Preliminary Tests in order to assess the Pollutant Emissions of a New Designed Lignite Burner

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Preliminary Tests in order to assess the Pollutant Emissions of a New Designed Lignite Burner: *The paper presents a comparison between the measured emissions at one of the steam generators of the CHP Işalniţa – Romania and those registered at the pilot furnace of the University Politehnica of Bucharest, equipped with a new designed*

Key words: *Lignite Combustion, Pollutant Emissions, New Designed Burner.*

INTRODUCTION

One of the objectives of our Research Project [1] is the development and implementation of advanced combustion technology, innovative and original with low emissions, for indigenous coal to be combusted in industrial energy boilers in Romania. By the high level of complexity for the scientific and technical activities which are developed during the research, it will be developed a clean-burning coal technology with application to steam generators of type 525 t/h. The past status of the research is represented by the design, tests on wind tunnel and modeling [2] of a new experimental model burner based on the staggered combustion technique, in order to decrease the NO_x emissions.

The present research stage, that will be further presented, is focused on the design, manufacturing, mounting and testing of a pilot prototype burner. The tests were performed in a 2 MW_{th} pilot furnace installed at University Politehnica of Bucharest and the results were compared with the tests achieved on the site of CHP Işalniţa at the start of the project.

DESCRIPTION AND PERFORMANCES OF THE INDUSTRIAL STEAM GENERATOR

The steam generator is designed with unique forced passing through with variable vaporization point, having a constructive form in π shape. The fuel is the lignite from Oltenia region, with a LCV (low calorific value) of 7500-8000 kJ/kg.

A cross-section of the unit is presented in figure 1.

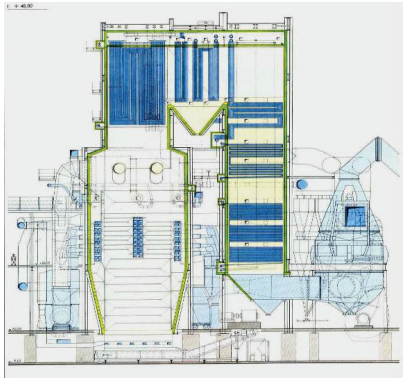

Figure 1. Cross-section of the 525 t/h lignite fueled steam generator

The spatial location of the coal dust routes is shown in figure 2, while the structure of a set of 16 burners is presented in figure 3.

Figure 2. Spatial location of coal dust routes

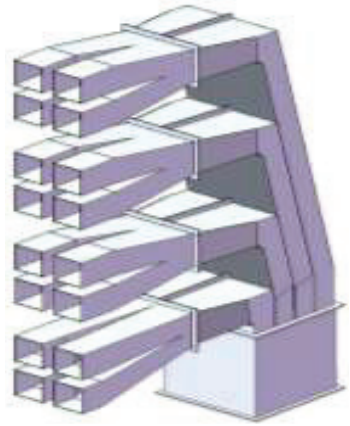

Figure 3. Structure of a set of coal burners

In order to compare the current burner performances regarding the level of the pollutant emissions to the new designed pilot burner, a set of tests have been performed at the CHP Işalniţa on two steam generators (C7A and C7b) coupled to one 315 MW steam turbine. The results of the tests are presented in table 1:

Table 1. Performance test results of the steam generators from CHP Işalniţa

No.	Name	M/U	TEST 1	
			C7A	C7B
1.	Live steam flow	t/h	440.8	419.4
2.	Boiler thermal load	%	86.43	82.24
3.	Flue gas temperature at stack	°C	151.8	150.8
4.	Air excess after air pre-heaters	-	1.836	1.614
5.	Thermal load	MW_{th}	396.0	381.7
6.	Corrected efficiency	%	83.71	83.41
7.	Specific heat consumption for producing 1 kg of live steam	kJ/kg	3864.0	3927.6
8.	Overall traditional coal consumption	kJ/kg	58116.2	56205.3
9.	NO_x emissions in the flue gases at stack	mg/m^3_N (O_2=6%)	394	409

The measurements indicate an increase in NO_x emissions ranging between 320 – 425 mg/m^3_N, therefore surpassing the limit of maximum de 200 mg/Nm^3 established as mandatory since 2016. This can be determined by the nitrogen in the fuel (see elementary analysis: N > 0.50 %) and also by the nitrogen in the air.

