CHEMICO-TECHNICAL AND ENERGETICAL CHARACTERIZATION OF SOME COALS USED FOR BURNING IN PAROŞENI POWER PLANT

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În această lucrare se prezintă rezultatele cercetării făcute în scopul stabilirii parametrilor care privesc procesul de combustie al cărbunilor din Valea Jiului în termocentrala de la Paroşeni, care are un sistem de ardere a cărbunelui pulverizat.

Acesti cărbuni sunt clasaţi printre cărbunii româneşti cu conţinut foarte redus de bitum (cărbuni bituminoşi din clasa C cu un conţinut foarte ridicat de volatile) şi denumiţi bituminoşi după utilizarea lor. Ei au un conţinut ridicat de material mineral în special « mixtele energetice » folosite la termocentralele Paroşeni şi Mintia. Buna lor funcţionare în diferite sisteme de operare- pat fluidizat sau în stare pulverizată,- cere cunoaşterea anumitor caracteristici ale cărbunilor care le influenţează comportarea în utilizare.

The paper presents the results of our research work aimed to establish the parameters affecting the Valea Jiului coal combustion process in Paroşeni power plant with pulverized coal burning system.

These coals are integrated in Romanian coal classification as very low rank bituminous (high volatile bituminous C coals) and denominated, after their proper use, "energetic bituminous".

They have a high mineral matter content, especially the "energetic mixted" (not washed coals), actually used for burning in Paroşeni and Mintia power-plants.

Their good run, in different operation systems – fluidized bed or pulverized raw coal combustion – requires the knowledge of raw coals characteristics that influence their behaviour of use.

There are given here chemical, technical and elemental characteristics, together with some energetic criteria of classification, after ignition capacity and burning intensity, for six coal samples used in full-scale experiments.

Keywords: bituminous coal, rank, burning, ignition, energetic criteria.

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1. Introduction

The program of Romania energetic development, for 2003 – 2015 period of time, stipulated the use of 3.5 mil.t (1.2 mil t conventional combustible) Valea Jiului coals for both Paroşeni and Mintia power plants. When this fuel is not quantitative enough, it is completed with imported bituminous or subbituminous coals.[1]

Paroşeni power-plant is situated in the center of Petroşani depression, near Lupeni coal preparation plant and Paroseni mining exploatation. Its objective is the production of thermic and electrical energy for the towns: Paroşeni, Vulcan, Lupeni and Aninoasa. Processing technology uses the system with pulverized raw coal combustion.

From Valea Jiului coal combustion results an appreciable ash quantity, between 35-60%, that requires technical measures suitable for diminishing the impact on the environment.[4]

Between the pollutants evacuated to chimney, a particular importance, from the viewpoint of environmental protection, is represented by the powder emissions – *fly ash*, emissions with synergic effects at the regional scale – SO_2 *and* NO_2 and CO_2 emission with effects at the global scale. They are especially monitorized as a result of even more severe environment conditions imposed to energetic sector. [5,9,10]

The pollutants emissions quantity depends on the fuel characteristics and on the parameters of their burning process. [6-10]

Because the utilization of Valea Jiului coals, now and in the near future, is guided towards energetic industry, it is important to determine their chemical, technical and energetical characteristics and to control their burning behaviour.

Experimental

2. Methods and apparatus

Combustion process of Valea Jiului coals uses 89wt% solid fuel, with 11% addition of natural gas for flame supporting.

The coals main characteristics, usefull to obtain information on pulverized fuel combustion behaviour, are: chemical, technical and elemental characteristics, rank and burning parameters. The experimental techniques and analyses were performed in accordance with international standards (ISO, SR ISO, SR EN).[7]

The full scale coal samples were collected three times from the two power-plant working-group, each time two samples, in parallel. They were “energetic mixtes”, provided by Coroieşti preparation plant.

3. Results and discussions

Rank and chemico-technical characteristics of the six coal samples are given in Table 1.

From these data it is remarquable the high ash proportion obtained for all samples, variable between 40 – 70%^{db} . The highest values belong to samples named “mixed coal” (non washed coal, with very high mineral matter percentage). Consequently, their calorific values Q_i^a are low and very low, varying between 1750 – 4368 kcal/kg.

The eng relationship between these two parameters, is very important for the burning process and its products.

It was observed that a high mineral matter content, respectively high ash proportion, in the flame zone of pulverized fuel combustion boiler, may have different undesirable effects on coal chars reactivity and combustion rate, depending on the temperature.

The volatile matter percentage, from the proximate and ultimate coals analyses, is usually very important being an expresion of rank and petrographic composition. The very high mineral matter content of the coal samples in this study, perverts this correlation; therfore we can not use chemical rank parameters but the physical one, that is vitrinite reflectance. These values show a very low rank, coresponding to bituminous C coals.

A particular characteristic for Valea Jiului coals is the big sulphur content, with some variations for coals of different mines and exploatated seams.

The analytical samples had relatively low sulphur content, 0,8 – 1,3%, that are superior for the combustible mass with values up to 2,8%. This shows a specific distribution of this mineral between the organic coal components, especially as pyrite or siderite fine diseminated in vitrinite and carbargilite.

In the energetic sector the main coal controlled parameters, in order to provide a corresponding flame in the furnance are: water, ash and calorific value that, for the studied coal samples, are variable in time.

This fact and the poor quality of supplying coals have a direct influence on the: energy cost price, exploatation charges, including ash and slag evacuation to waste heap, and equipments maintenance expenses.

