PARAMETERS THAT CHARACTERIZES FUEL QUALITY

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ABSTRACT
The process of burning the coal particle is a complex process that depends on a multitude of factors: coal composition, coal moisture, fineness of grinding, type of combustion plant, combustion air temperature, combustion air distribution, outbreak temperature. Therefore, in this paper was made a study of the parameters that influence the quality of the fuel used in the combustion process.

Keywords: coal, combustion, fineness, fuel, particle.

1.INTRODUCTION

Combustion of solid fuels is almost always an incomplete combustion. However, the air required for combustion is introduced for a complete combustion. When combustion is incomplete, unused combustion air is found in the flue gases. This air often contributes to the formation of new pollutants such as NOx or SO_3.

The fineness of grinding the coal influences the combustion time of the particle. The smaller is a particle, the shorter the combustion time.

CTE Rovinari uses coals from several quarries, which have different characteristics, as a result the fineness of grinding is different. As desulphurisation plants have been installed to reduce sulfur oxides, sulfur emissions are in line with European standards. Instead, NOx emissions are quite high and exceed the permitted limits. Reducing NOx emissions remains an issue that will need to be addressed to avoid shutting down energy groups.

1. THE FINENESS OF GRINDING COAL

Coal burning in the Oltenia Basin is done in a pulverized state. Its grinding is performed on each boiler with six DGS 100 fan mills, four of which are in operation and two in reserve. The lignite being a young coal with several wooden structures in it is harder to grind. It is necessary to know the grindability of coal to determine the number of mills required, the power required to drive the mills.

The fineness of grinding coal directly influences the combustion process. Small particles have a short burning time while large ones burn harder.

The grinding coefficient is determined experimentally because this process is very complex and is conditioned by the inhomogeneous structure of the coal.

Trying to establish a theory of grinding leads to results far from reality.

Grinding is determined by the VTI method in a laboratory mill for 15 minutes. The fineness of measurement is measured by the rest that remains on a certain sieve. It is expressed as a percentage ratio between the amount of dust remaining on the sieve and the total amount subjected to sieving. It is denoted by the letter R followed by the site number. For example, the remainder that remains on the sieve with 900 stitches per cm^2 is denoted R0.2. The smaller this residue, the greater the fineness.

Passing the dust through several sieves, the residues that remain on them are measured and the particle size curve is drawn according to the size of the meshes.

Rammler - Rosin established a distribution law for this curve, given by the formula:

$$R_x = 100\, e^{(-bxn)} \qquad (1.1)$$

where:

x - particle diameter, in microns;

R_X - the amount of particles larger than x (the rest on the sieve with the eye x);

b - coefficient that takes into account the fineness of grinding.

$$b = \frac{1}{x_1^n} ln \frac{100}{R_{xi}} \qquad (1.2)$$

n - coefficient of polydispersity of coal dust, which characterizes the distribution of particles according to dimensions, calculated with the relation:

$$n = \frac{lg \frac{ln \frac{R_{x1}}{100}}{ln \frac{R_{x2}}{100}}}{lg \frac{x_1}{x_2}} \qquad (1.3)$$

where:

R_{x1}, R_{x2} - the rest on the sieve with the eye of x_1, respectively x_2.

The total coal flow rate is:

$$D_x + D_y = 100\% \qquad (1.4)$$

where:

D_x - the flow that remains on the sieve, in%;

D_y - the flow that passes through the sieve, in%.

CTE Rovinari works with coal from three quarries that have different grinding coefficients. Figures 1.1– 1.3 show the Rosin-Rammler particle size distribution curves for each type of coal.

