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GRINDING OF MECSEK COALS IN PRESENCE OF ADDITIVES I.

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ABSTRACT

The authors have investigated the intensifying effect of surface active materials and water in series of laboratory tests by using energetic coals. They have stated that the quantity of fine fractions (the surplus output) increases when using water, but this effect can be increased further with additives.

INTRODUCTION

In our epoch striving against energy crises the using of coal as a traditional fuel has come into the limelight besides the investigation of the applicability of alternative energy resources. The role of thermoplants in the production of electricity is increasing and according to estimations the thermoplants will keep their importance for a long period due to their reliable operation. Despite the fact that the thermoplants functioning with coal have operated for over decades, however there are many tasks to be solved, just to mention the most important one, the elimination of the environment pollution. All, over the world researchers investigate the possibilities of the rationalization of costs in order to render more efficient the production of energy. Such a factor decreasing the costs could be the amelioration of the grinding of fuel by using additives in the power plants operating with pulverized coal.

During grinding in presence of additive (1)

— the performance of the mill can be increased with the same energy input
— with same performance of the mill and energy input the grinding is finer.

The using of materials facilitating the grinding has became widespread in the cement industry, where it is possible to produce dust with fine-grain structure only in presence of additives. Such additives are glycols, ethanolamins etc., (2, 3, 4). There is no reference data to our disposal regarding the grinding of coals with additives.

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EXPERIMENTAL PART

In our series of laboratory grinding tests we have tested the grinding capabilities of coals to be processed in the Pécs Thermal Plant — that is slurry, Pécs pulverized coal, coal with refuse, rice coal "B" from Komló —.

We investigated the relation between the type of coal to be grinded, the quality of the additives, the revolution number of the mill, the mass proportion of coal/grinding body in presence of additive or without additive. We considered as a basis for comparison the so-called standard grindings without grinding additive.

The characteristic ash, volatile and moisture content of the tested coals is resumed in Table 1.

TABLE 1.

Ash, volatile and water content of various coal types used in PTP.

Coal type	Ash (%)	Volatile (%)	Water (%)
Pécs mud	31.5—34.3	11.0—12.4	20.5—25.0
Pécs dust	53.0—64.0	10.0—13.0	0.8—1.5
Komló B breeze	52.3—62.2	13.7—15.1	5.5—7.0
Goaf with coal	66.0	10.0—11.0	5.3—6.2

In the furnace of the Pécs Thermal Plant an average fraction of 74 μm of mixtures of coal of a given calorific value are burned. The crushing is performed in ball crushers during grinding with a moisture content of coal mixtures of almost 0. We analyzed the components of the mixed materials due to the very different place of origin of the materials.

We have chosen as grinding additives the surface active materials sulfonate anion type:

— Évatriol (E) — sodium salt of dodecil-benzol sulfonic acid
— Evanat (T) — sodium salt of fatty alcohol sulfonic acid
— Persulfite alkaline dust — sodium salt of lignine sulfonic acid with carbohydrate content
— Petroleum sulfonate of type PS-948 with 18 % oil content.

We have characterized the surface active materials with the concentration dependence of the surface stress (*Fig. 1*).

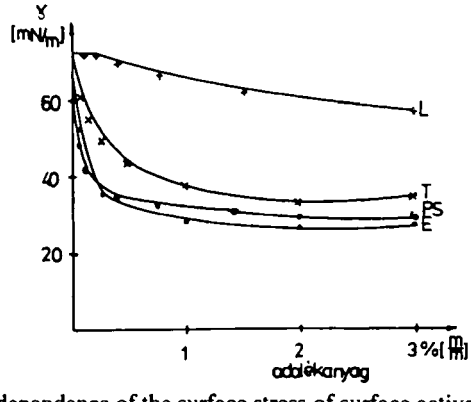

Fig. 1. Concentration dependence of the surface stress of surface active minerals. E—Evatriol, PS—Petroleum sulfonate, T—Evanat, L—alkaline dust of persulfit.

The original moisture content of coals varies considerably, therefore we have stocked the coals in a covered storage place for several weeks, so as to obtain an equilibrium moisture content (air dry coals) (Table 2).

TABLE 2.

Moisture of several air-dry coals

Type of coal	Moisture content %
slurry from Pécs	1.00
pulverized coal from Pécs	1.00
refuse with coal	1.20
rice coal from Komló	1.80

The raw coal samples were crushed in pre-crushers (VEB Special Maschinenbau 64 Typ 214) to obtain a grain size bellow 2.5 mm.

The distribution of the additive on the surface of the coal is carried out by means of spraying of water solution of the surface active material, so that the concentration of the surface active material is 0.05 % (m/m) and quantity of the distributed water was 1.5 % (m/m) regarding the air dry coals. The grinding experiments were carried out in a laboratory mill system with changeable revolution number.

