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GRINDING OF MECSEK COALS IN PRESENCE OF ADDITIVES, II.

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ABSTRACT

Authors present the grinding experiments of refuses with coal in presence of additives at the Pécs Thermal Plant. They have examined the relation of the quantity of fine fractions and grain sizes during the process of crushing, as well as their changes as a function of the grinding time taking into consideration a mass proportion of coal-grinding body of 1:1 and 1:3.

INTRODUCTION

In power plants operating with pulverized coal the energy demand for the crushings of the fuel to be burned means a significant amount of costs, and that is the case with the Pécs Thermal Plant as well. The production of the fine grain fraction of about 74 μm in the process of the so-called drying grinding is carried out in ball crushers with high performance.

From the types of coal to burned at the Pécs Thermal Plant, i.e. /1/ slurry from Pécs, /2/ pulverized coal from Komló, /3/ rice call type "B" from Komló, and /4/ coal with refuse, we have dealt in the first part of this study with the grinding experiments in presence of additives of three different quality of coals. In the second part of this study we have investigated the refuse with coal applied for the appropriate adjusting of the caloritic value.

THE EXPERIMENTS

The grinding tests were carried out in laboratory mills simultanously, in five mills in presence of additives, in other five mills without additives. The mills were equipped with revolution adjusting device and with a counting system. We have performed the measurements with a mass proportion of coal: grinding body of 1:1 and 1:3, and with a revolution of 80 1/min. (The present revolution number corresponds to the optimal revolution number of the mill). The structure of the raw refuse with coal > 200 mm, therefore it is crushed (on a crusher type VEB Spezial

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Maschinenbau 46 typ 214) bellow the grain size of 2.5 mm. We have considered this size as standard.

The auxiliary material for grinding was dispersed on the surface of the air dry coal with spraying of a 10 % ($\frac{m}{m}$) water solution; the auxiliary material in this case was the sodium salt of the alkil-benzosulfonate — its trade name is: Evatriol, manufacturer Egyesült Vegyiművek. The concentration of the utilized auxiliary material was always 0.05 % ($\frac{m}{m}$) referring to the mass of the air dry coal.

The grain structure of all samples has been determined before grindings. This step was followed by an experimental grinding by changing the time and the mass porportion of coal:grinding body. The samples have been crushed for 5, 10, 20, 40 and 60 minutes. After the grinding time the grinding bodies were separated from the grinded material by means of a funnel fitted with filter. We have determined the grain structure distribution of the grinded material.

THE PROCESSING OF THE MEASUREMENT RESULTS

The measurement data were processed by means of regression analysis of grain size distribution according to ROSIN-RAMMLER-SPERLING-BENETT (RRSB) (2, 3).
The relation RRSB

$$R(x)=e^{-\left(\frac{x}{\bar{x}}\right)^{n_e}} \qquad (1)$$

taking into consideration

$$Y_i = \ln \ln \frac{1}{R_i} \qquad (2)$$

$$X_i = \ln x_i \qquad (3)$$

by correlation that is (X_i; Y_i) a linear regression can be applied to the pair (x_i; R_i) (it is the serial number of the measuring points), and for the new variable;

$$Y = a_d + bX \qquad (4)$$

From the comparison results that:

$$n_e = b \qquad (5)$$

$$X_0 = e^{-\frac{a_d}{n_e}} \qquad (6)$$

$$a_d = \ln x_0^{-n_e} \qquad (7)$$

On the basis of the relations (1)—(7) we have carried out the calculations by means of a program written for a computer PC-1500

$$B = 1 - \frac{f(x_i) - R_i^2}{R_i^2 - \frac{1}{N}(R_i)^2} \cdot 100$$

where the B value was denominated the linear accuracy of the measurement which is the square value of the correlation coefficient calculated by means of non logarithmic values of the corresponding points of the regression and measurement data. We have calculated furthermore the standard error of the linear regression on the basis of the relation:

$$S_f = \frac{f(X_i) - e_i^2}{N - 1} \tag{9}$$

The results are shown in Tables 1 and 2, where

- n_e the factor of uniformity
- a_d axis section
- x_0 the characteristic grain size (mm)
- B_{lin} the accuracy of determination (%)
- S_f the standard errors of measurements (%)

belonging to given revolution number (n), mass proportion of coal grinding body (m_{COAL}/m_{BALL}) and grinding time (t).

