n*-butane. Two units have been constructed, producing 1267 and 4000 lb. of product per day. The process selected to give a dry product free from oxygen, carbon monoxide, carbon dioxide, sulphur, and nitrogen compounds consisted of the combustion of dissociated ammonia vapours with gaseous chlorine, followed by extraction and drying. This process has advantage of giving no by-products difficult to dispose of. The ammonia is "cracked" at 1700° F. to nitrogen and hydrogen, the mixture being burned with chlorine in an atmospheric type burner. The hydrogen chloride is extracted from the burner

reaction products by counter-current flow against C.B.M. hydrochloric acid, which is stripped, and the wet gas dried with sulphuric acid. Corrosion difficulties have been overcome by using an asbestos resin for the absorber and stripper and lines for hydrochloric acid and wet HCl gas, rubber-lined steel for the C.B.M. acid reservoirs and tanks, high-silicon iron for the C.B.M. pump, high-chromium nickel steel for the sulphuric acid tank, silver for most of the chlorine line to the burner, and glass for the exhauster, etc. Coatings of special corrosion-resisting paint have been applied to pockets, parts of the lines, and for general exposed steel protection, while carbon tetrachloride is used as sealing medium to protect meters. C. L. G.

132.* New Process Increases Recovery of High-Melting-Point Wax. J. Salmond. *Petrol. Engr*, May 1943, **14** (8), 180.—The conventional sweating process will not refine the crude wax, composed of high-melting-point wax and high-viscosity oil, obtained in the refining of mixed base crudes. Union Oil Co. has developed a process suitable for the de-oiling of such wax, and this is now in operation at their refinery at Oleum, Cal.

The principle involved is that by continuous stirring during cooling a smooth, semi-fluid slurry of wax crystals in oil is obtained instead of a rigid, interlocking structure. By the use of an appropriate solvent the wax can be recovered by leaching the oil from the slurry. Solvent-oil ratios and chilling rates are important, and must be carefully controlled.

Development work was carried out on a pilot plant consisting essentially of a wax chiller, a vessel equipped with a high-speed stirrer, a solvent recovery column, a continuous vacuum filter, and the necessary pumps, calibrated vessels, etc. The waxy charge to be de-oiled is weighed into the chiller at 150–160° F., cooled at a rate of 1° F./minute to 65–75° F., and then mixed with the required volume of solvent, which may be methyl ethyl ketone alone or mixed with naphtha. The slurry is filtered, the wax washed with solvent and separated again by the same procedure. The resulting wax cake is topped free of solvent under vacuum and then clay-treated to colour with Filtrol clay.

The commercial plant follows the same sequence of operations as the pilot plant, but provides for continuous charging. Capacity is 5000 brl. daily of crude wax obtained from propane dewaxing of vacuum distillates, and the yield is about 20 tons/day of refined wax. A flow-sheet showing the flows of wax, solvent, and filtrate, but not the inert gas blanketing system, photographs of the plant, and details of its operation are given. The maximum volume of M.E.K. solvent necessary is 6·5 times the volume of crude wax being de-oiled.

The refined wax is marketed under the trade name of "Aristowax," and the properties are given of the two grades prepared. The 145–150° F. grade is obtained in a yield of 25–27% from a crude wax produced from S.A.E. 20 distillate, and the 160–165° F. in a yield of 15–17% from crude wax from S.A.E. 40 distillate.

Present restrictions make the construction of new wax plants unlikely. However, to obtain much-needed wax and high-V.I. oil, the process may be incorporated into existing refinery operations. The author suggests how this new process may be combined either with a conventional cold pressing and sweating procedure or with an existing dewaxing plant, treating waxy raffinate by means of mixed solvents such as M.E.K. and benzene. J. C.

133.* Synthetic Rubber. Its Production from Petroleum, Coal, and Other Materials. W. C. Holliman. *U.S. Bur. Mines. Information Circular No.* 7242, May 1943.—Before the war there was a considerable demand for so-called synthetic rubber, even though the price was several times that of natural rubber. This demand was due to the fact that all synthetic rubbers have some of the physical properties of natural rubber and, in addition, they frequently possess some outstanding property not found in the natural substance. Superiority of performance is, however, at present a minor consideration. Economic and military necessity have formulated the production programme, and in the United States alone a planned annual production of 900,000 tons is envisaged, in contrast to the actual production figure of 17,000 tons in 1941.

The object of this report is to catalogue general information taken from technical journals on the chemistry and physical properties of synthetic rubbers now being produced on a commercial scale in the United States and elsewhere.

Types of synthetic rubbers announced to date include butadiene polymers and copolymers, substituted butadiene polymers, butene polymers and copolymers, organic polysulphides, and plasticized vinyl chloride polymers.

Under the present production programme in the United States butadiene is the most important raw material for synthetic rubber. It is obtainable by thermal cracking of petroleum fractions at a high temperature, by direct catalytic dehydrogenation of normal butane or of butanes and butenes produced by cracking, from acetylene formed by pyrolysis of natural gas, or from alcohol manufactured from ethylene obtained as a by-product in cracking petroleum or dehydrogenating ethane. Other raw materials of importance are styrene, commonly produced by the catalytic dehydrogenation of ethyl benzene, acrylonitrile obtained by treating ethylene with hypochlorous acid and reacting the resultant product with sodium cyanide to form hydracrylic nitrile, which is afterwards dehydrated, chloroprene, *iso*prene, dimethylbutadiene, *iso*butylene, alkali polysulphides, and organic dihalides.

In this report synthetic rubbers are listed under their trade names, and a summary of information on structure, manufacture, and physical properties is appended wherever possible. To fill the present production programme in the United States the Baruch Committee has recommended neoprene (60,000 tons), butyl rubber (132,000 tons), Buna S (845,000 tons) and thiokol (60,000 tons). H. B. M.

134. Utilities are a Major Factor in Synthetic-Rubber Operations. C. O. Wilson. *Oil Gas J.*, 3.6.43, **42** (4), 29.—To convey an idea of the magnitude of the U.S. Government $56,000,000 project at Institute, W. Va., some figures are quoted for the utilities involved—*e.g.*, in full operation the plant will use as much water as the town of Los Angeles. The output at full capacity will be 90,000 long tons yearly of Buna S. Production of the same quantity of natural rubber would require 270,000 acres of plantations and a labour force of 90,000 men.