CONCEPTION OF THE NEW PILOT BURNER AND CONNECTION WITH THE FURNACE

The new pilot burner is derived from the experimental model burner tested last year on the wind tunnel [2]. In order to be implemented to the $2MW_{th}$ furnace, the following requirements will be respected:

- the slots assembly will be geometrically framed by a circle with a diameter of 200 mm, imposed by the embrasure of the furnace;
- achievement of the velocities obtained during pre-dimensioning phase: 13-15 m/s for the mixture air-coal dust and 40 m/s for the secondary air. In the space between the slots and the circular enclosure will circulate the tertiary air, with an average velocity of 10 m/s;
- the slots width is about 80 mm, while the height is 30 mm for the primary air slots and 25 mm for the secondary air slot;
- in order to obtain the staggered combustion, the inferior primary air slot is axially aligned with the embrasure, the superior primary air slot is retired inside the embrasure with 70 mm, while the secondary air slot will surpass the embrasure line with 75 mm.

In figure 4 is presented the connection of the burner with the air and fuel supply utilities of the furnace.

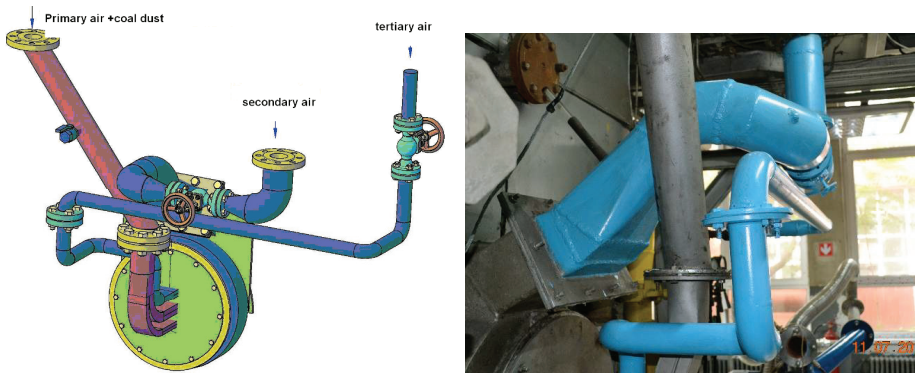

Figure 4. The connection of the pilot burner with the air and fuel supply utilities of the furnace

In figure 5 you can see a view of the burner from inside of the furnace.

Figure 5. Inside view of the burner installed on the furnace

In figure 6 is presented the pilot furnace of 2 MWth.

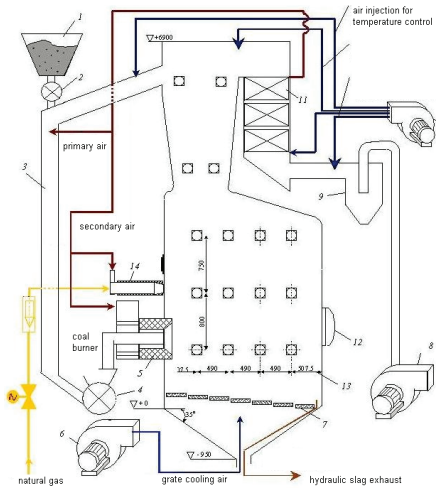

Figure 6. Scheme of the 2 MW_{th} experimental furnace

PRELIMINARY TEST OF THE BURNER OPERATION

After installing the new burner on the experimental furnace, we performed a test of the burner, using a lignite type with the following characteristics: wetness W_a=7 %, ash A_a=11-12 %, volatile content V_a=66-68 % and charcoal C_a=13-16 %. The LCV is 10000-11000 kJ/kg. The results are shown in Table 2:

Table 2. The results of the first test of the new burner

	Value	M.U.	Note
Coal flow-rate	120	kg/h	
Natural gas flow-rate	30	m^3_N/h	
Temperature of flue gasses	860-890	°C	End of furnace
Temperature of flue gasses	126-130	°C	At stack
CO_2	60-75	mg/ m^3_N	At stack (6 % O_2)
NO_x	115-132	mg/ m^3_N	(current burner) 1 coal injection, primary and secondary air
NO_x	75-95	mg/ m^3_N	(new burner) 2 coal injections, primary, secondary and tertiary air

The NO_x reduction in the operation with the new staggered combustion burner in comparison with the current coal burner of the furnace was about 30-40 %. The flame in this case was more stable and shorter than the usual one.

CONCLUSIONS AND FUTURE WORK

After the dimensioning and modeling phases, the new pilot burner, designed to replace the industrial burner from CHP Işalniţa with better results regarding NO_x emission

level; has been installed and primary tested on the 2 MW_{th} experimental furnace. The results were quite satisfactory: the emission decreased with 30-40 %. The next step is to repeat the tests with the same coal type that is burned in the CHP, in order to generalize the test results and to enable the replacement of the modules of the industrial burner (figure 3)

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