Parameters of mill: Internal diameter: 12:0 mm, Volume: 950 cm^3, Height: 840 mm.

We have grinded parallel standard coals and coals containing additives with a mass proportion of coal:grinding body of 1:1 and 1:3, where the grinding bodies were steel balls of 11 and 15 mm.

The volumetric factor of the mill was 27 % (v/v).

By applying several additives we have investigated the effect of the revolution number of the mill on the grinding.

The revolution numbers were as follows: n_{opt} = 88 l/min., n_{opt} = 44 l/min., n_{opt} = 22 l/ min.

Furthermore, we have carried out a series of experiments regarding the effect of water to facilitate the grinding. We used the rice coal type "B" from Komló for grinding. We have increased the moisture content by 0.5 % (m/m); 1.5 % (m/m); 2.5 % (m/m) relating to air dry coal, then we have grinded with a mass proportion of coal:grinding body of 1:1 and 1:3, as well as with a varying revolution number.

RESULTS OF THE EXPERIMENTS

We have characterized the effect of the various additives and modified mill-parameters influencing the grinding by the amount of surplus output (K) comparing to the standard. After 60 minutes of grinding we have screened the grinding material and we have determined the (K) value of the quantity of fractions bellow 74 μm.

$$K = \frac{D_{60A} - D_{60E}}{D_{60E}} \cdot 100 \ (\%)$$

where: D_{60A} = % of the passing-through of material in 60 minutes of grinding with additive, D_{60E} = % of the passing-through of material of a standard grinding of 60

minutes. The diagrams plotted on the basis of our measuring results are shown in *Figures 2, 3, 4* and *5.*

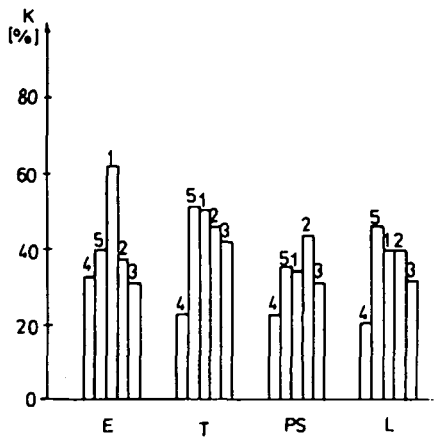

Fig. 2. Surplus output (K) during the grinding of slurry from Pécs with additives: Evatriol (E), Evanat (T), Petroleum sulfonate (PS) and lignine sulfonate (L). (1) Mass proportion 1:3 coal:ball, n_{opt}; (2) Mass proportion 1:3 coal:ball, $n_{opt}/2$; (3) Mass proportion 1:3 coal:ball, $n_{opt}/4$; (4) Mass proportion 1:1 coal:ball, n_{opt} ; (5) Mass proportion 1:1 coal:ball, $n_{opt}/2$

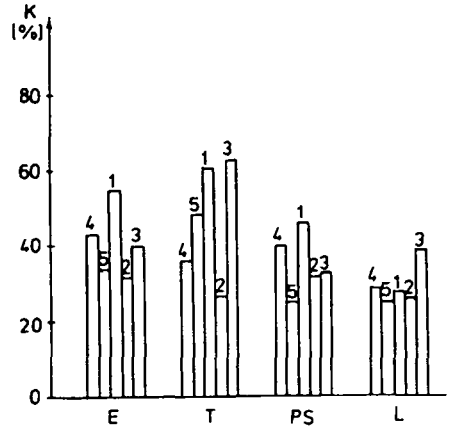

Fig. 3. Surplus output (K) during of the grinding of pulverized coal from Pécs (additives and mill parameters are shown in *Fig. 2*).

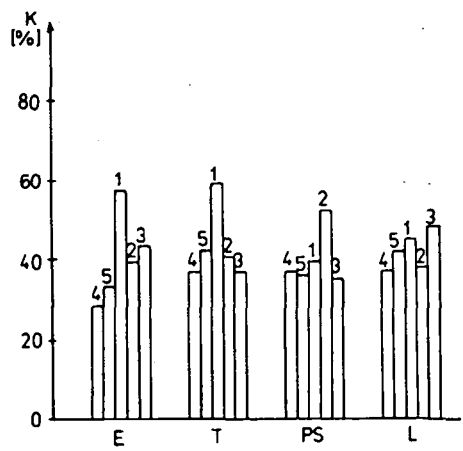

Fig. 4. Surplus output (K) during of the grinding of rice coal type "B" from Komló (additives and mill parameters are shown in *Fig. 2*).

