

## WAR-TIME SPECIFICATION FOR I.P. PETROLEUM HYDROMETERS

A war-time specification for hydrometers has been prepared by the Standardization Committee in close collaboration with representatives of the manufacturers. The complete specification is printed below, prior to publication in the next edition of "Standard Methods," so that the new hydrometers can come into use immediately. Instruments conforming to the 1935 and 1942 specifications may still be used, but, in future, hydrometers manufactured in accordance with this war-time specification will be generally acceptable.

Under the restrictions imposed by war-time conditions manufacturers have experienced considerable difficulty in maintaining the required output, and it has frequently happened that time and material have been wasted as the result of instruments failing to meet stringent dimensional requirements which were not absolutely essential for the production of accurate hydrometers.

Wherever possible, the more stringent dimensional requirements have therefore been relaxed. Thus it will be seen that the obligatory specification includes the overall length, the length of scale, and the minimum length of stem below the bottom graduation, in addition to the accuracy clause. It is hoped that these war-time specifications will ensure that the best use is made of available material and labour, and it will be noted that while relaxing the dimensional requirements, it has been considered reasonable to stipulate rather greater accuracy than was demanded in the 1942 specifications.

The war-time specification aims at the highest standards in all essentials, while removing unduly restrictive dimensional requirements.

In connection with these war-time hydrometers, it will be appreciated that certification by the National Physical Laboratory will refer essentially to the accuracy of the instruments when used for petroleum products.



**WAR-TIME I.P. PETROLEUM HYDROMETERS**

Hydrometers shall conform to the dimensions given in Table I (p. 4) and to the following specification:—

(i) Hydrometers shall be made of glass, free from striae or similar defects, and in particular the external surface of the stem shall be quite smooth. The glass shall be resistant to the action of chemicals and possess properties such as would render it suitable for use for thermometers; *i.e.*, it should have low thermal hysteresis and small secular change in volume.\*

(ii) Hydrometers shall be thoroughly annealed before the scale is fixed.

(iii) For ranges above 0.700, the main bulb shall be cylindrical and/or torpedo-shaped (cylindrical for the greater part of its length and terminating in a cone), whilst for ranges below 0.700 it may be of any suitable shape. In all cases the cross-section of the stem shall be circular.

(iv) A thermometer shall not be part of the instrument.

(v) When mercury is used for loading, it is to be contained in a bulb at the base of the hydrometer, suitably sealed off with glass from the main bulb of the instrument.

(vi) In special hydrometers for use at higher temperatures than 100° F. any material used for sealing off the bulb or for holding loading material, such as shot, shall not soften below 212° F. (All hydrometers, after use at a higher temperature than 100° F., shall, as a matter of precaution, be allowed to drain and cool in a vertical position.)

(vii) The hydrometer shall be symmetrically constructed so that it floats with the stem vertical.

(viii) Paper of high quality shall be used for the scale, conforming with the requirements that it does not discolour at 212° F. with use and that all divisions may be sharply and accurately marked on it.

(ix) The scale shall be straight and without twist, and fixed with a cement which will not soften at the highest temperatures at which the hydrometer may be used.

(x) The scale of each hydrometer shall be graduated at each end for four divisions beyond its nominal range in Type 1, for two divisions in Type 2 and for one division in Type 3.

(xi) The graduation marks shall be made by fine straight lines, which lie in planes perpendicular to the axis of the hydrometer, so that the graduation marks are horizontal when the stem is vertical.

(xii) The subdivisions of the scale shall be without evident irregularities.

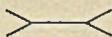
(xiii) Every 0.05 graduation mark shall be numbered without inserting either the decimal point or the figure 0 preceding the

\* During the present war emergency, good quality glass other than of thermometric type may be used.

decimal point. The first one (or two) of the figures shall appear to the left of the scale and the last two to the right, e.g., 6-50 and 7-00; 9-50 and 10-00. In addition, every intermediate 0.01 graduation mark shall be numbered, but abbreviated numbers shall be used for this purpose, e.g., 60, 70, etc. These abbreviated numbers shall be printed on the right of the scale.

(xiv) The length of the graduation marks must be varied so that the exact reading corresponding to any mark can be easily identified. The shortest graduation marks must be at least 2 mm. in length.

