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THE INTRODUCTORY INVESTIGATION OF ATOMIZATION OF A LIQUID-PULVER MIXTURE

Summary. The influence of presence of the coal pulver in a liquid on the comminution degree of this liquid mixture was investigated by means of the experiments with the model liquid which solidifies in flight. The pulver gram fraction in mixture as well as the grain coarseness were taken into account. Experimental results are presented by formula (3).

The development of a general fuel situation in the world led to the increase of importance of heavy liquid fuel mixed with the combustible pulver [1],[7],[3],[4],[6]. Among the numerous problems connected with the combustion of such fuel there also appears the problem of a quality of atomizing and so far this is not reflected sufficiently in the literature. The present paper is the attempt of an introductory experimental investigation of the influence of an amount and size of solid suspension in liquid on the comminution degree at atomizing.

The liquid fuel was substituted by the model liquid (C_6H_5COOH), [5]. The droplets of this liquid solidify in flight. The droplet sizes were determined by means of the sieve analysis. The investigations were carried out in the simple installation (Fig. 1) without any burning.

The figure 2 presents the examples of some gram distributions of the solidified droplet diameters d at an atomizing process of the mixture of various gram fraction of coal dust. The size of this dust was within the range of 0-54 µm. The quantity G is a ratio of the mass of droplets of the diameter not larger than d to the mass of all droplets. The figure 3 presents the distribution of diameter d at various dust grain coarseness and at the dust gram fraction of constant value of g = 15%. In both cases (Fig. 2 and 3) the temperature and the manometric pressure of mixture and atomizing air were equal (433 K, 0,04 MPa). The atomizing air and mixture gram quantity ratio was about 0,75. The mixture was atomized without any swirl. Measurement results allowed to present the relationship of a mean mass diameter $\bar{d}$ of solidified droplets on the gram dust fraction g in the mixture (Fig. 4), at a constant dust grain coarseness of the dust diameters within the range of 0-54 µm.