A general description is given of the main features of the plant, which is operated for the Government by the Carbide and Carbon Chemicals Corp. and the U.S.A. Rubber Co. Butadiene is produced catalytically from grain alcohol, and styrene from benzene and ethylene. The oil industry's only participation is the furnishing of ethylene gas, which is combined with the benzene by a process similar to that used in the petroleum industry for the manufacture of cumene. The resultant ethyl benzene is then dehydrogenated to styrene. The copolymer plant is of normal type and, in addition to the two main ingredients, uses salt, soap, acid, and caustic soda. J. C.

135. Bottoms from Re-Run Pressure Distillate Converted to Industrial Oils. Anon. *Oil Gas J.*, 1.7.43, **42** (8), 40.—A refinery employing a cracking process with facilities for re-running the pressure distillate after contact in the liquid phase with earth or activated clay, has constructed a unit designed to produce core oil from the pressure distillate bottoms. One clause in the specification of the core oil requires that not more than 12% shall distill over at 460° F. The bottoms from the re-run column pass through a float-control valve to an evaporator operated essentially at atmospheric pressure and a temperature of 575° F. Evaporator temperature is controlled by regulating the quantity of refinery heat-medium oil passing through the heating pipes. A liquid-level controller maintains the level of product in the evaporator above the heating coils. Vapours pass overhead to a condenser, and the liquid bottoms are constantly removed from the evaporator via a cooler to storage. The liquid bottoms constitute the core oil, and the yield obtained is about 50% of the original pressure distillate bottoms. Previously these bottoms were passed back to process via the fractionating column and gave rise to corrosion and tube deterioration. R. A. E.

136. Plastics from Petroleum. Anon. *Oil Gas J.*, 1.7.43, **42** (8), 49.—In an address before the American Institute of Chemists, R. J. Moore discussed the basic materials from which synthetic resins and rubbers are manufactured, pointing out that petroleum and natural gas hydrocarbons formed the most prolific source of these materials. All the important intermediate products can be, and in many cases are, produced from petroleum. Possible developments include the production of CO_2 (for urea) and CO (for methanol and formaldehyde) from the coking of petroleum, sodium tetrasulphide

(for thiokol) from caustic soda, and the sulphur from high-sulphur-bearing crudes, and fats and oils from petroleum glycerine and fatty acids from oxidized hydrocarbons.
C. L. G.

137.* New Bead Catalyst. Anon. *World Petrol.*, Ann. Ref. Issue, 15.7.43, **14** (8), 57.—A special plant is now being erected by the Lummus Co. under Government authorization, to manufacture the new bead catalyst developed by Socony-Vacuum Co. for use in catalytic cracking plants. The use of this catalyst is stated to yield aviation spirit of superior quality and to make possible the production of a motor gasoline of 10 R.V.P. having an octane number of 95–100 (Research method) after addition of 1 to 3 mls. T.E.L. per gal.

The beads are translucent spherical particles of about in. ¼ diameter, and an individual bead will carry a load of about 200 lb. before crushing. The history of the development of the catalyst from the laboratory to plant-scale manufacture is traced.

As applied to the Thermofor catalytic cracking process the beads are stated to possess the following advantages :—

1. Ideal form in respect of high percentage of fillage in a given space, uniformity of flow and of void passages, and presentation of a minimum of external surface for wear.
2. Resistance to attrition under conditions of operation.
3. Give high yields of products; are catalytically stable and will have long life.
4. Can be manufactured in large quantities at reasonable cost. A single plant now under construction will produce about 2½ million beads a day. R. A. E.

138.* Catalysts have an Important Rôle in War Industry. A. W. Trusty. *World Petrol.*, Ann. Ref. Issue, 15.7.43, **14** (8), 74.—A general outline is given of the diverse uses of catalysts in the production of materials vital in war-time. Examples include catalytic cracking, alkylation, polymerization, isomerization in the petroleum industry. Other products such as sulphuric, nitric, and acetic acids and ammonia are referred to, and brief details given of operating conditions and nature of catalyst used.
R. A. E.

139. Breakdown of Paraffin Wax by Bacteria. F. Howard Rogers. *Nature*, 24.7.43, **152** (3847), 105.—Non-reproducible results obtained in experiments on corrosion of metals in water were traced to variations in CO_2 concentration in the water, brought about by bacterial attack of the paraffin wax used for coating the glass vessels.

The organism involved was successfully cultivated in a medium containing paraffin wax as the sole source of carbon. It was tentatively identified as a strain of Söhngen's *Micrococcus paraffinae*, which is ærobic, of soil origin, and commonly found in surface waters. C. G. G.

140.* Helium. V. Biske. *Petrol.*, Aug. 1943, **6** (8), 119.—Displaced from its position of importance in aeronautics helium is provoking interest in physiology. The solubility of helium in the blood is 40% less than that of nitrogen, and an artificial atmosphere of 20% oxygen and 80% helium is found considerably to reduce the danger of caisson disease and to reduce decompression rates in deep-water diving. "Pressure poisoning" caused by the solution of nitrogen in lipoids and tissue is also reduced by the substitution of helium for nitrogen. A disadvantage attending the use of helium mixtures is the greater heat conductivity of helium which renders the use of electrically heated clothing necessary. H. G.

141.* Quenching Oils of Mineral Origin. E. R. Varley. *Petrol.*, Aug. 1943, **6** (8), 120.—Quenching is applied to metals to produce certain textures or crystalline states, either throughout the entire body of the piece under treatment or to a desired depth. The quenching medium may be gaseous, liquid, or solid. Modern metallurgical practice favours the use of high-grade mineral oil, such as solvent-extracted oil. The theory of quenching and the determination of sundry relevant properties of the oils are discussed. H. G.

142.* Styrene Plant Placed in Operation. C. C. Pryor. *Petrol. Engr*, Aug. 1943, 14 (12), 37.—Within a year a plant for the production of styrene has been constructed and put into operation in the Texas Gulf Coast area by the Monsanto Chemical Co. The plant has a capacity of 50,000 tons/annum of styrene from the dehydrogenation of ethyl benzene which is produced by alkylation of benzene, obtained from coke over gases, with ethylene obtained from an outside source by cracking propane. Additions to the plant to enable ethylene to be produced on the site are being made.

