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TECHNICKÉ VĚDY

Metalurgie

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RESEARCHING OF MIXING QUALITY OF BRIQUETTE MASS

Preparing of briquette mass consists of 2 parts: mixing (leveling) and physic-chemical processes of all components of briquette compositions. This processes often superimposed one on the other, partially flow sequentially.

For assessing the qualitative side of the mixing process, one of the important indicators is the degree of homogenization of the mixed mass. On the limit, fully homogenized mass must have same component and grain composition in any macro volumes. Therefore, measure of the performance of a mixer is the standard deviation of the composition of a sample taken after a certain mixing time, or the degree of mixing, expressing the ratio of the actual deviation of one or another component of the mixture to the theoretical standard deviation of an ideally mixed mixture. The last parameter, in the limit equal to 1 (or 100%), is more obvious for estimating the performance of the mixer.

Consequently, estimation of mixing quality can be partially carried out from the standpoint of statistical distribution parameters. There are dozens of formulas for quantifying the distribution of blended components in final products. As a criterion for the quality of mixing, the inhomogeneity coefficient (variation):

$$V_c = \frac{100S}{\bar{m}} = \frac{100}{\bar{m}} \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{m})^2}{n-1}}, \%$$

S – average square deviation;

$\bar{m}$ – average arithmetic content of the controlled component in all samples;

n – number of samples;

X_i- value of the random variable X in the i-th experiment.

The quality of mass mixing is advisable to be estimated by any control fraction of the base particles (for example, 0.8-1.2 mm or 1-1.5 mm) in single samples of Ci:

$$V_c = \frac{100S}{\bar{C}} = \frac{100}{\bar{C}} \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (\bar{C}_i - \bar{C})^2}, \%$$

$\bar{C}$ – average arithmetic value of the number of particles in the samples,%.

However, as indicated at the beginning of this section, mechanical mixing (homogenization) does not mean that the briquetting mass is obtained as a stable polycomposition. The second stage - adhesion (wetting, sorption), capillary impregnation, etc. provide a stable formation of the thinnest layers on the boundary of the abrasive-substrate, which are connected by Van der Waals, molecular and electrostatic forces. Availability of this forces leads to the formation of a solid three-dimensional structure. Only after the completion of these processes, the briquette mass is converted into a cohesive, highly concentrated and structurally stabilized substance. It is the spatial structure of molecular forces that imparts plasticity, viscosity and stability to the substance.

For a normal (Newtonian) fluid, displacement of the layers is caused by an arbitrarily small force. In structured systems, as a result of the availability of a sufficiently strong continuous structural grid, some effort must be exerted to destroy it. According to a number of articles [1-4], flow of that system begins only from the moment when the shear stress R exceeds some critical value Rk necessary for the destruction of the structure formed in the given system. Such a flow is called plastic flow, and Rk is the yield point.

In briquette mass, at operating temperatures, a viscous flow is characteristic for normal Newtonian fluid. In the mixture mass, as a result of a sharp increase of base concentration, an appreciable appearance of elastic plastic properties and yield strength should be expected, which is especially important in the formation of briquettes in roll presses. This is what ensures the preservation of a stable form of briquettes after they exit from the cells of the mold.

Considering the complexity of the above processes, technological evaluation of the mixing quality of peck-coal masses has a number of features. It is very important to evaluate the completion of the main mixing processes: homogenization, adhesion, coating, impregnation, etc. Also considered rheological characteristics of the masses (viscous flow and plasticity, sedimentation in the liquid phase of the binder, press characteristics, etc.)

We will take a look on these requirements in more detail. For the briquette mass, the indicator of the mass bulk density or the sometimes used residual porosity index that characterizes the degree of capillary impregnation of the filler grains is of interest.