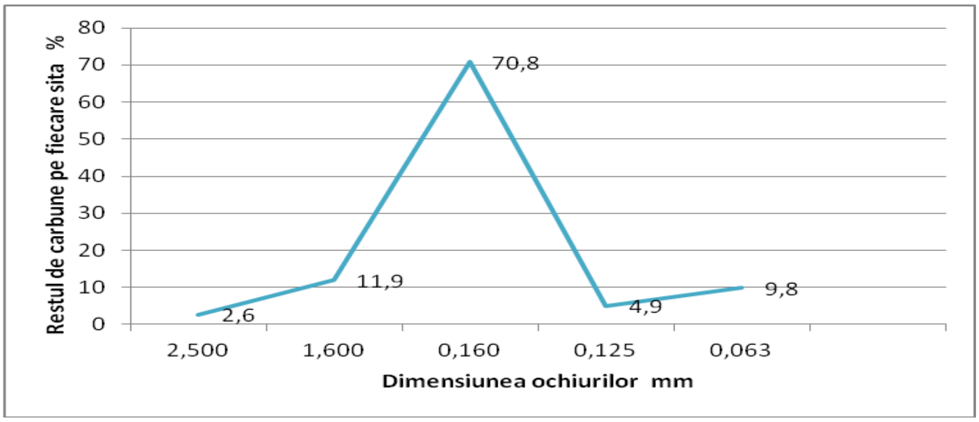

Fig.1.1.Rosin-Rammler particle size distribution curve for the Rovinari Nord quarry