C. L. G.

143. How to Handle Anhydrous Hydrofluoric Acid Safely. C. M. Fehr. *Refiner*, Aug. 1943, 22 (8), 239–244.—The history of the manufacture of hydrofluoric acid is briefly reviewed, together with the problems of its handling. Certain properties have direct relationship to the problem of handling and are briefly outlined: Freezing point is approximately − 117·4° F. This unusually low value assures that it may be stored and used in process at very low temperatures without the problem of solidification. For example, 66° baume sulphuric acid (93·19% H_2SO_4) freezes at − 20° F. Likewise, 98% H_2SO_4 freezes at 36° F. Boiling point is approximately 66·9° F. at atmospheric pressure. This is ideal, assuring ease of handling either as a liquid or a gas. The vapour pressure, which is about 17 lb./sq. in., gauge, at 100° F. assures storage in medium pressure vessels and its retention as a liquid at elevated temperatures without objectionable pressures.

The low viscosity and surface tension cause the acid to flow easily in comparatively small pipes. Less equipment is required and less time is consumed in transferring. The heat of reaction with water is approximately 11,500 calories/formula weight. Less heat of reaction will be evolved than with other alkylation catalysts, and temperature control should be simplified. Heat of vaporization is about 6000 calories/formula weight, assuring its removal from reaction products by application of a small quantity of heat. Materials of construction are described. Steels, Monel metal, copper, silver, and platinum have all been found good. Among the unsatisfactory materials of construction, probably the most readily attacked are those containing silica, such as glass, porcelain, enamelware, asbestos, certain silica cast irons, etc. While lead is serviceable for acids below 65%, under normal conditions, it is unsatisfactory for strong acids, especially anhydrous hydrofluoric acid. Cast iron is more resistant to anhydrous hydrofluoric acid than lead, but, probably due to silica inclusions, it is not a generally satisfactory material. Cast-iron fittings will last only a comparatively short time before requiring replacement. Among other materials found unsuitable for anhydrous hydrofluoric acid are wood, which chars instantly; rubber, which polymerizes and hardens, and most plastics.

Different type containers are discussed both for shipping and for storage. Transfer of acid by "pressure padding" with dry air or an inert gas as well as by pumping is studied. Extra heavy seamless-steel pipe and forged-steel fittings are preferable for handling anhydrous hydrofluoric acid. Welding makes the ideal joint, provided the weld is homogeneous and free of slag and oxides. Welded fittings should be used wherever possible. If threaded joints are used on small pipe, the threads should be carefully cut, pulled up tight, and seal welded. Some designers do not seal weld pipe under ½-in. size, reporting threaded joints satisfactory. For connecting pipe larger than 2-in. ring flanges with soft iron gaskets are satisfactory. Neoprene or Vistanex impregnated asbestos gaskets have been successful, especially on small lines. Heavy copper tubing is satisfactory for flexible connections to scale mounted tanks. Valves and pumps are discussed.

Safety practices are detailed, followed by first-aid instructions. A. H. N.

144.* Synthetic Rubber Programme Moves Forward on Schedule. L. K. Francis. *World Petrol.*, Aug. 1943, 14 (9), 29.—Tables show the location and capacity of individual butadiene, styrene, and copolymer plants completed by 30th June, 1943. Details are also given of location and capacity of plants expected to be in operation shortly. It was estimated that in the last quarter of 1943 about 150,000 tons of synthetic rubber of all types would be produced, and that in the first quarter of 1944 the output will be approximately 195,000 tons. Flow-sheets, illustrations, and brief manufacturing details are provided and post-war potentialities of synthetic rubbers discussed.

R. A. E.

145.* Big Texas Plant Supplies Styrene for Buna S. Anon. *World Petrol.*, Aug. 1943, **14** (9), 34.—The first large-scale plant for the manufacture of styrene to start production is that of the Monsanto Chemical Co. at Texas City. The first delivery was made on 10th March, 1943, less than a year from the beginning of construction. It is designed to produce 50,000 tons of styrene/annum. The method employed is the cracking of propane to yield ethylene, which is then alkylated with benzene to form ethylbenzene, which is dehydrogenated to styrene. Materials used in construction include 13,250 tons of steel and iron, alloy steels 260 tons, copper and copper alloys 290 tons, nickel alloys 16 tons. Photographs of section of the plant are provided, together with some details of auxiliary equipment. R. A. E.

146.* Making Synthetic Rubber at Institute. Anon. *World Petrol.*, Aug. 1943, **14** (9), 37.—The synthetic rubber plant at Institute came into full operation in July, and is expected to produce 90,000 tons of Buna S/annum. The plant comprises (*a*) four butadiene units, each rated to produce 20,000 short tons of butadiene/annum, (*b*) a styrene plant of 25,000 tons capacity, (*c*) three copolymer units each of 30,000 tons capacity. The butadiene is prepared from industrial alcohol, a supply of 197,000 gal./day being required. The ethylene required for styrene production is manufactured from petroleum sources at Charleston, 5 miles distant. Illustrations, a flow-sheet, and general description of the co-polymerization unit and of the method of operation are given. The number of samples tested daily for control of processes averages 1800. R. A. E.

147. Mammoth Utilities of Unusual Design Installed at Port Neches Plant. J. P. O'Donnell. *Oil Gas J.*, 12.8.43, **42** (14), 49.—A description is given of the steam, gas, cooling, water, electric power, etc., utilities being installed at the Port Neches, Tex., butadiene plant. The plant is estimated to produce 100,000 tons/annum of butadiene by dehydrogenation of butane–butylene supplied by the unit companies of Neches Butane Products Co. from their refineries in this area. C. L. G.

148.* Triptane on Commercial Scale. Anon. *Nat. Petrol. News*, 1.9.43, **35** (36), 18.—Universal Oil Products Co. have announced a process for the commercial production of triptane (2 : 2 : 3-trimethylbutane), an aviation fuel component of particularly high anti-knock value. The process gives a 90% yield of liquid, of which over 50% is triptane, two other products, which are superior to alkylates as blending agents for aviation gasoline, being 2 : 3-dimethylbutane and 2 : 3-dimethylpentane. The raw materials are condensable gases produced in petroleum refineries as by-products of catalytic and non-catalytic cracking or reforming of petroleum oils. The catalysts are readily available materials, and only normal refinery equipment and operating conditions are used. Triptane should be available at a cost of $1/gal. Properties of triptane, 2 : 3-dimethylbutane, and 2 : 3-dimethylpentane, are as follows: Boiling point 80·8° C., 58·0° C., and 89·7° C.; melting point − 25° C., − 128·8, and (not given); Refractive index n_{20}^{D} 1·3894, 1·3750, and 1·3920; Specific gravity 0·6901, 0·6620, and 0·6944, respectively. C. L. G.