TABLE 1.

Data of the regression analyses of grainsize distribution according to ROSIN, RAMMLER, SPERLING, BENETT
Model: refuse with coal

n $\left(\frac{1}{min}\right)$	$\frac{m_{COAL}}{m_{BALL}}$	t (min)	n_e	a_d	x_0 (mm)	B_{lin} (%)	S_f (%)
88	1 : 1	5	1.011	0.128	0.987	96.20	6.31
		10	0.989	0.094	0.909	96.10	6.25
		20	0.990	0.174	0.838	96.30	6.21
		40	0.988	0.285	0.749	97.27	5.35
		60	1.006	0.351	0.705	97.20	5.35
88	1 : 3	5	0.981	0.226	0.793	97.44	5.10
		10	0.967	0.324	0.714	97.50	5.06
		20	0.885	0.386	0.647	96.95	5.38
		40	0.847	0.424	0.606	97.17	5.05
		60	0.859	0.511	0.551	97.46	4.80

Figures 1, and 2, show the dependence of the grinding time (t) and the factor of uniformity of coal:grinding body mass proportion of 1:1 and 1:3. It can be observed that n_e which characterizes the dispersity of the grinded material changes abruptly with the time during grinding in presence of additive (EVATRIOL).

Figures 3. and *4.* show the axis section (a_d) deriving from the distribution functions in function of the grinding time (t). The value of (a_d) is charcteristic for the proportion of the fine grain fraction of the grinded material. During the grinding with additive the fine grain fraction exceeds significantly the values obtained at the standard measurement both in case of mass porportion of coal:grinding body of 1:1 and 1:3.

TABLE 2.

Data of the regression analyses of grainsize distribution according to ROSIN, RAMMLER, SPERLING, BENETT

Model: refuse with coal + E

n $\left(\frac{1}{min}\right)$	$\frac{m_{COAL}}{m_{BALL}}$	t (min)	n_e	a_d	x_0 (mm)	B_{lin} (%)	S_f (%)
88	1 : 1	5	1.044	0.148	0.868	96.71	6.21
		10	1.067	0.232	0.804	96.48	6.33
		20	1.036	0.350	0.714	96.09	6.59
		40	0.974	0.424	0.647	96.19	6.45
		60	0.937	0.487	0.595	96.12	6.44
88	1 : 3	5	1.025	0.450	0.644	97.06	5.68
		10	0.981	0.498	0.602	97.02	5.58
		20	0.891	0.597	0.511	97.42	4.89
		40	0.853	0.650	0.466	97.19	4.96
		60	0.798	0.828	0.354	97.03	4.83

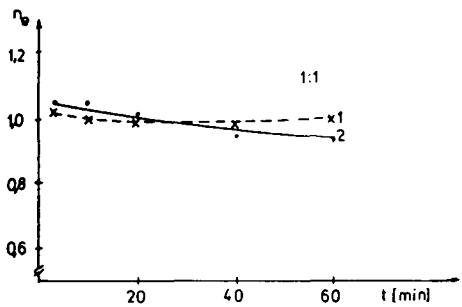

Fig. 1. Changes of the uniformity factor in function of the grinding time in case of refuse with coal

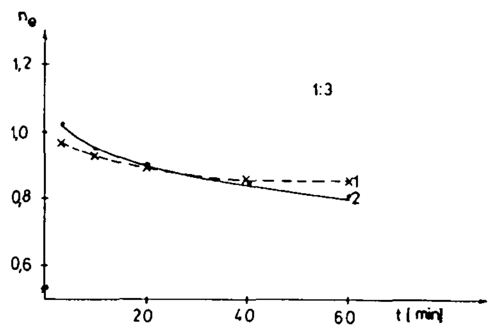

Fig. 2. Changes of the uniformity factor in function of the grinding time in case of refuse with coal