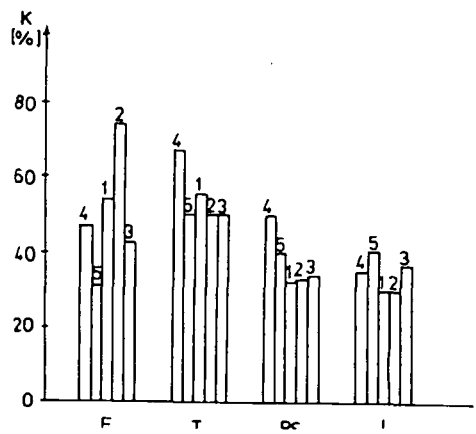

Fig. 5. Surplus output (K) during of the grinding of refuse with coal (additives and mill parameters are shown in *Fig. 2*).

Comparing the diagrams we can state the followings:

— the K factor varies from 20 to 50 %, irrespective of the concentration dependence of the surface stress of surface active material (*Fig. 1*).
— there is no significant effect of the mass proportion of coal:grinding body on the surplus output.
— the effect of the revolution number of the mill on the surplus output cannot be separated as well unambiguously, the K value is situated in one single band, that is between 20—60 % (*Figures 6, 7, 8, 9*).

During our study we have investigated the facilitating effect of the water regarding the grinding. *Fig. 10.* shows the dependence of the moisture content regarding the surplus output of fractions bellow 74 μm; the dependence of the surplus output on the revolution number is shown in *Figure 11.*

EVALUATION

In our series of study we have investigated the effect of various surface active materials on the grinding process of coals. We have determined the extent of the modification according to the place of origin of coals, mass proportion of coal:grinding body, the revolution number of the mill and the type of additive. We have characterized the grinding facilitating effect with the quantity of fraction size bellow 74 μm.

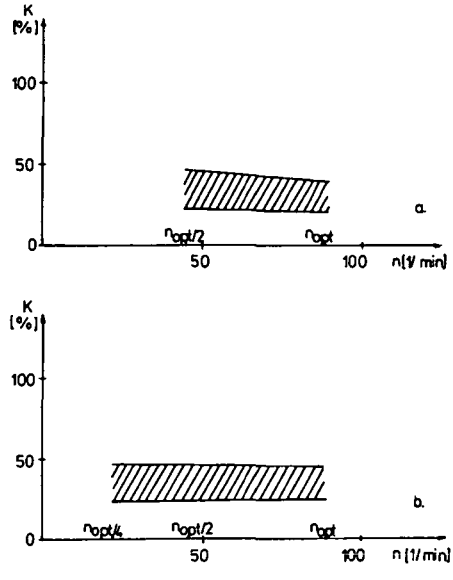

Fig. 6. Relation of the surplus output and revolution number in case of grinding rice coal type "B" from Komló, pulverized coal from Pécs, and slurry using lignine sulfonate (L) additive. (a) in case of mass proportion of coal:grinding body of 1:1; (b) in case of mass proportion of coal:grinding body of 1:3.

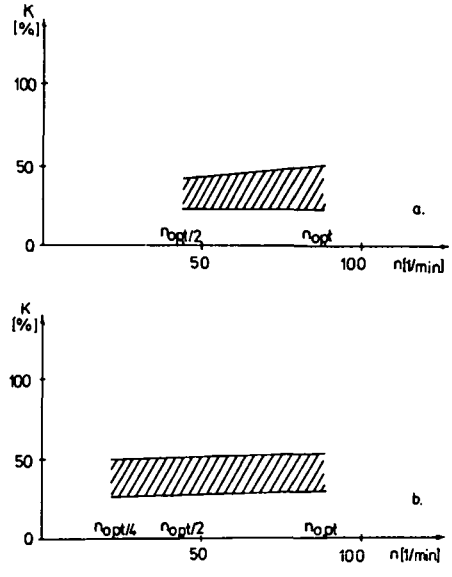

Fig. 7. Relation of the surplus output and revolution number in case of grinding slurry from Pécs and rice coal type "B" from Komló using petroleum sulfonate additive. (a) in case of mass proportion of coal:grinding body of 1:1; (b) in case of mass proportion of coal:grinding body of 1:3.

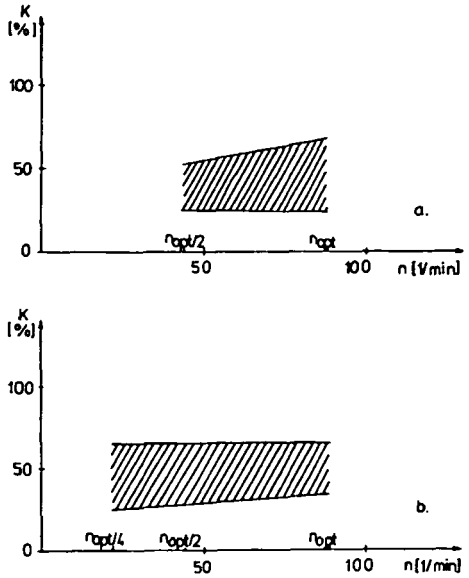

Fig. 8. Relation of the surplus output and revolution number in case of grinding rice coal type "B" from Komló, pulverized coal from Pécs, and slurry using Evanat (T) additive. (a) in case of mass proportion of coal:grinding body of 1:1; (b) in case of mass proportion of coal:grinding body of 1:3.