Methodically, this is done in the following order. The briquette mass is placed in a detachable liner and heated in the resistance furnace smoothly to 170 0C. When filling the mixture in the sleeve, it is compacted manually with a wooden rammer without knocking smoothly to a density of 1.15 - 1.20 g / cm3. After 5 minutes at this temperature, the sleeve is pulled out and cooled in water for increasing speed of cooling. After cooling in water, bulk density of the briquette mass is determined, which after the cooled sample is crushed in a laboratory jaw crusher.

Then follows the grinding in a laboratory ball mill to class - 0.16 mm.

The pycnometric density in an aqueous solution of ethyl alcohol without boiling is determined. The porosity is determined by the formula:

$$P = \frac{\rho_п - \rho_б}{\rho_п} 100\%$$

P – porosity,

$\rho_п$ and $\rho_б$ – micrometrically and bulk density of briquette mass

The briquette components were first mixed in a roller mixer in a cold powder state for 3, 6, 9 minutes. Then, 140 grams of the stirred mixture were placed in a detachable sleeve, also heated to 170 °C, and after standing for 5 minutes were placed on a laboratory bench and the hot briquette was compacted by three blows of the koper. After cooling in water, the sleeve was separated, and the sample of the briquette was pulled out of the liner cavity and placed in a preheated oven.

After a two-minute drying at a temperature of 105 °C, the sample was taken out of the camera, after being exposed to air for 5 minutes, weighed on an electronic balance. The experiments were performed three times for each mixing time of the briquette components in the roller mixer. The results are shown in Figure 1.

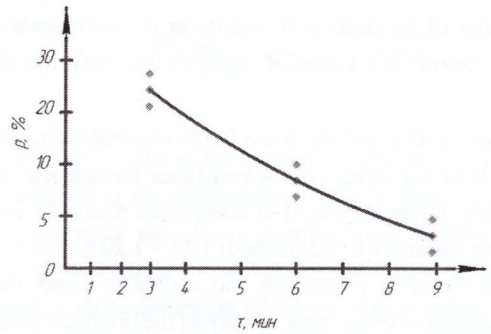

Figure 1 – Dependence of the porosity of the briquette from time of dry blending

As can be seen from the graph, durability of dry mixing reduces the porosity of the briquettes, that is, increases its mechanical durability to abrasion, which is the main indicator during the transportation of the finished briquettes. The dry mixing for 9 minutes to reduce the porosity of the briquette noticeable influence does not render. Therefore, laboratory tests that time will be taken as established. Next, prepared mixture briquette mass split in the sleeve was heated up to 120, 130,140, 150, 160, 170 0C. The results of measurement of porosity is presented in figure 2.

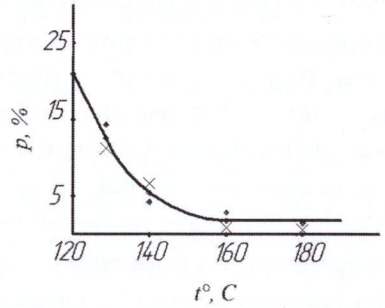

Figure 2 – Effect of heating temperature of briquette mass on porosity

With increasing temperature in the sleeve, the volume of unfilled pores is reduced and becomes stable at 140 ÷ 160 0C. This consistent with the results of the study of wettability: at these temperatures the contact angle reaches the limits of the beginning of wetting. At the same time, unreasonably high temperature heating of the mixture can lead to oxidation of the binder and loss of part of the cementitious properties [5].

Another indicator of the quality of mixing can serve as the thickness of the layer of binder between the grains foundation. To determine this figure, the briquette thin sections of the samples were studied under the microscope. When we zooming x 200, distribution curves were constructed according to the method [6].

Conclusions:

1 Researched and assessed quality of the mix briquette mass through the degree of homogenization, coefficient of heterogeneity, interaction and adhesion through rheological characteristic briquette mass.

2. Compiled experimental method of determining indices of volumetric mass density and residual porosity of the briquette.

3. The optimal temperature scale stabilization of heating the briquette mass. The optimal thickness of the layer of binder between the grains Foundation.

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