149. Naphthenate Uses. Anon. *Chem. Tr. J.*, 1.10.43, **113**, 308.—An article in the April 1943 issue of *Light Metals* discussed some newer applications of the metallic naphthenates. Aluminium naphthenate can be used as a rubber extender, but has a low tensile strength compared with that of rubber, while the presence of inorganic salts decreases the dielectric strength. Mixtures of different metal naphthenates can be prepared to any required texture and, as they are highly water-resistant, stable, flexible at low temperatures, and will flow at 80–150° C., they can be used as water-resistant seals or lutings of great tenacity. A recent application of these mixtures is as a tube-filling medium for the bending of aluminium and copper tubing, the subsequent case of removal by solution in white spirit being a great advantage. Solutions of naphthenates are used as wood and fabric preservatives, for increasing the viscosity of lubricating oils, as extreme pressure lubricants, as waterproofing agents for fabrics, temporary rust preventives for metal sheets, as lubricants for the deep drawing of aluminium sheet, and as " filler " for porous metals.

Evaporated films of these solutions are extremely hard, tough, and elastic and

(with the exception of aluminium naphthenate) will adhere to almost any surface. Aluminium naphthenate gives a strong gel structure on dilution, a film of which is weak though it can be improved by the addition of zinc naphthenate which also reduces the viscosity. In general, naphthenates are good low-temperature heat insulators, and if freed of water and inorganic salts have a fairly high dielectric strength.

C. L. G.

150. Butylene Glycol by Fermentation. Anon. *Chem. Tr. J.*, 1.10.43, **113**, 310.—A description is given by G. A. Adams in the July issue of *Canadian Chemistry and Process Industries* of the development of a process and the construction of a pilot plant for the manufacture of 2 : 3-butylene glycol, for butadiene production, by the fermentation of grain. Three types of fermentation processes have been studied: (1) the Aerobacter, which produces a dextro-meso mixture of butylene glycol from saccharified grain mash, but will not ferment starch directly; (2) the Aerobacillus, which produces 2 parts of lævo butylene glycol to 1 of ethyl alcohol directly from starch; and (3) the Aeromanas, which produces pure meso butylene glycol and lactic acid.

The Aerobacter fermentation gives a higher yield than the Aerobacillus fermentation (14–15 lb. against 8–9 lb. glycol plus 5–6 lb. ethyl alcohol), and fermentation is more rapid, but the latter is simpler, as it utilizes starch direct. A pilot plant of capacity 25 bushels of grain per day has been constructed, and will be used to study mainly the Aerobacillus fermentation. The high-protein, non-fermentable residue has possibilities for use as fodder for dairy rations. The butylene glycol may also prove of value in plastics. solvents, coatings, humectants, pharmaceuticals, and in chemical production, while the lævo glycol produced by Aerobacillus fermentation may be of use in anti-freeze compounds. C. L. G.

151. Acid Sludge Utilization. Anon. *Chem. Tr. J.*, 3.12.43, **113**, 554.—E.P. 556,209 of 1943, granted to H. Moore and F. Kind, covers the use of acid sludge for the production of hydrochloric acid for the treatment of acid clays and earths for the refining of petroleum or fatty oils.

The sludge is first diluted with hot water, the oily layer separated, and the lower layer treated with sodium chloride and distilled, the hydrochloric acid and steam being passed directly into contact with the clay or earth, and thus utilizing to some extent the heat expended on distillation. C. L. G.

152. Products Formed in Pyrethrin Concentrates During Storage. T. F. West. *Nature*, 4.12.43, 152, 660.—It has been shown that concentrates rich in pyrethrin I and II form, on storage in the dark, residues which are insoluble in petroleum ether and of comparatively low toxicity. The residues, however, show a high apparent pyrethrin content by the Wilcoxon–Holaday test (based on the $\alpha\beta$-unsaturated ketonic grouping in the *cyclo*pentenolone ring) and by the Soil test (based on the acidic groups in the molecule), so that these two parts of the molecule are unaltered by the change. On the other hand, the residues show appreciable light absorption at the maximum characteristic of the unaltered pyrethrins, this light absorption having been attributed to the ketonic grouping mentioned above and to the conjugated dienoid system in the pentadienyl side-chain. Thus, any change must have affected the side-chain, probably by polymerization. In this connection it has been shown that saturation of the side-chain leads to decreased knockdown and kill. C. L. G.

Detonation and Engines.

153.* Use of Entropy in Practical Diesel Engine Applications. O. Adams. *Petrol. Engr*, Aug. 1943, **14** (12), 43.—The concept of entropy is explained and its value in the study of the fundamentals of thermodynamics in relation to the internal combustion engine discussed. Entropy associated with a change is defined as the ratio of heat change divided by the absolute temperature. As it is not made up of basic units, only the change in entropy, measured in what are termed "units of entropy,"

is significant. For a heat change (at constant pressure) over a small temperature range, the change in entropy is given by :—

$$\frac{W \cdot C_p(T_2 - T_1)}{T},$$

where W = weight of gas, C_p specific heat of gas at constant pressure, T_1 = initial, T_2 = final, and T = average temperature (absolute). The entropy change decreases with rising temperature. The equation of the change of heat content with respect to temperature is :—

$$H = W \cdot C \int_{T_2}^{T_1} dT.$$

The 4 key processes involved in thermodynamic cycles are : (1) Constant pressure, (2) isothermal, (3) adiabatic (constant entropy), (4) constant volume.