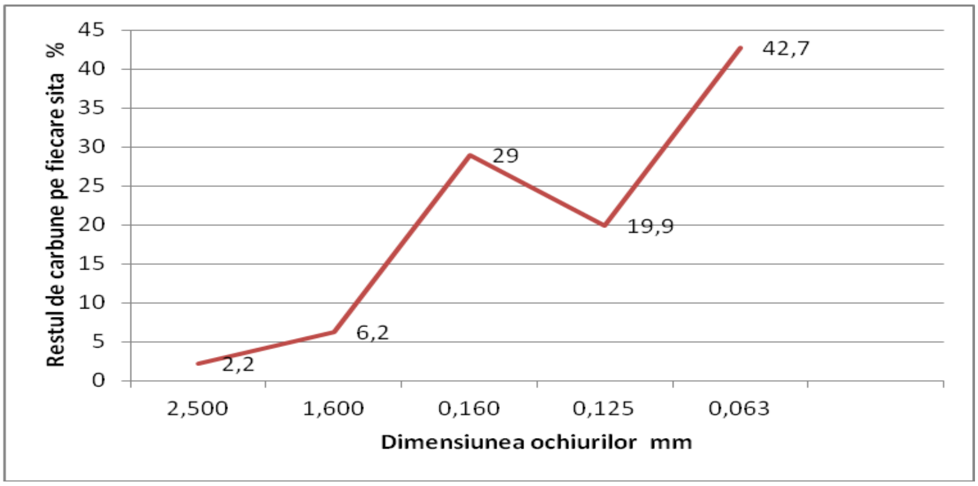

Fig.1.2.Rosin-Rammler particle size distribution curve for the Rosia quarry

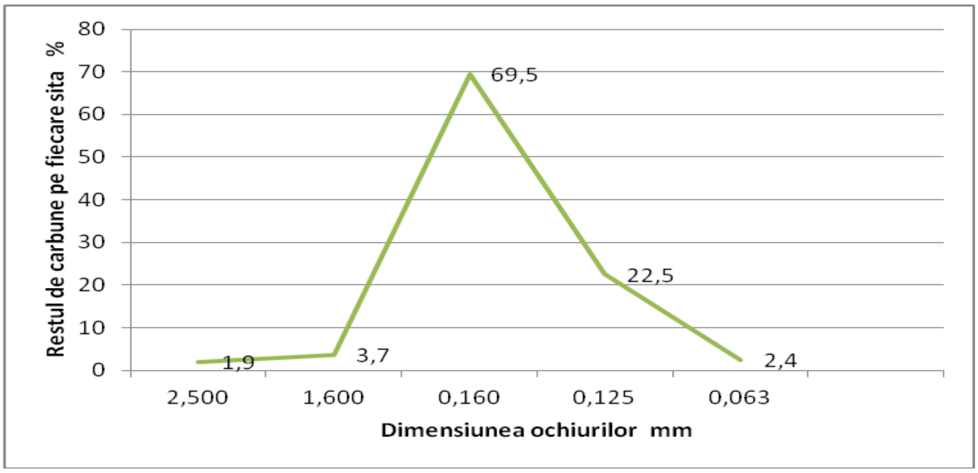

Fig.1.3. Rosin-Rammler particle size distribution curve for the Pinoasa quarry

The calculations were performed for a coal flow of 200 kg / h and a natural gas flow of 40Nm^3 / h. The combustion air is divided into secondary air and primary air in order to obtain a complete combustion and to reduce the NOx level, the temperature for this being maintained at 250^{o}C for most simulations.

The experimental results show that the highest fineness of grinding is obtained for the coals from the Roşia quarry, and the lowest fineness for the coals from the Rovinari Nord quarry.

The main objective of the measurements was to establish the optimum between the quality of the coal, its fineness of grinding, the combustion process and NOx emission, comparing the values resulting from the measurements with those estimated in the combustion modeling.

The grinding of lignite was carried out with the help of a fan mill, which is part of a coal dust preparation plant with direct insufflation and the recirculation of flue gases from the end of the hearth. Coal combustion was performed with natural gas thermal support or without thermal support. The entire similarity with the industrial hearths for the hearth-mill thermal processes has been preserved.

2.QUALITY AND FINENESS OF GRINDING EXPERIMENTED COALS

Experimented coals are characterized by a high content of moisture and ash. The lignite used in the experiments has the elementary analysis from table 1.1, determined in the laboratory.

The elemental analysis of lignite was determined using the carbon, hydrogen, nitrogen, sulfur and oxygen analysis system model FLASH-EA 1112 CHNS-O, with an analysis time for CHNS of 720 seconds and for oxygen of 320 seconds.

The humidity and ash of the analyzed fuel were determined in the oven at 1050C for one hour and in the oven at 8500C for one hour, respectively. The fuel sample was previously weighed using a high precision class analytical balance.

The calorific value was determined with the help of the calorimeter pump - adiabatic calorimeter type IKA C5000 (adiabatic).

Table 1.1 Elementary analysis of lignite

Quarry	Month	*Analysis of lignite* (%)							*Caloric power* (kJ/kg)
		C	H	N	S	O	A	Wt	Qi
Rovinari Nord	october	20,42	2,35	0,70	0,65	10,50	22,52	42,80	1770
	november	20,40	2,36	0,72	0,60	10,42	23,00	42,50	1770
	december	20,45	2,35	0,71	0,70	10,56	22,43	43,00	1770
Roșia	october	22,40	2,50	0,70	0,60	11,42	19,38	43,00	1940
	november	22,30	2,46	0,70	0,60	11,57	21,17	41,20	1930
	december	21,50	2,45	0,73	0,80	10,92	19,60	44,00	1870
Pinoasa	october	21,40	2,40	0,74	0,65	11,19	21,88	41,80	1850
	november	21,35	2,47	0,75	0,70	11,29	21,94	41,50	1865
	december	20,50	2,35	0,73	0,70	10,81	22,91	42,00	1775

For lignite, the presence of xyloid (woody) structures increases the resistance to grinding, the presence in a very large amount of volatile materials not requiring a very fine grinding. The standard fineness obtained at the fan mills and recommended for this quality of coal is characterized by R90 = 60-75% and R200 30%.

Coal dust sampling was performed with an isokinetic probe located on the connecting pipe between the mill and the burner. The constants of the particle size distribution b and n from the Rossin-Rammler law: Rx = 100exp (-bxn), were established by analytical calculation, based on the data determined by the laboratory.

The DGS 100 mills from CTE Rovinari currently operate without the mill dust separators, allowing the dust thrown from the mill to reach directly into the hearth without the large particles being returned to the mill. Large particles fall on the grill where they burn harder. By mounting the aftermath grate, the temperature in the hearth increased and the temperature at the end of the hearth decreased. As a result, the burning of coal in the hearth is more stable. However, the burning is not complete.

