Research of parameters of the steam boiler BKZ-220-100 at joint burning of natural gas and low-grade fuel

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Abstract. In this article the research of prospects of use of low-grade brown coal of the Talovsky Deposit of the Tomsk region as fuel for local power is carried out. The study is carried out by checking calculations of the steam boiler BKZ–220–100. The result of the study is to obtain data on the parameters of the boiler during the combustion of brown talovsky coal as the main fuel, as well as in a mixture with natural gas or Kuznetsk coal.

1 Introduction

Brown coal of the talovsky Deposit of the Tomsk region has the following characterized by high humidity in a wide range (20 % – 60 %), low heat of combustion, large yield of volatile. Such parameters of brown coal indicate that this fuel is low-grade and its use is economically feasible only for the needs of local energy [1].

The object of the study is a steam boiler with natural circulation BKZ-220-100. The boiler unit is operated at Tomsk SDPP-2.

The aim of the work is to study the parameters of the steam boiler in the combined combustion of brown talovsky coal and natural gas.

2 Initial data and research methods

Due to the wide range of moisture content of brown coal of the talovsky Deposit, using the methods of numerical simulation of combustion processes, the optimal for combustion in the boiler furnace BKZ-220-100 values of fuel moisture. Fig. 1 shows the temperature change in the height of the combustion chamber of the boiler under study when burning tall brown coal with a moisture content of 20-50% and Kuznetsk coal.

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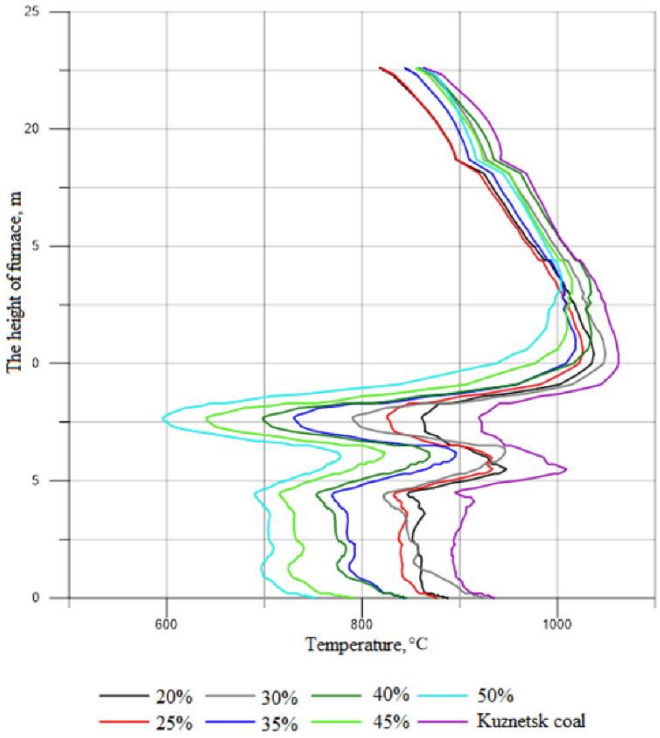

Fig. 1. The temperature Distribution along the height of the boiler furnace.

Fig. 1 shows that the temperature distribution in the boiler furnace height depends on the humidity of the talovsky coal, i.e. as the humidity of the burned talovsky coal increases, the temperature in the area of the burner devices decreases. In addition, there is a similar pattern of temperature distribution in the combustion of talovsky coal with a moisture content in the range of 25-30% and Kuznetsk coal [2].

As a result of numerical simulation of the combustion process of tall brown coal in the furnace of the steam boiler BKZ–220–100, the optimal range of fuel moisture was determined, which was 25% – 30%. The conclusion of numerical modeling is the conclusion that the mathematical model of the boiler furnace

BKZ-220-100 is suitable for further research. The obtained concentration fields of particles, water vapor and temperature regime in the combustion volume correspond to the accepted combustion scheme [2]. For further research, the selected coal with a moisture content of 25%.

The initial characteristics of the talovsky brown coal with a moisture content of 25% are presented in table 1.

Table 1. Features Talovsky brown coal with a moisture content of 25% in working condition.

Moisture content W^r, %	Ash content A^r, %	Volatile yield V^{daf}, %	Low heat of combustion Q_i^r, MJ/kg	Ultimate analysis (dry ash-free basis, %)				
				C^r	H^r	N^r	S^r	O^r
25.00	27.69	63.1	14.05	30.55	3.19	12.93	0.09	0.55

After determining the optimal humidity, the calibration calculation of the boiler BKZ–220–100 was performed for the burning of brown coal from the Talovsky Deposit, as well

as mixtures of brown coal with natural gas and brown coal with Kuznetsk coal, which is designed for the boiler unit under study.

Calculations for the combustion of a mixture of coal is made as an alternative, as natural gas is more expensive fuel compared to Kuznetsk coal and its combustion is less cost-effective.