The Otto cycle consists of : (1) An adiabatic compression, (2) combustion at constant volume, (3) an adiabatic expansion—the working stroke, and (4) a constant volume reduction, in which in actual practice heat is lost. By plotting these processes on pressure/volume and temperature/entropy curves, the lines indicate the processes and the areas the work (on the P.V. plane) and heat quantities (on the T.S. plane). The diesel cycle is similar to the Otto cycle, except for the combustion process, which is at constant pressure. The Carnot cycle, which is of only theoretical interest, as it is not practicable, consists of an isothermal compression, an adiabatic compression, an isothermal expansion, and an adiabatic expansion. The impracticability of the cycle is due to the necessity for pistons and cylinders which are perfect non-conductors, and for a heating and a cooling element which must function at a fixed rate during a part of the cycle. The efficiency of the cycle is expressed by $\frac{T_1 - T_2}{T_1}$.

C. L. G.

Coal and Shale.

154. Coal and Oil. W. A. Bristow. *Petrol.*, May 1943, **6** (5), 66. (Condensed report of address to *Fuel Luncheon Club*, April 16th).—Since the war began, attention has been concentrated on the possibilities of expanding the production of coal tars, and increasing the number and usefulness of the derivatives. A striking advance had been made in the production of fuel oils and other liquid products of coal in collaboration with the Coal-Tar Control. The production, distribution, and use of road tar was also being carried out by producers in conjunction with the Control. There has also been a large increase in the quantity of alternative liquid fuels produced from low-temperature oils, which were successfully used for transport vehicles. Diesel fuels from coal could be produced with any desired cetene number between 50 and 80.

Tar producers and disinfectant manufacturers had drawn up plans for production, supply, and export of high-boiling tar acids. New products evolved include pale and dark resinous bases for the paint industry. Attention has been directed to the better utilization of low-temperature gases, which recent results show to contain 97% by wt. of methane, ethylene, and ethane. Possibilities in the direction of production of ethylene from low-temperature plants and of a variety of synthetic products from ethylene are discussed.

Suggestions are made in regard to a post-war fuel policy for Britain based on the better utilization of coal resources, and the relationship between coal-oil and petroleum industries is discussed. R. A. E.

155.* Creosote-Pitch Fuel : Its War-Time Development in Britain. A. J. Gibbs Smith. *Petrol. Times*, Part 1, 18.9.43, **47**, 496; Part 2, 2.10.43, **47**, 520.—Present-day interest in creosote-pitch as an industrial fuel in Britain is to be attributed mainly to the shipping position and its effect upon supplies of imported fuel oil, rather than to the intrinsic merits of the home-produced fuel. A somewhat similar situation arose in 1918. There is little information as to the precise extent to which creosote-pitch is being used, but one maker of oil burners now has 1250 installations working with it.

The mixture available usually consists approximately of 50% creosote and 50% pitch, but is sold not on a stated composition basis, but to a specification laid down by the Petroleum Board. A mixture which has given successful results has the following characteristics: s.g. at 60° F. 1·102, water content 0·2%, ash 0·12%, Fl. Pt. over 150° F., viscosity R. 1 at 80° F. 4061–5000 secs., at 100° F. 1329–1500 secs., at 200° F. 60–100 secs. A typical ultimate analysis is carbon 86·0%, hydrogen 6·2%, nitrogen 1·8%, sulphur 1·0%, oxygen, ash, errors 5·0%.

For successful utilization as industrial furnace fuel the mixture should be maintained at 90° F., as with this temperature the suspension of free carbon is most satisfactory. At lower temperatures viscosity increases rapidly, with resulting difficulties in pumping. At the burner the temperature should be raised to 160–300° F., according to the type of burner used. These considerations necessitate an elaborate installation so that the fuel is not suitable for small-scale users. Main features of a typical installation are: (*a*) Storage tank. A 3000-gal. lagged tank normally adequate for an installation using 150–250 gal./day. If steam heated, supplementary electric immersion heaters, thermostatically controlled, to maintain temperature at 90° F. in case of shut-down are recommended. These should be set at lowest point of tank and run as near as possible the whole length. Suitable drains for water liable to collect on surface should be provided. (*b*) Lagged and heated filter should be installed between storage tank and circulating pump. (*c*) Lagged and externally heated pump having a capacity at least four times burner requirements. (*d*) Ring main and line-heaters. The main should be lagged and a line-heater fitted in each of the branches between oil supply main and burner. The heaters should be provided with thermostats permitting adjustment at any temperature between 140° F. and 220° F. The lay-out should permit easy drainage of the whole system. Valves should be of a type permitting uninterrupted flow of fuel. Filters and pumps should be duplicated to provide for cleaning, breakdown, etc. The system is illustrated.

A standard design of furnace needs no alteration on changing over to creosote–pitch, and on occasions satisfactory results may be obtained from burners of standard design if run near full capacity. A number of reliable burners have, however, been specially designed for the purpose, using steam pressures of 100 lb./sq. in. or over on air pressure of 16-in. water gauge or more. One of the main essentials is freedom from annular spaces or cavities in which free carbon can accumulate. Arrangements permitting drainage and isolation from furnace heat when not in use are advantageous. Nozzles require to be made in special steel to resist abrasive action of the mixture. Details of 5 of the specially designed burners are given, together with capacities, auxiliary requirements, and operational hints.

Up to the present, little information is available concerning working results and costs compared with those obtained on imported fuel. In view of the capital cost involved in the installation, continued use of the mixture after the present emergency is likely, provided the present relative price levels of the two fuels are approximately maintained. R. A. E.

Economics and Statistics.

156. Resumé of Oil-Field Operations in 1941. R. D. Bush. *Calif. Oil Fields*, 1941, 27, 18.—In 1941, total production of oil in the State of California was 229,664,779 brl., or 6,372,716 brl. more than in 1940. Production of oil for the second half of 1941 was 6,703,041 brl. more than for the first half.

According to American Petroleum Institute records, total crude and refined petroleum in storage in Pacific Coast territory at the end of 1941 was 137,683,332 brl., representing a decrease in storage during the year of 7,883,192 brl., compared with a decrease of 6,368,724 brl. in 1940.

1175 wells were reported as being ready to drill and six new oil-fields or productive areas were discovered during the year under review. One new gas area was discovered near Petaluma, Sonoma County, and the limits of Rio Vista gas-field in Solano and Contra Costa Counties were considerably extended.

Tables appended to this report give summarized production records of each district, segregated data of production of clean oil and water in various fields, average daily oil production and average daily production and disposition of natural gas by fields monthly, for the year 1941. H. B. M.