(xv) A fine horizontal line shall be etched on the stem of the hydrometer Types 1 and 2, and this shall coincide with the horizontal part of a "pointing mark" which shall be ruled on the paper scale about 5 mm. above the highest graduation. This "pointing mark" shall be a short, fine line with a V at each end, thus:



(xvi) All hydrometers shall be graduated for reading correctly at the point of intersection of the level liquid surface with the stem.

(xvii) Hydrometers must be adjusted so that the reading on the scale in a liquid whose temperature is 60° F., which, in the case of Type 1 and Type 2 hydrometers, has the appropriate surface tension as given below, gives the specific gravity of the liquid at 60° F. relative to water at 60° F. (sp. gr. 60° F./60° F.)\*

Hydrometer ranges.	Surface tension.
0.650 to 0.700 and 0.700 to 0.750 . . . . .	20 dynes/cm.
0.750 to 0.800 and 0.800 to 0.850 . . . . .	25 "
0.850 to 0.900 and 0.900 to 0.950 . . . . .	30 "
0.950 to 1.000, 1.000 to 1.050 and 1.050 to 1.100 . . . . .	35 "

The specific gravity 60° F./60° F. of water\* shall be taken as 1.000 and the scale numbered accordingly.

(xviii) The maker shall mark each hydrometer with:

- "S  $\frac{60^\circ \text{ F.}}{60^\circ \text{ F.}}$  at 60° F.," to indicate the basis of the scale.
- "Petroleum."
- "I.P. Type . . ." and an identification number.
- Vendor's or maker's name or mark.
- "Max. Temp. 212° F." or "Max. Temp. 100° F." according to whether the cementing material for fixing the loading is or is not suitable for the hydrometer to be used above 100° F.

\* Specific gravity is defined as the ratio of the mass of a given volume of the product at a temperature  $t_1$  to the mass of an equal volume of pure water at a temperature  $t_2$ . The masses are compared by weighings in air using brass weights and correcting to the corresponding weights *in vacuo*.

$$\text{Sp. Gr. } \frac{60^\circ \text{ F.}}{60^\circ \text{ F.}} = \frac{\text{Mass of a given volume of the substance at } 60^\circ \text{ F.}}{\text{Mass of an equal volume of water at } 60^\circ \text{ F.}}$$

Three series of hydrometers, covering a range in each series of 0.650–1.100 specific gravity, have been adopted. Each series consists of ten separate instruments, each having a range of specific gravity of 0.05, as follows:

0.600 to 0.650	0.850 to 0.900
0.650 to 0.700	0.900 to 0.950
0.700 to 0.750	0.950 to 1.000
0.750 to 0.800	1.000 to 1.050
0.800 to 0.850	1.050 to 1.100

When extreme accuracy is required, or in referee work, instruments certified by the National Physical Laboratory for accuracy shall be used. The corrections shown on the accompanying certificate shall be applied.

TABLE I.  
*Specified Dimensions and Tolerances.*

	Type 1.	Type 2.	Type 3.
Length overall, mm. . . . .	Max. 360 Min. 330	Max. 240 Min. 210	Max. 180 Min. 160
Number of sub-divisions in nominal scale . . . . .	100	50	50
Length of nominal range of scale, mm. . . . .	Max. 185 Min. 155	Max. 115 Min. 90	Max. 65 Min. 50
Length of plain cylindrical stem below bottom graduation mark, mm. . . . .	Min. 5	Min. 5	Min. 5
Maximum permissible error at any point on the scale . . . . .	±0.0003	±0.0005	±0.001

The further dimensions shown in Table II are not to be regarded as obligatory, but merely as indicating the types of instruments desired.

TABLE II.  
*Recommended Dimensions and Tolerances.*

	Type 1.	Type 2.	Type 3.
Diameter of bulb, mm. . . . .	Max. 40 Min. 35	Max. 25 Min. 20	Max. 20 Min. 16
Diameter of stem, mm. . . . .	Min. 5.0	Min. 4.3	Min. 4.0
Distance of top nominal graduation mark from top of stem, mm. . . . .	Min. 25	Min. 15	Min. 10