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CHOICE OF TECHNOLOGY AND THE EQUIPMENT FOR PREPARATION OF WATER-COAL FUEL IN LABORATORY CONDITIONS

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Summary. This paper deals with the basic questions connected with the choice of equipment and technology for water-coal fuel preparation. The influence analysis of grinding bodies granulometry in spherical mills on rheological characteristics of fuel and on power inputs is carried out at its transportation.

Key words: water-coal fuel, rheological characteristics, ash content, granulometric composition, grinding bodies, ball mill.

INTRODUCTION

Constantly growing prices of liquid fuel and natural gas cause constant growth of expenses for manufacture of thermal and electric energy. Besides, direct incineration of traditional firm, liquid and gaseous kinds of fuels is connected with high level of harmful emissions to atmosphere. The combination of these factors brings forth the problem of searching and working out of technologies leading to the use of less expensive and ecologically safer alternative kinds of fuels. One of such energy carriers is water coal fuel (WCF) which can be prepared from different coals as well as cleaning waste and fine coal, with the advantage of rather limited demand in the market in connection with their advanced humidity and regrinding. Besides, low technological provision of the enterprises does not allow to use effectively low-grade kinds of coal fuel in laminary and chamber fireboxes of various power installation.

A crucial aspect of the introduction of suspension fuels is the reception process of strong sewage water coal suspensions (SWCS). A combustible component in such systems is the crushed coal of various metamorphism degrees, and water acts as the dispersion medium. WCF is prepared by means of clean coal crushing and the subsequent mixing of the crushed product with water and chemical additives in various dispersive installations. Structure of WCF: coal (0-250 microns) - 59-70 %, water - 29-40 %, a reagent-softener - 1 %, ignition temperature - 450-650°C; firing temperature - 950-1050°C.

OBJECTS AND PROBLEMS

The basic technological operations at the preparation of WCF are crushing of coal to gradation which is coming nearer to «maximum packing» and a choice of the chemical additives providing fluidity and sedimentation stability of water coal fuel. Theoretical and experimental researches have shown, that the closest to «the maximum packing» is bimodal granule composition of the coal. Key parametre defining character of a firm phase granule composition, is the technological scheme of coal crushing.

Now many ways of water coal fuel preparation are known. Reception of coal bimodal granule composition by its two-phasic grinding in spherical and rod mills is traditional. The first stage of grinding is carried out by wet grinding in spherical mills at mass concentration of coal of 50 %. Till the size of 10 microns no more than 5 % are exposed to crushing and only 30 % of the initial material with the size of particles 1 … 3 mm [7, 11].

At the second stage the crushing is carried out in rod mills, in which 70 % of the initial material (1 … 3 mm) is moved together with the grinding product in spherical mills and technical water. At this stage the definitive grinding, careful hashing of the water coal mix and filtration are carried out. It is necessary to notice, that softener is entered at the realisation of the first stage of grinding in spherical mills [2, 7, 11].

Preparation of WCF whith necessary grain-size distribution by coal grinding in two stages considerably raises power consumption in the process, hence the higher fuel price. The evidence of this is the field experience of complex Belovo-Novosibirsk (Russia). Here at the high expense of (90-110 kV t·h/t) on the block of manufactured WCF of the initial terminal it is necessary to consume the power of two-phase grinding of 75,1 % of operational expenses [2, 10].

The analysis of the researches carried out by scientists working in this area proves the possibility of reception of necessary bimodal granule composition of particles at performance of one stage of grinding in a spherical mill, by change of granulometry grinding bodies. In Fig. 1 the scheme of preparation of WCF by one-phase grinding [3, 7, 10] is presented.

According to this scheme the received coal was split up to the size of 3-6 mm in a hammer crusher then it was mixed with water and chemical additives. At the following stage coal was subjected to crushing to the size of 0,3 mm. Then the obtained hydromixture underwent homogenization and filtration processes and as a result we received water coal fuel with bimodal granule composition.