157.* Capital Flow and Capital Formation in the Petroleum Industry, 1934–1941. J. E. Pogue and F. G. Coqueron. *Petrol. Engr*, Reference Number, 1943, **14** (10), 351. See Abstract No. 927 (1943). G. D. H.

158.* Economics of Peat Fuel Utilization. Part 2. G. Howell. *Petrol.*, Dec. 1942, **5** (12), 199.—The official pamphlet issued in 1921 by the Fuel Research Board on "The Winning, Preparation and Use of Peat in Ireland," gives a more favourable recommendation of peat utilization than the first adverse report made by Lord Henley's Committee. It is pointed out, however, that when the fuel is first gasified, with by-product recovery, and the value of the sulphate of ammonia obtained is taken into account, peat for power purposes is in a much stronger position to compete with coal than would appear from thermal considerations alone. Conditions for maximum yield of ammonia differ, however, from those which yield the most valuable oils, and references are given to literature and patents on the subject of by-products recovery. R. A. E.

BOOKS RECEIVED.

Proceedings of the Institution of Mechanical Engineers. Vol. 149, January–June 1943. Pp. 197. Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.

British Standard No. 410 : 1943.—Test Sieves. Pp. 29. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s*. net.

Some Tools and Methods Used in Cleaning Oil Wells in California. G. B. Shea. U.S. Bureau of Mines Report of Investigations No. 3706. Pp. 39.

This report reviews recent improvements and developments in the application of engineering and chemical principles to well-cleaning technology. Developments in preventing and removing mud sheaths in well-completion operations are described.

Synthetic Rubber : its Production from Petroleum, Coal, and Other Materials. W. C. Holliman. U.S. Bureau of Mines Information Circular No. 7242. Pp. 36.

The purpose of this paper is to catalogue for quick reference general information taken from technical journals regarding the chemistry and physical properties of the synthetic rubbers produced commercially in the United States and other countries.

A short list of selected articles is appended.

A.S.T.M. Standards on Petroleum Products and Lubricants. Prepared by Committee D-2 on Petroleum Products and Lubricants, October 1943. Pp. x + 442. American Society for Testing Materials, 260 S. Broad Street, Philadelphia, Pa.

The sixteenth edition of this book gives in their latest form some 80 specifications, tests, and definitions that have been standardized by Committee D-2 on Petroleum Products and Lubricants. New items include a test for oil content of paraffin wax (D 271), the emergency method of test for colour of U.S. Army motor fuel (ES 32), and also two proposed tests published for information and comment covering saponification number of petroleum products by electrometric titration and a test for oxidation characteristics of steam turbine oils.

Extensive changes were made during 1943 in many of the standards, including the following : Knock characteristics of aviation and motor fuels, viscosity temperature charts, and others.

Copies of this publication can be obtained from the offices of the Institute at 12*s*. 6*d*. per copy.

INSTITUTE NOTES.

JANUARY 1944.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

LYON, James Robert, Student, Royal School of Mines. (*V. C. Illing.*)

MOCKFORD, Denis James, Student, Royal School of Mines (*V. C. Illing.*)

PARTRIDGE, Edwin Francis, Commander (E) R.N.R., Marine Engineer. (*A. L. Anfilogoff ; R. F. Hurt.*)

SMITH, Ernest Daniel, Chemist, Anglo-American Oil Co., Ltd. (*C. Chilvers ; E. B. Evans.*)

WATSON, Kenneth James, Student, Royal School of Mines. (*V. C. Illing.*)

WYKES, Frederick Edgar, Lt.-Comdr., R.N.R. Tea Transport Officer. (*Edwin Thornton ; C. Gourlay.*)

YOUNG, John Paterson, Research Chemist, Scottish Oils, Ltd. (*Robert Crichton ; G. H. Smith.*)

Applications for Transfer.

ALLCARD, Harry Ganly (Assoc. Member), Managing Director. (*J. E Haslam ; E. J. Dunstan.*)

HALL, John Desmond (Assoc. Member), Technical Assistant. (*John A. Oriel ; P. M. Griffiths.*)

HARDIMAN, Eric W. (Assoc. Member), Petroleum Chemist. (*H. C. Tett ; C. S. Windebank.*)

HITT, Donald George (Assoc. Member), Major, R.E. (*G. Elias ; E. Boaden.*)

NISSAN, Alfred Heskel (Assoc. Member), Lecturer, Birmingham University (*F. H. Garner ; C. E. Wood.*)

THORN, Ernest George (Assoc. Member), Sales Manager. (*C. Dalley ; R. R. Tweed.*)

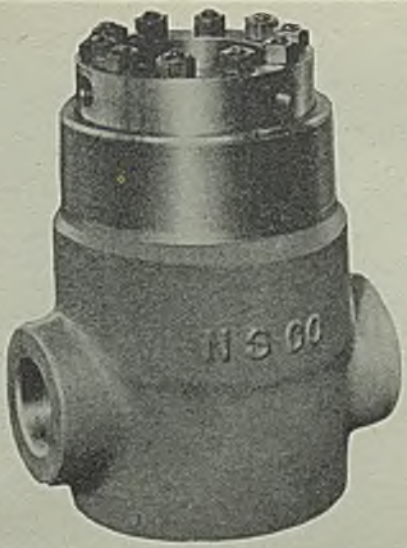
ARTHUR W. EASTLAKE,

ASHLEY CARTER.

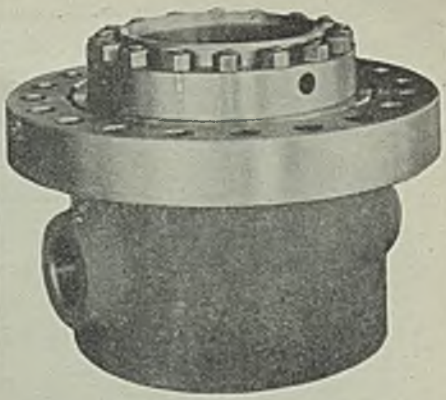
Joint Honorary Secretaries.

LIST OF ADVERTISERS

Kindly mention this Journal when communicating with Advertisers.



Type JH-1 Casing Heads to support and pack off long strings of Casings against high pressure.



Type EH-3 has a flange at the upper end permitting the attachment of blow out preventers or flanged tubing or casing heads.