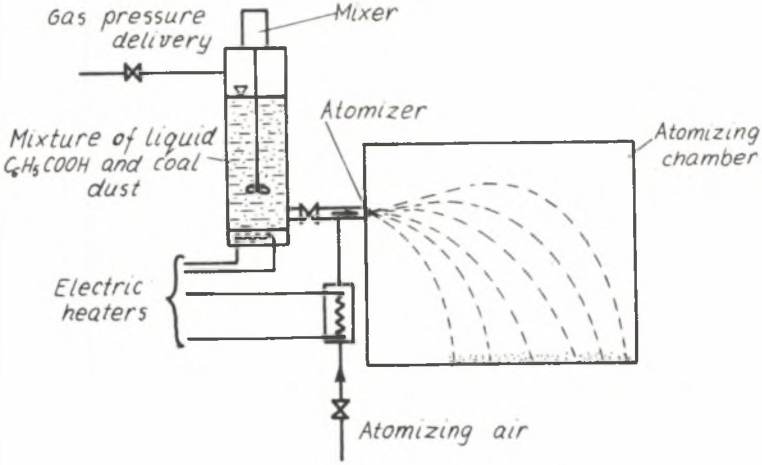

Fig. 1. Installation for investigation

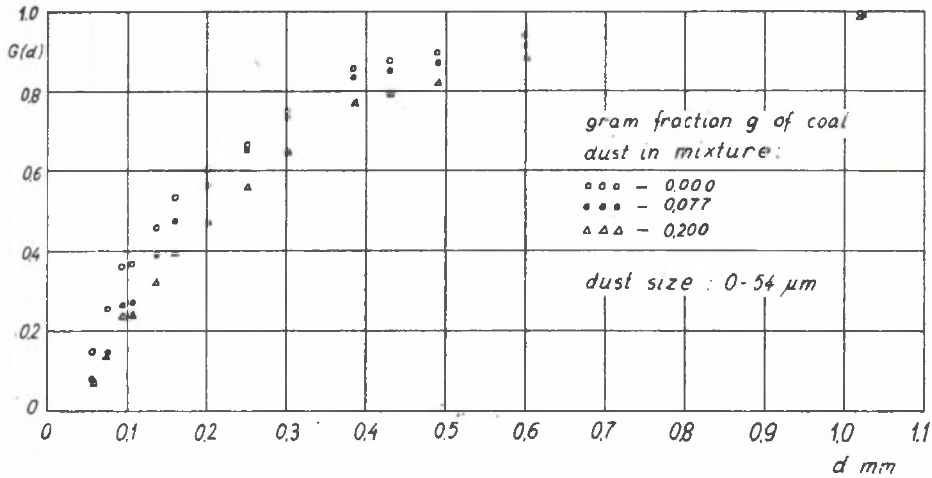

Fig. 2. Distribution of droplet diameters at constant dust size

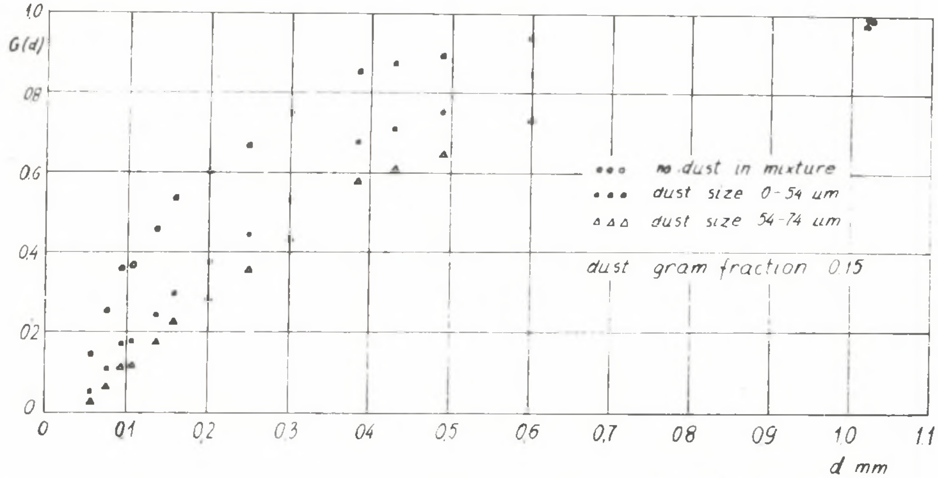

Fig. 3. Distribution of droplet diameters at constant dust gram fraction

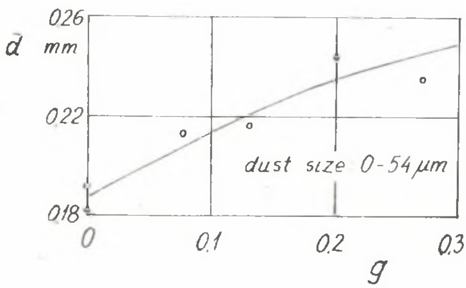

Fig. 4. Mean droplet diameter versus the gram dust fraction

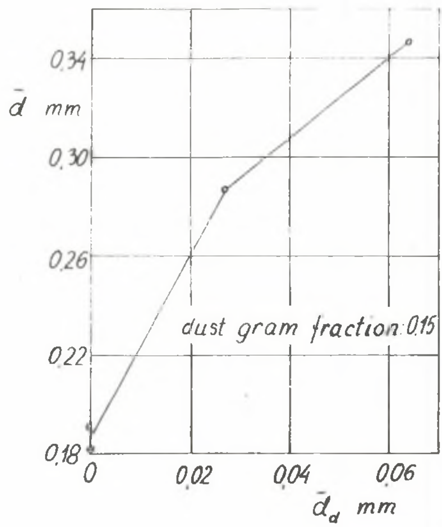

Fig. 5. Mean droplet diameter versus the mean dust diameter

The value of $\bar{d}$ as dependent on the mean dust diameter $\bar{d}_d$ at the constant gram fraction g = 15%, is shown in Figure 5. The value of $\bar{d}_d$ is determined as a middle value of the ranges of 0-54 and 54-74 µm.