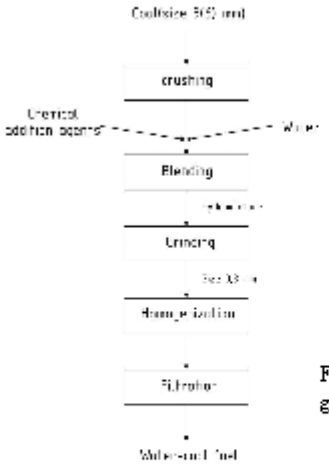


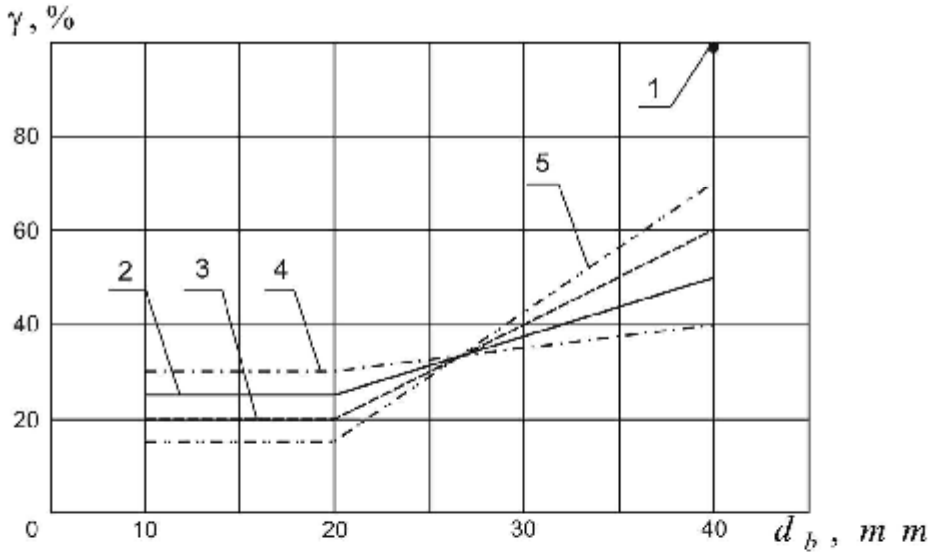
Fig. 1. The technological scheme of WCF preparation with bimodal granule composition by one-phase grinding

As indicated above, coal bimodal granule composition was received in connection with the change of granule composition of grinding bodies in a spherical mill. In table 1 data on loading of a drum of spherical mills by grinding bodies are shown. The grain-size of spherical loading is presented graphically in Fig. 2.

Table 1. Grain-size of grinding bodies [3, 10]

Variant of loading	Sphere diameter, mm		
	40	20	10
	The maintenance of spheres in a hump		
I	100	—	—
II	50	25	25
III	60	20	20
IV	40	30	30
V	70	15	15

Each of the specified variants of loading of spherical mill grinding bodies gives a defined grain-size distribution of a firm component in WCF. The maximum size of spheres for initial maximum coal fineness 3 mm to 40 mm [3, 10].



1, 2, 3, 4, 5 - Loading of spheres by variants I, II, III, IV, V accordingly
Fig. 2. Grain-size of grinding bodies

For preparation of water coal fuel with setting grain-size in laboratory conditions the most rational is the method of a coal grinding in one stage. For preparation of coal for crushing, i.e. for the reception of firm material the size of 3 mm, the application of spherical mill is offered.

The aforesaid analysis has allowed to define the most comprehensible operating modes for a spherical mill:

- Relative speed factor - $\psi = 0.76$,
- Filling of a drum of a mill grinding bodies factor - $\varphi = 40\%$,
- Diameter of grinding bodies - $D = 40$ *mm*,
- Mill operating mode - waterfall,
- Crushing time - $t = 30$ min.

Further technological reception process of bimodal composition of the firm component is spent according to the scheme presented in Fig. 1.

Grain-size of coal particles with the initial size of 3 mm depends on the variant of loading of grinding bodies. It is presented in Table 2 on an example of coal of mark «G» with ash on dry weight $A^d = 16.5\%$ and humidity $W_t = 8\%$.

The estimation of grain-size distributions is presented in Table 2 shows. They differ considerably on an outflow of class 40 microns, on the sieve residue 80-90 microns, on an outflow of a class +200 microns, on the weight-average diameter, on an outflow of intermediate class. These parametres influence the rheological characteristics of water coal fuel and its stability.

Table 2. Grain-size of coal at various variants of loading [10]

Fineness, mm	Variant of loading									
	I		II		III		IV		V	
	y,%	Σy,%	y,%	Σy,%	y,%	Σy,%	y,%	Σy,%	y,%	Σy,%
+0,5	0,7	0,7	-	-	-	-	-	-	-	-
0,3-0,5	0,8	1,5	-	-	-	-	-	-	-	-
0,25-0,3	0,6	2,1	0,1	0,1	0,5	0,5	-	-	1,1	1,1
0,2-0,25	2,8	4,9	2,8	2,9	2,7	3,2	-	-	3,3	4,4
0,1-0,2	9,9	14,8	8,0	10,9	8,5	11,7	4,3	4,3	9,2	13,6
0,08-0,1	23,0	37,8	18,5	29,4	19,5	31,2	15,5	19,8	21,9	35,5
0,04-0,08	7,1	44,9	6,5	35,9	6,8	38,0	4,5	24,3	6,1	41,6
0,02-0,04	30,1	75,0	33,8	69,7	34,0	72,0	33,2	57,5	31,9	63,5
0-0,04	25,0	100	30,3	100	28,0	100	42,5	100	26,5	100

Researches of WCF rheological characteristics, prepared under the offered scheme and for four variants of the firm component's crushing, were carried out with the use of chemical additive «Dofen» at the mass concentration of 62-65 %.

Flow characteristics of the prepared water coal fuel is presented in Fig.3 and Fig.4.