NATIONAL CASING HEADS

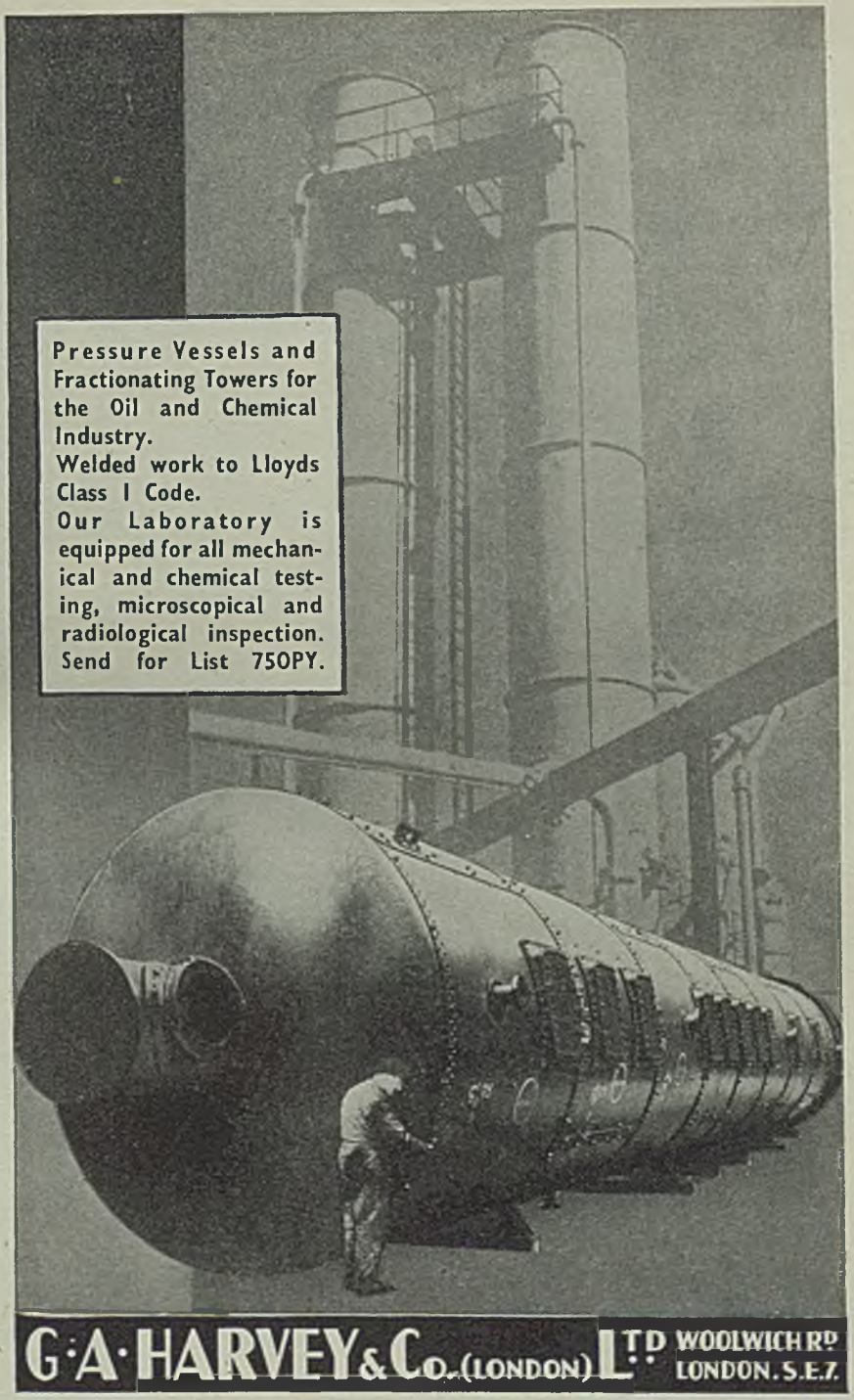
Type KH-1 is for medium pressure service.

Types JH and KH Casing Heads are of the slip suspension type permitting setting casings at any depth without cutting special nipples. Packing is located above slips and is independent of the weight of the casing.

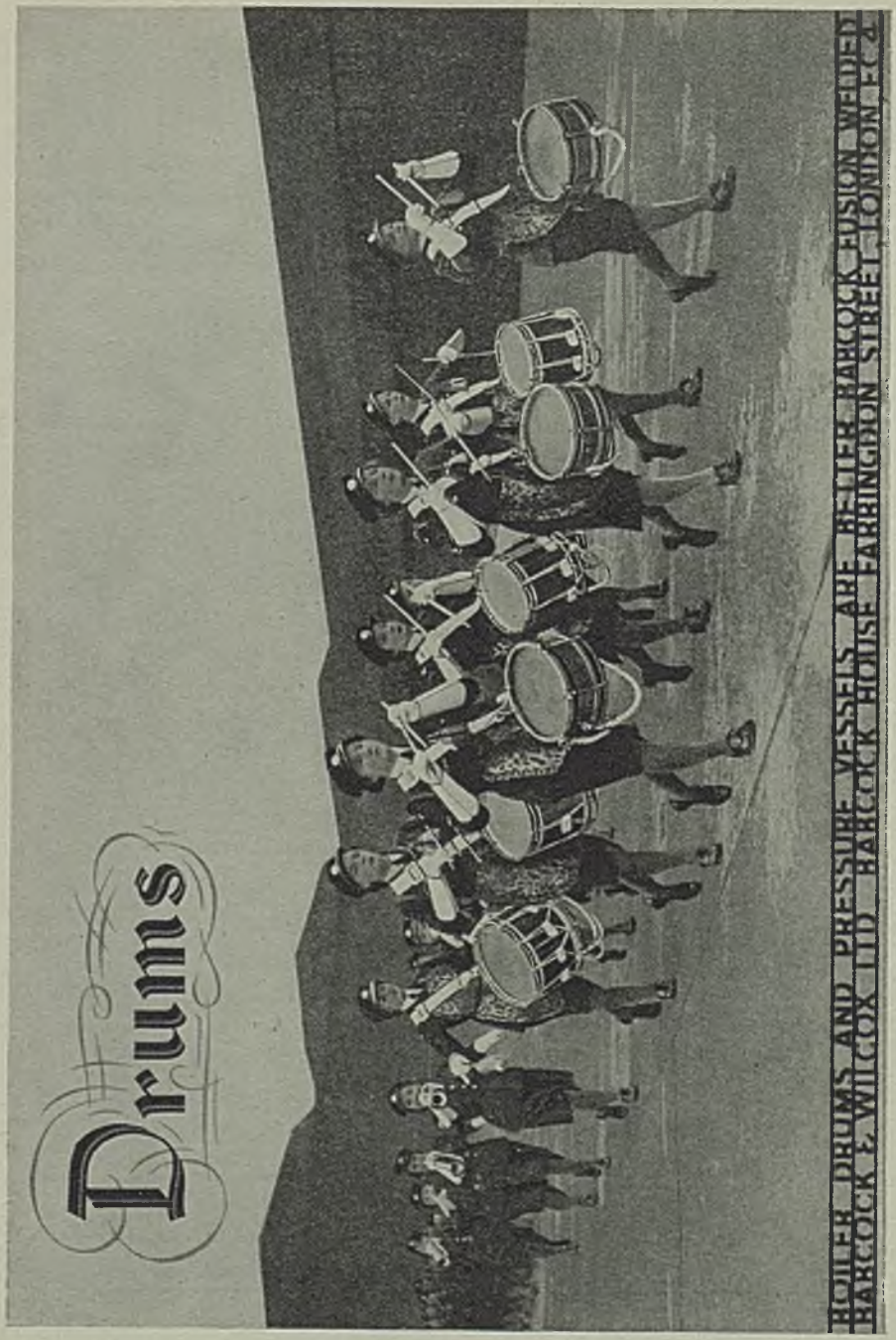
Type EH Casing Head is of the mandrel suspension type. In the patented packing arrangement a single gland compresses two rows of narrow asbestos packing.