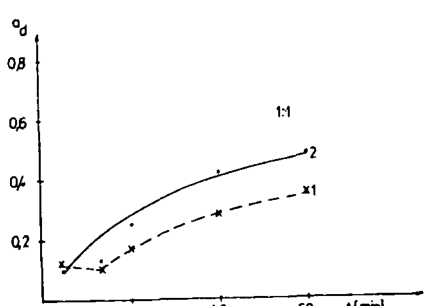

Fig. 3. Changes of a_d in function of the grinding time

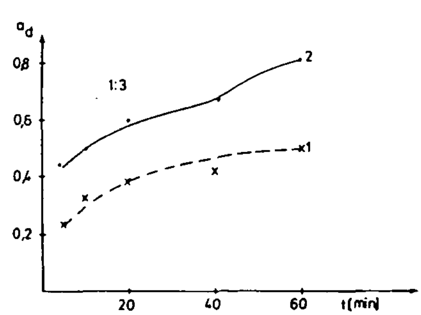

Fig. 4. Changes of a_d in function of the grinding time

Figures 5. and 6. show the dependence of the grinding time for characteristic grain sizes (X_0). The effect of the surface active material is obvious in case of this comparison as well: the grain size is lower in each measuring point than in the case of standard grinding, namely the use of Evatriol increases the efficiency of the crushing.

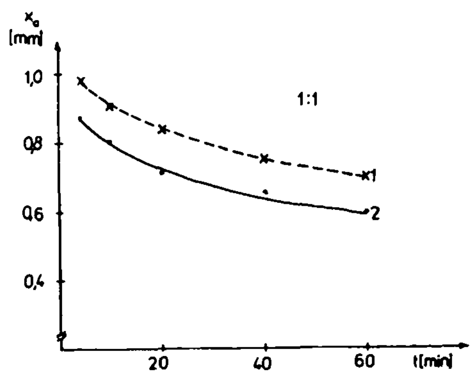

Fig. 5. Changes of the characteristic grain size in function of the grinding time

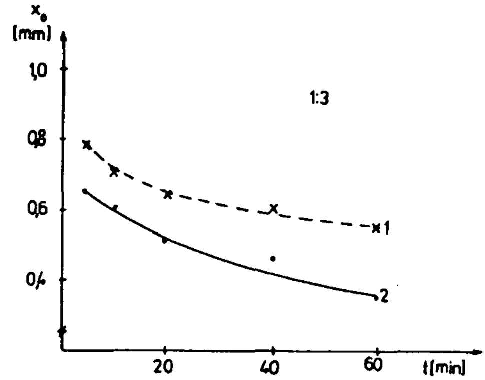

Fig. 6. Changes of the characteristic grain size in function of the grinding time

We have investigated the modification of grain size compared to the standard (ΔX_0) in function of the grinding time in case of grinding with additive. The relation obtained is shown in *Fig. 7.* On the basis of the diagram we have stated that in case of grinding with refuse with coal in presence of additive and with a mass porportion of coal:grinding body of 1:1 the decrease of grain size ranges from 13 to 20%, in case of a proportion of 1:3 from 18 to 55% during a given grinding interval.

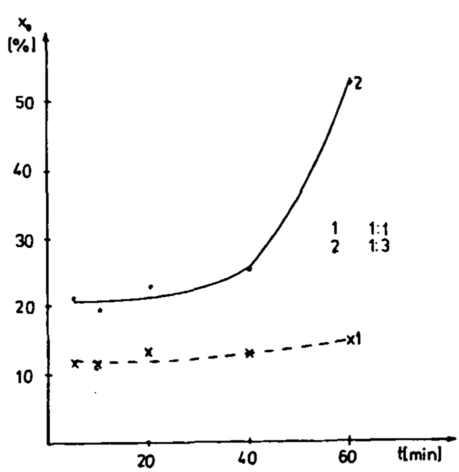

Fig. 7. Changes of the grain size compared to the standard grinding in function of the grinding time.

SUMMARY

In the second part of this paper we have presented the experiments carried out at Pécs Thermal Plant related to the grinding of refuses with coal in presence of additives. Furthermore we have investigated the distribution of grain size of the grinded material, the relation of the quantity of fine fractions during the crushing as well as the grain sizes and their changes function of the grinding time with a mass proportion of coal:grinding body of 1:1 and 1:3.

On the basis of our measuring results we have stated that in case of using Evatriol, an anion surface active material, the effect is favourable in comparison with the standard grinding without additive. During the same grinding time it is obtained a higher proportion of fine fraction and lower grain sizes, which show the increase in efficiency of the crushing.

When applying a mass proportion of coal:grinding body of 1:3 the results are more favourable in each case, however the capacity factor is more advantegous in case of a mass proportion of 1:1.

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