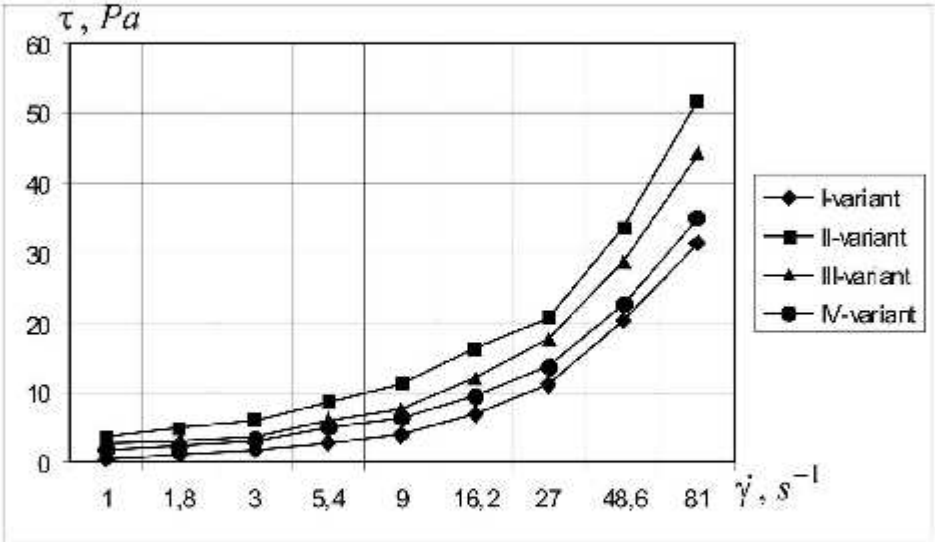


Fig. 3. Flow characteristics of WCF subject to the granulometry of grinding bodies

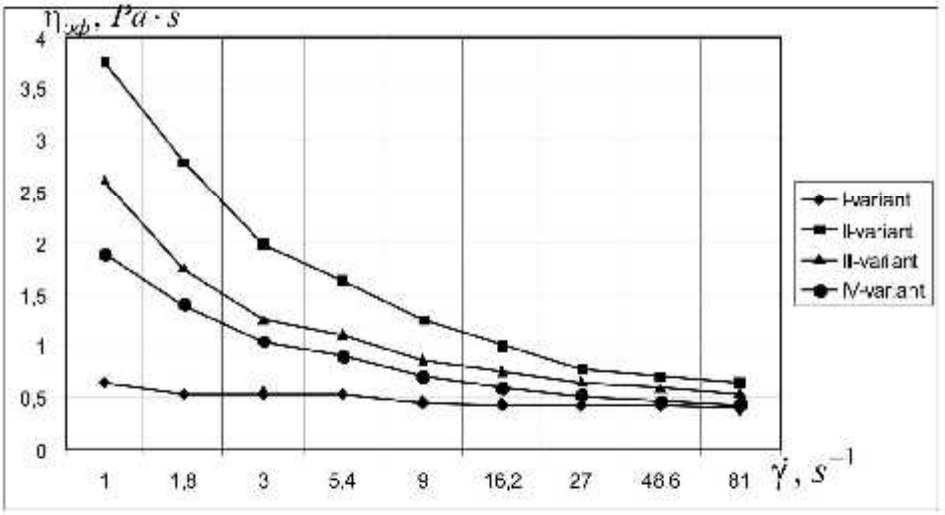


Fig. 4. Dependence of WCF effective viscosity on the granulometry of the used coal

CONCLUSIONS

The analysis of the received data shows that all the water-coal suspensions possess the sufficient fluidity, allowing to make reliable rheological measurements.

In respect of an estimation of power expenses for transportation of water-coal fuel, the obtained data can be estimated as follows: the minimum power inputs on the moving of water coal-fuel through pipelines can be at its preparation with the use of grinding bodies by the first variant and further according to the deterioration of rheological characteristics of located variants IV, III, II (Fig. 3, Fig. 4).

If we choose the most rational grinding bodies' grain-size it is necessary to consider the grain-size of a firm component providing the greatest possible concentration. Therefore it is possible to make a conclusion that the most comprehensible is the use of the Ivth variant of grinding bodies' grain-size in a spherical mill.

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WYBÓR TECHNOLOGII I OBRÓBKI DLA PRZYGTOWANIA WODOROWĘGLOWEGO W WARUNKACH LABORATORYJNYCH

Streszczenie. W pracy wpatrzono podstawowe problemy, związane z wyborem technologii i obróbki dla przygotowania wodorowęglowego paliwa. Przeprowadzona analaiza wpływu granulacji mielonych charakterystyki wodorowęglowego paliwa i na energetyczne wartości przy jego transportowaniu.

Słowa kluczowe: wodorowęglowe paliwa charakterystyka ideologiczna, granulacja, mielenie materiału, młyn kulowy.