Table 2 presents the characteristics of natural gas, table 3 – characteristics of Kuznetsk coal.

Table 2. Characteristics of natural gas.

Methane CH_4 %	Dioxide CO_2 %	Ethane C_2H_6 %	Propane C_3H_8 %	Bhutan C_4H_{10} %	Nitrogen N %	Low heat of combustion, Q_d^r MJ/m^3
98.72	0.14	0.12	0.01	0.01	1.00	34.86

Table 3. Characteristics of Kuznetsk coal.

Moisture content W^r, %	Ash content A^r, %	Volatile yield V^{daf}, %	Low heat of combustion Q_i^r, MJ/kg	Ultimate analysis (dry ash-free basis, %)				
				C^r	H^r	N^r	S^r	O^r
13.8	14.4	24.0	20.92	55.7	4.0	9.9	0.3	1.9

3 Results

The parameters of the boiler operation at the brown angle with a moisture content of 25 % are presented in table 4.

Table 4. Parameters of the boiler BKZ-220-100 in the combustion of brown coal.

Name	Dimension	Value
Low heat of fuel combustion	MJ/kg	14.052
Excess air ratio at the exit of the furnace	–	1.2
Boiler efficiency	%	92.237
Exit-gas temperature	°C	136
Fuel consumption	kg /c	10.97
Flue gas temperature at the exit of the furnace	°C	900
Temperature of superheated steam	°C	454

Check calculation of the boiler during combustion in its combustion chamber of talovsky coal with a moisture content of 25 % showed that without the reconstruction of the heating surfaces the required temperature of superheated steam is not achieved.

The results of verification calculations for the combustion of talovsky coal with natural gas and Kuznetsk coal are presented in tables 5 – 6.

Table 5. Parameters of the boiler BKZ-220-100 when burning a mixture of tall brown coal and natural gas.

Name	Dimension	Brown coals content, %			
		30	40	50	60
Low heat of fuel mixture combustion	MJ/kg	46.84	35.13	28.10	23.42
Boiler efficiency	%	93.11	93.22	93.32	93.19
Exit-gas temperature	°C	135	134	133	135
Coal consumption	kg /c	3.39	4.50	5.60	6.68
Gas consumption per 1 kg of coal	m^3/ kg	0.94	0.61	0.40	0.27
Gas consumption	m^3/c	3.19	2.72	2.26	1.80
Flue gas temperature at the exit of the furnace	°C	1132	1081	1043	1006
The temperature of cold air	°C	52	51	50	55
The temperature of hot air	°C	348	338	337	320
The temperature of hot water	°C	303	298	296	284
Temperature of superheated steam	°C	510	510	510	497

The test calculations of the boiler under study when using a mixture of talovsky brown coal and natural gas as a fuel showed that the required parameters of superheated steam are achieved at a fraction of brown coal in the range from 30 % to 50 %.

With a decrease in the proportion of brown coal below 30%. there is a danger of exceeding the temperature of the flue gases at the exit of the furnace over the temperature of the beginning of deformation of the ash of the brown coal. which is equal to 1180 ° C. The maximum share of brown coal in the fuel mixture at which the required temperature of superheated steam is reached is 50%.

The increase in the share of talovsky brown coal leads to a decrease in temperature parameters. however. the boiler efficiency increases. This is due to the decrease in the volume of flue gases and their temperature.

Table 6. Parameters of the boiler BKZ-220-100 when burning a mixture of tall brown coal and Kuznetsk.

Name	Dimension	Brown coals content. %			
		10	20	30	40
Low heat of combustion of fuel mixture	MJ/kg	20.23	19.55	18.86	18.17
Boiler efficiency	%	92.2	92.25	92.36	92.57
Exit-gas temperature	°C	134	135	135	136
The flow rate of the mixture	kg /c	7.94	8.18	8.45	8.72
Flue gas temperature at the exit of the furnace	°C	1098	1080	1061	1038
The temperature of cold air	°C	47	50	50	54
The temperature of hot air	°C	352	349	347	335
The temperature of hot water	°C	304	301	297	292
Temperature of superheated steam	°C	510	510	510	503

Results of verification calculations of the steam boiler BKZ-220-100 at burning of a mixture of brown coal with project Kuznetsk coal (table 6) allow to draw a conclusion that the maximum share of brown coal with a moisture content of 25% in the mixture is 30%. With the increase of the share of talovsky brown coal. the temperature parameters are reduced. due to the decrease in the heat of combustion of the mixture. Boiler efficiency increases by reducing the volume of flue gases and their temperature.

4 Conclusion

The study showed that the use of brown coal from the talovsky Deposit of the Tomsk region with a moisture content of 25% as a fuel for local energy is possible. However use it for combustion in the boiler BKZ-220-100 working as a part of the power unit of Tomsk SDPP–2. it is advisable only in a mixture with natural gas or Kuznetsk coal.

References

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