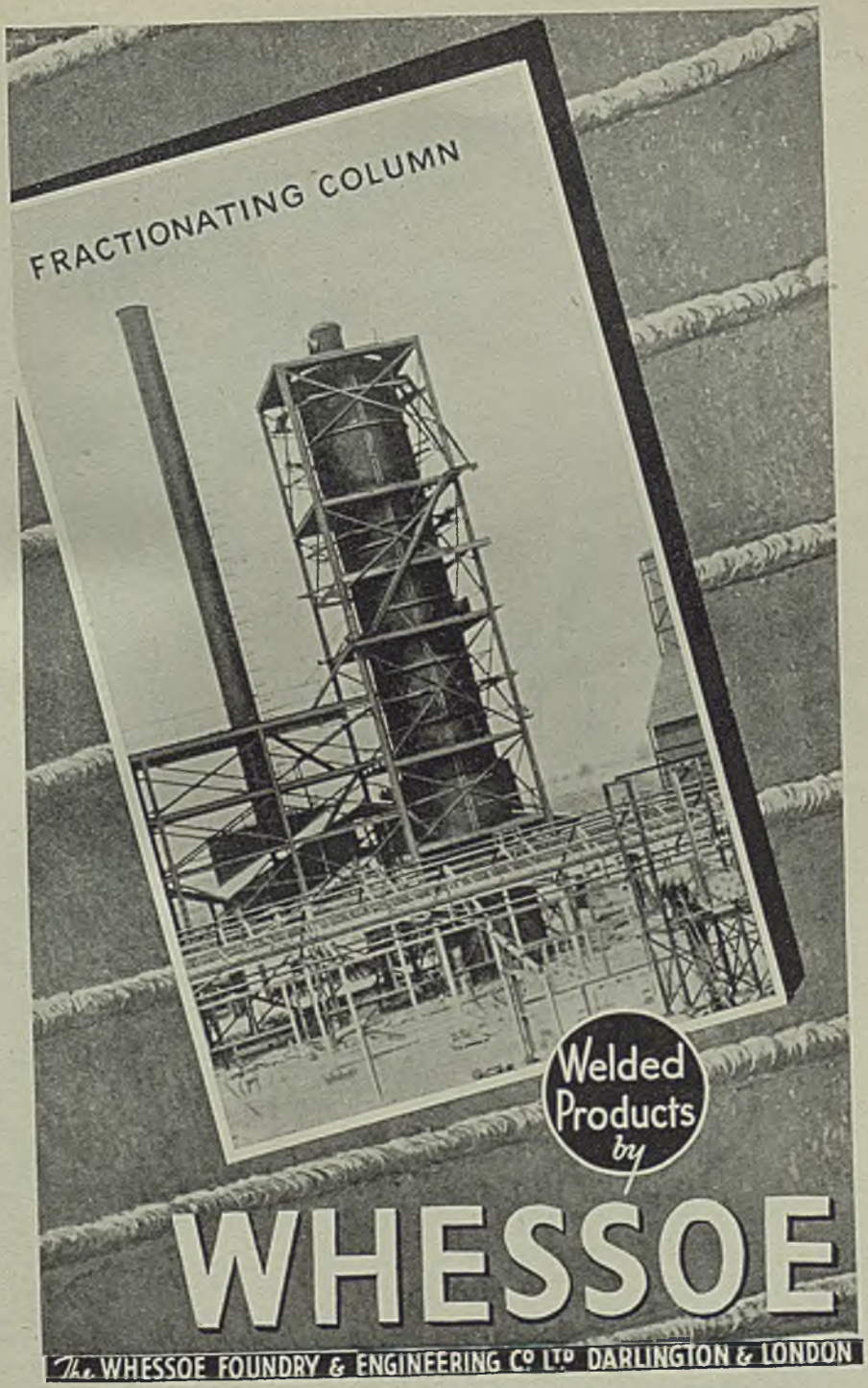
NATIONAL OWECO

RIVER PLATE HOUSE LONDON E.C.2.


Pressure Vessels and Fractionating Towers for the Oil and Chemical Industry.
Welded work to Lloyds Class I Code.
Our Laboratory is equipped for all mechanical and chemical testing, microscopical and radiological inspection.
Send for List 750PY.
G·A·HARVEY & Co. (LONDON) LTD
WOOLWICH RD
LONDON. S.E.7.

Kindly mention this Journal when communicating with Advertisers.




FRACTIONATING COLUMN
Welded Products by
WHESSOE
The WHESSOE FOUNDRY & ENGINEERING Co Ltd DARLINGTON & LONDON