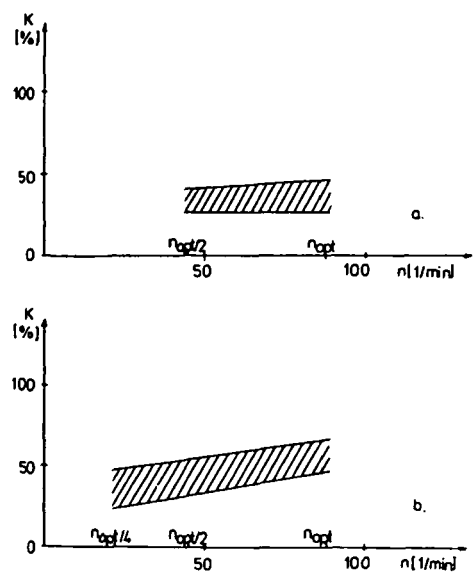

Fig. 9. Relation of the surplus output and revolution number in case of grinding rice coal type "B" from Komló, pulverized coal from Pécs, and slurry using Evatriol (E) additive. (a) in case of mass proportion of coal:grinding body of 1:1; (b) in case of mass proportion of coal:grinding body of 1:3.

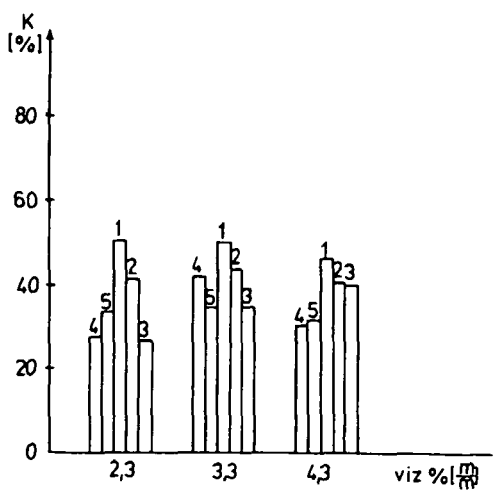

Fig. 10. Surplus of output (K) during the grinding of air dry rice coal type "B" from Komló increased with 0.5 %. 1.5 %, 2.5 % water. (1) mass proportion of coal:ball of 1:3 n_{opt}; (2) mass proportion of coal:ball of 1:3 $n_{opt}/2$; (3) mass proportion of coal:ball of 1:3 $n_{opt}/4$; (4) mass proportion of coal:ball of 1:1 n_{opt}; (5) mass proportion of coal:ball of 1:1 $n_{opt}/4$.

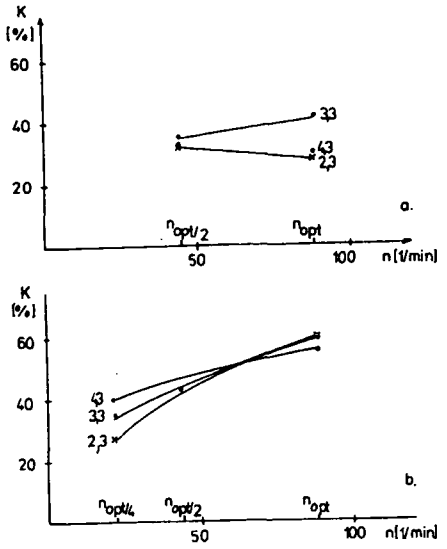

Fig. 11. Relation of surplus output during the grinding of rice coal type "B" from Komló in case of various moisture content. (a) mass proportion of coal:ball of 1:1; (b) mass proportion of coal:ball of 1:3

On the basis of our measurement results we can state that the anion surface active materials of sulfonate type have an effect of facilitating the grinding.

The value of the calculated surplus output factor (K) ranges from 20 to 60 %, which suggests that in case of grinding with additive the quantity of the finer fraction increases.

By using water as an auxilary material we have stated that the water in itself has an effect of facilitating the grinding. Our experiences acquired during the tests show that the intensifying of grinding is mainly a function of water content. This effect can be increased by means of surface active materials requires supplementary technological equipment.

Summing up our results we can state that in case of using of auxiliary materials for grinding, the revolution number of the mill can be decreased at a quarter of the optimal value; the mass proportion of coal:grinding body can be increased at 1:1 without any noticable change in the effect of intensifying the grinding.

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