

Effect of Oxidant Composition on Obtaining Raw Material for Pulverized Coal Production from High-sulfuric Low Grade Coal

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Abstract – The effect of the water steam on the sulphur removal degree and conversion level of coal organic matter has been determined. Sulfur content, as well as ash content and volatiles yield depend on the mentioned values. The optimal the content of water steam in oxidants to realize the oxidative desulphurization process has been found with the aim of obtaining raw material for pulverized coal production.

Keywords – water steam, oxidative desulfurization, coal organic matter, pulverized coal.

I. Introduction

It is well know, that to improve technical and economic indicators of the metallurgy industry can be used pulverized fuel. It considerably decreases the expenses of the imported natural gas and coke, and cheapens the process of steelmaking.

The requirements to the raw stuff of pulverized fuel are rigid enough. It primarily concerns the sulfur content, as it shouldn't accede 1.5%. The balance reserves of Ukrainian coal is considerable, approximately 33873 millions ton., it's 3,8% of world stocks. However, the exploitation of Ukrainian coal for production of raw stuff for pulverized fuel is impossible because of high sulfur content.

To extend the sources of raw materials for PCI technology it is proposed [4] to use oxidative desulphurization of the coal, i.e. selective oxidation of pyrite sulphur, which is the main sulphur in coal, by an oxidant (air or air-steam mixture – ASM) to the sulphur(IV) oxide. The influence of the oxidant composition on the process of oxidative dehydration to get the raw materials for pulverized fuel production hasn't been study. The study of the influence of this parameter is considered in the work.

II. Initial Material

Low-rank coal from "Belorechenskaya" mine (Donetsk coal basin, Ukraine) was used for the experiments. It was grinded and fractions of 0.1-0,25mm were chosen. The characteristic of the initial coal coal is given in Tab 1-2.

TABLE 1
CHARACTERISTICS OF THE INITIAL MATERIAL

Moisture contn, W^A , wt %	Ash content, A^D , wt %	Volatiles yield, V^{DAF} , wt %
3.91	8.15	38.08

As can be seen from Tab. 1 the investigated coal is high-sulphuric coal with the pyrite form forming the bulk of coal sulfur.

TABLE 2
SULPHUR CONTENT IN INITIAL MATERIAL

Sulphur content relative to the dry mass, wt %			
total (S_t^d)	Pyrite (S_p^d)	organic (S_o^d)	sulphate ($S_{SO_4}^d$)
3.29	1.67	1.25	0.37

III. Experimental

The process conditions under which the effect of the water steam on the oxidative desulphurization is studied are presented in Table 3.

TABLE 3
OXIDATIVE DESULPHURIZATION CONDITIONS

Parameter	Values
Time, min	15
Temperature, K	698
Oxidant linear velocity, m/s	0.044
OFR, m ³ /h.kg.	4.8

As a result of the experiments was defined that in a case of water vapor increasing in steam-air mixture, boost the yield of the distilled coal (fig.1). The matter is that the water vapor slows down the reaction of the coal organic part burning. And total amount of the solid desulphuration products output increases.

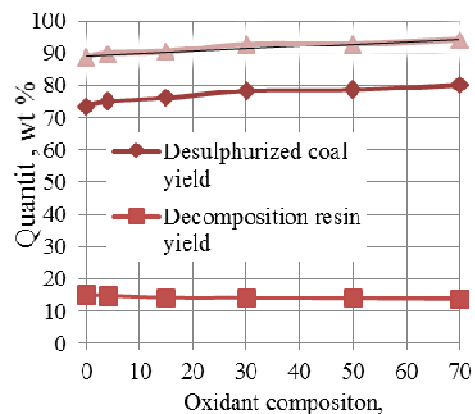


Fig. 1 Desulphurized coal yield; decomposition resin yield; solid products yield vs. oxidant composition.

It is shown in the table 4 that at the increasing of the water vapor content in the steam-air mixture decreases the ash level of desulphurizing coal in a result of reaction impairing of OMD burning.

At the increasing of water vapor in the oxidant the amount of pyrite and total sulfur in coal develop through the minimum (tab.5). The addition of first dosage of water vapor, not only slows the process of organic and mineral depositions burning, but intensifies the process of pyrite

oxidation. The enrichment of sulfur content in the desulphurizing coal after getting the maximum is explained by the lack of oxygen in the reagent (reduction of its concentration in reactive capacity).

TABLE 4

DEPENDENCE OF DESULPHURIZED COAL PROPERTIES ON OXIDANT COMPOSITION

Water steam content in oxidant, vol %	Moisture content, W^A , wt %	Ash content, A^D , wt %	volatiles yield, vdaf, wt %
0	0,98	12,24	31,28
4,5	1,08	11,88	32,10
15	1,13	10,98	33,23
30	1,17	10,13	37,66
50	1,25	8,99	38,59
70	1,32	8,67	39,46

TABLE 5

SULPHUR CONTENT IN DESULPHURIZED COAL

Water steam content in oxidant, vol %	Sulphur content, wt %			
	total (S_t^d)	pyrite (S_p^d)	organic (S_o^d)	sulphate ($S_{SO_4}^d$)
0	2,74	1,24	0,30	1,19
4,5	2,43	1,01	0,28	1,13
15	1,92	0,86	0,26	0,80
30	1,36	0,28	0,22	0,85
50	1,52	0,39	0,23	0,89
70	2,25	0,94	0,27	1,03

In the fig.2 is depicted the areas of water vapor content in the steam-air mixture, what helps to obtain the suitable characteristics of the desulphurizing coal, which meet the requirements of the raw stuff for PVP (Polyvinylpyrrolidone).

As we can see the fig.2 presents a wide range of the water vapor content values in the oxidant (32,3–42,7 % vol.), in consequence of the oxidative desulfurization of the low-metamorphosed coal, can be obtained the raw materials for PVP production, it meets the requirements of the coal brands №3–4 [2]. It is worth mentioning that at the given parameters of the water vapor content in the oxidant, is observed considerably high yield of the solid desulfurization products, near 92,5 % wt.

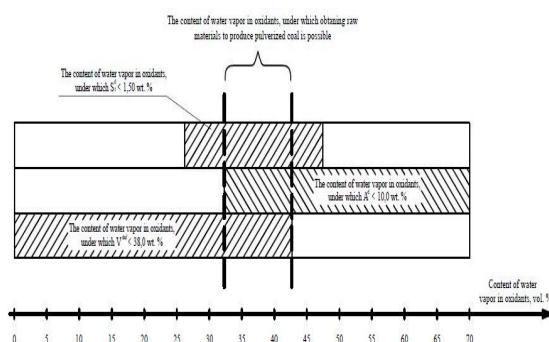


Fig. 2 Contents water steam values, under which the raw material for PCI may be obtained

Conclusion

The conducted experimental research made it possible to determine the water vapor influence in an oxidant on the process of receiving of the raw materials for pulverized coal fuel from high-sulfur low-grade metamorphosed coal by means of its oxidation desulfurization. The increase of water vapor quantity in an air-vapor mixture has the following general influence on the research procedure: yield of sulfur-free coal grows, yield of tar from disintegrated coal becomes slightly reduced, ash content in sulfur-free coal decreases, the number of volatile matters increases, the amount of pyritic and general sulfur goes through a minimum.

The duration of the process is 15 min., the temperature 698 K and OFR 4,8 m³/h·kg, however, an optimal interval of the value of water vapor quantity in an oxidant is 32–43 % wt. (sulfur-free coal receiving is provided, which can be classified, due to its characteristic features, as a raw material for pulverized coal fuel production)

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