The obtained data show to what an extent the droplet grain coarseness increases with the increase of the gram dust fraction in mixture as well as of the dust grain coarseness.

The conditions during creation process of the droplets one can describe by means of the criterial similarity numbers of Weber

$$We = \frac{w_a^2 \varrho_a D}{\sigma_1} \tag{1}$$

and Laplace

$$Lp = \frac{D \varrho \sigma_1}{\eta^2} \tag{2}$$

where

ϱ_a, w_a – density and mean velocity of atomizing air at an atomizer outlet,

σ_1 – surface tension coefficient of liquid,

ϱ, η – density and viscosity dynamic coefficient of atomized mixture,

D – diameter of atomizer outlet.

So, the obtained experimental results one can use to formulate, for example, the following relationship

$$\frac{\bar{d}}{D} = a(We\ Lp)^b \tag{3}$$

where

a, b – searched values.

The application of the product (We Lp) in formula (3) let to eliminate from considerations the quantity of σ_1. The mixture density can be determined on the base of values of liquid density ϱ_1 and dust density ϱ_d by means of the following formula

$$\varrho = \frac{1}{c\left[\frac{1}{\varrho_1} + g\left(\frac{1}{\varrho_d} + \frac{1}{\varrho_1}\right)\right]} \tag{4}$$

in which there was assumed for simplicity that the volumetric contraction ratio c = 1.

The mixture viscosity one can determine by formula [2] transformed as follows

$$\eta = \eta_1 \left[1 + \frac{4,5}{1 + \left(\frac{1}{g} - 1\right)\frac{\varrho_d}{\varrho_1}}\right] \tag{5}$$

where

η_1 – viscosity dynamic coefficient of liquid.

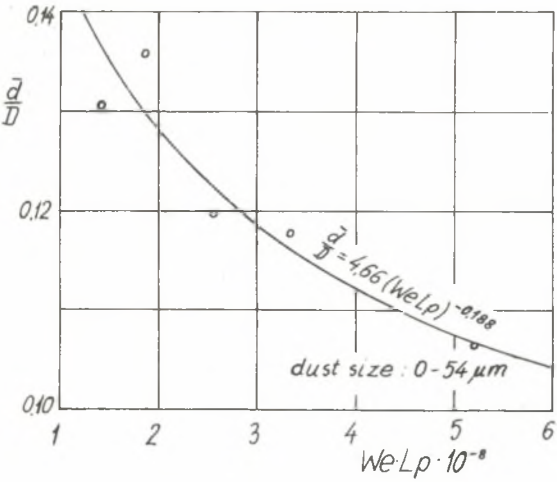

Fig. 6. Diagram of formula (3)

Using the experimental results it was possible to calculate the values a = 4,66 and b = - 0,188. For these values the relationship (3) is presented in Figure 6.

The used coal pulver and the obtained solidified droplets were observed by a microscope. The shape of the coal particles was very irregular. The solidified droplets were in general of spherical regular shape and only the large droplets, of a diameter larger than about 385 µm, were hollow inside.

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WSTĘPNE BADANIA ROZPYLANIA CIECZY ZAWIERAJĄCEJ PYŁ

S t r e s z c z e n i e

Zbadano doświadczalnie jak wpływa obecność pyłu węglowego w cieczy na stopień rozdrobnienia przy rozpylaniu. Zastosowano ciecz modelową, której krople zastygały w locie. Uwzględniono udział gramowy pyłu w mieszaninie oraz ziarnistość pyłu. Wyniki doświadczeń przedstawiono za pomocą wzoru (3).

ПЕРЕДОВЫЕ ИССЛЕДОВАНИЯ РАСПЫЛИВАНИЯ ЖИДКОСТИ СОДЕРЖАЩЕЙ ПЫЛЬ

Р е з ю м е

Исследовано экспериментально как влияет присутствие угольной пыли в жидкости на мелкость распыливания. Использовано модельную жидкость, которой капли затвердевались в полёте. Учестно весовое участие пыли в смеси и зернистость пыли. Результаты представлено математической зависимостю (3).