The coal from the Roşia quarry is better ground and has a finer fineness than the coal from the Rovinari Nord quarry.

By making measurements for the two types of coal, the following values presented in table 1.2 were obtained.

Table 1.2 Measurements made for the two types of coal

Quarry	$R_{0,20\%}$	Temperature to end of outbreak	O_2 to end of outbreak %	NO_x
Roşia	2,2	1520 K	5,39	356
Rovinari Nord	5,1	1497 K	4,69	301

The coal from the Roşia quarry, being finely ground, burns faster and consumes the oxygen in the hearth, not allowing it to combine with N2 and form NOx. It decreases from 5.39% to 4.69%. The temperature in the hearth increases but at the end of the hearth it decreases from 1520 K to 1497 K.

The research was done in the warm period when the humidity in the coal was low. It is possible that when the humidity is higher the stability of the flame is reduced by the fact that a smaller amount of coal burns on the grill.

Increasing the fineness of coal grinding leads to increased electricity consumption with coal grinding. An optimization will have to be made between the two measures.

The temperature in the outbreak must also be monitored because a smaller amount of coal remains on the grill. This could lead to more difficult burning of coal in the outbreak.

CONCLUSION

A significant number of cases were studied in which the input data for the use of methane gas for flame support were changed. The methane gas support has the consequence of increasing the temperature inside the hearth.

The time-temperature cycle for each coal particle passing through the hearth will include: rapid heating before spraying - where evaporation will take place, reducing temperature rise and very rapid heating in the combustion zone leading to particle crushing, vaporization and many other interactions. Carbon combines with oxygen.

In the case of coals with a high moisture content, the temperature rises very quickly at first, then evaporation follows, the temperature can reach an equilibrium value depending on the level of moisture content. At this stage, the heat released due to chemical reactions and the heat dissipation due to evaporation and other transfer mechanisms were approximately equal. Oxidation and drying rates also depend on the particle size. It is known that the oxidation and evaporation rates increase with increasing particle size due to lower diffusion resistances and higher external surfaces and also the oxidation rate increases due to the catalytic effect of moisture. The release of moisture leads to an increase in the surface for oxidation due to the opening of active centers that can be attacked by oxygen. Similar to the effect of coal moisture shown above, the moisture adsorption of coal is an inhibitor of the reaction surface. Oxygen access to the active centers can be obstructed by the water layer formed on the reaction surface.

In general, the oxidation rate should depend on the actual surface area per unit volume of coal particles. This surface increases with decreasing particle size. Coals have different surface areas specifically depending on the size, structure and porosity of the particles. Some studies have confirmed that the outer surface of coal particles plays a key role during the early stages of oxidation, at low temperatures for coal with small surface areas.

REFERENCES

[1] V.Paliţă –Combustibili. Generatoare de abur, Ed.Didactică şi Pedagogică, Bucureşti, 2003

[2] M. Aldea, ş.a. - Îndrumător. Cazane de abur şi recipiente sub presiune, Ed. Tehnică, Bucureşti, 1972.

[3] C.Ungureanu, N. Pănoiu, ş.a. - Combustibili. Instalaţii de ardere. Cazane, Ed. Politehnica, Timişoara, 1998.

[4] *** Manualul inginerului termotehnician, Ed. Tehnică, Bucureşti, 1985.

[5] I. Carabogdan, N. Pănoiu - Bazele teoretice ale aprinderii şi arderii combustibililor solizi, Ed. Academiei, Bucureşti, 1969.

[6] N. Pănoiu, ş.a. - Modernizarea instalaţiilor de ardere pentru cazanele industriale, Ed. Tehnică, Bucureşti, 1964.

[7] N. Pănoiu, ş.a. - Instalaţii de ardere, Ed. Tehnică, Bucureşti, 1968.