Table 1

Rank and chemico-technical characteristics of coal samples

Sample	Time of sample drawing	Reported to the initial material								Rank
		W^a_h	A^a	A^{db}	MV^a	C^a_{fix}	S^a_c	Q^a_i	Q^a_s	R_r
		%	%	%	%	%	%	kcal/kg	kcal/kg	%
Paroşeni 1	10.2006	1.24	68.9	69.8	19.5	10.5	0.8	1750	1847	0.585
Paroşeni 2	10.2006	1.93	51.6	52.6	24.5	22.0	1.3	3125	3277	0.590
Paroşeni 3	01.2007	2.38	39.4	40.3	26.6	31.7	1.1	4368	4555	0.657
Paroşeni 4	01.2007	1.75	53.3	54.3	22.6	22.4	0.9	3216	3360	0.621
Paroşeni 5	03.2007	1.66	42.0	42.7	25.2	31.2	1.2	3983	4155	0.610
Paroşeni 6	03.2007	1.62	45.1	45.8	24.0	29.3	1.2	3855	4017	0.646

Table 2

Coal energetic characteristics

Sample	W^a_h	A^a	MV^a	C^a_{fix}	Q^a_i	W^{rep}	A^{rep}	k_i	k_b	Coals enclosing
	%	%	%	%	kcal/kg	%/10^3 kcal/kg	%/10^3 kcal/kg			
Paroşeni 1	1.24	68.9	19.5	10.5	1648	0.75	41.8	1.86	6.56	i.c. high and b.i. very low
Paroşeni 2	1.93	51.6	24.5	22.0	3125	0.62	16.51	1.11	2.35	i.c. high and b.i. low
Paroşeni 3	2.38	39.4	26.6	31.7	4368	0.54	9.02	0.84	1.24	i.c. medium and b.i. low
Paroşeni 4	1.75	53.3	22.6	22.4	3216	0.54	16.57	1.01	2.38	i.c. high and b.i. low
Paroşeni 5	1.66	42.0	25.2	31.2	3993	0.41	10.52	0.81	1.35	i.c. medium and b.i. low
Paroşeni 6	1.62	45.1	24.0	29.3	3855	0.42	11.70	0.82	1.54	i.c. medium and b.i. low

i.c. –ignition capacity; b.i. –burning intensity; k_i –ignition criterium ; k_b –burning criterium

In the same time, high percentages of powder ash, that must be retained or deposited on large ground surfaces, create big environmental problems.

Some energetic characteristics of studied coal samples are presented in Table 2.

- The characteristics ***„reported humidity”*** (W^{rep}) and ***„reported ash”*** (A^{rep}) are two factors used in many expressions for steam generators design and calculation.

$$W^{rep} = W^a/Q^a_i \ [\%]; \qquad A^{rep} = A^a/Q^a_i \ [\%] \qquad (1)$$

- The two analytical criteria: ***”ignition capacity”*** (i.c.) and ***„burning intensity”*** (b.i.) give the possibility of these coal classification from energetic vuepoint.

Ignition criterium characterizes coal ignition susceptibility:

$$k_i = MV^a / C^a_{fix} \qquad (2)$$

So, here are distinguised three groups:

1- with low ignition capacity, $k_i < 0{,}5$ (for anthracite and bituminous coals); **2-** with medium ignition capacity $0{,}5 \le k_i \le 1{,}0$ (hard subbituminous and some bituminous coals) and **3-** with high ignition capacity $k_i > 1{,}0$ (lignites, soft brown coals and peat).

Burning intensity criterium characterized burning intensity of coal is:

$$k_b = A^a / C^a_{fix} \qquad (3)$$

In this case also, coals may be classified in three categories:

1- with high burning intensity, $k_b < 0{,}5$ (peat, lignites); **2-** with medium burning intensity $0{,}5 < k_b < 1{,}0$ (soft brown coals, hard subbituminous, some lignites, bituminous coals and anthracite) and **3-** with low burning intensity $k_b > 1{,}0$ (inferior lignites).

The high ash percentage of P_1, P_2 and P_4 samples influences burning criteria values, in their classification detriment, so, they became corresponding to inferior lignites, with very low burning intensity ($P_1 \rightarrow k_b = 6{,}56$; $P_2 \rightarrow k_b = 2{,}35$; $P_4 \rightarrow k_b = 2{,}38$) respectively soft brown coals and lignites with high ignition capacity ($P_1 \rightarrow k_i = 1{,}86$; $P_2 \rightarrow k_i = 1{,}11$; $P_4 \rightarrow k_i = 1{,}01$).

The other three samples (P_3, P_5, P_6) are correctly classified by burning criterium, as hard brown coals or energetic bituminous.

Determined analitical characteristics (Table 1), attest the low rank of Valea Jiului coals that, according their geological age, would have been hard brown coals while chemical age places them in the high volatile bituminous coal C class.

4. Conclusions

- Energetical bituminous coal samples coming from Valea Jiului different mines for being burnt in Paroşeni power-plant have a very high ash percentage with a large variation interval (40 – 70%) and inconstant in time.

- After combustion, the very high mineral matter content of these coals gives impressive ash and slag quantities, with very negative environmental impact.
- The heigher mineral matter in coal, the lower his calorific value. This fact is directly reflected by the diminishing of combustion process efficiency, that requires additional natural gas for the flame support.
- From energetic viewpoint the studied coal samples are included in the coal category with high and medium ignition and low or very low burning intensity.
- The sulphur content of analitical samples is relatively low but it has higher values when reported to the combustible mass.
- The results of chemical, technical and energetic analyses show that Valea Jiului coals, used for burning in Paroşeni power-plant, do not create particular problems that could produce disturbances of industrial process. As a matter of fact this power-plant was projected and built up for using this sort of coal (preparation plant mixed coals).

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