STUDY ON THE ECOLOGICAL FUNCTIONING OF 330 MW ENERGY GROUPS USING FOSSIL FUELS

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ABSTRACT. This paper presents a case study on the ecological functioning of the 330 MW energy groups within the National Energy System. The experimental measurements were carried out at energy group no. 6 at the Rovinari thermoelectric power plant, which is part of the Oltenia Energy Complex.

KEY WORDS. Elemental composition coal, flue gas desulphurization, dense fluid, electrofilter, NO2 catalyst.

1. INTRODUCTION

Through the National Recovery and Resilience Plan (NRRP), Romania has committed to giving up coal-based electricity production by 2030. Until then, starting with 2026, two 330 MW energy groups operating on lignite, from the Rovinari thermoelectric plant, will remain at the disposal of the National Energy System. Two new energy groups will be built, operating on natural gas, at the Turceni and Iṣalnița thermoelectric power plants.

The stability and security of the National Energy System can be ensured by keeping the 330 MW coal-fired power groups in operation. The basic fuel of the 330 MW energy group is lignite, fuel oil and natural gas being used at start-up and for flame stabilization. For the preparation and combustion of lignite, the boiler is equipped with 6 DGS-100 type coal mills, with hammers and fan, and 2x6 coal burners with slots. The green functioning of the energy group is ensured by:

- modernization of electrofilters;
- wet desulphurisation of flue gases;
- reducing NOx emissions by using the SCR process- Selective Catalytic Reduction Technology<
- use of the system for the evacuation of slag and ash in dense fluid.

To reduce CO2 pollution, carbon dioxide capture and storage technology (CCUS), which is also applied in thermoelectric power plants abroad, can be used. The captured CO2 emissions are either used for the production of various products or are stored underground in special units. In November 2024, the modernized energy group no. 5 was put into operation at the Rovinari thermoelectric power plant, the best performing coal-fired energy group operating within the Rovinari Energy System.

2. EXPERIMENTAL RESULTS

Figure 1 shows the Rovinari thermoelectric power plant in which energy group no. 6 operates, with a power of 330 MW. Figure 2 shows balance flue gas. Figure 3 shows installation of burnt gases. Figure 4 shows Selective Catalytic Reduction Technology.

Figure 1 The Rovinari thermal power plant.

- measuring points for measuring the flow rates of live steam, drinking water and injection water in the intermediate steam. The flow measurement was carried out with Terranova transducers – accuracy class 0.08;

- measurement points for determining the static pressures of fluids (live steam, drinking water and water injection in intermediate). The measurement of static pressures was performed with Terranova transducers – accuracy class 0.08;

- measurement points for determining static pressures on air and flue gas circuits. The measurement was carried out with "U" tube pressure gauges;

- measurement points for determining the temperatures on the air and flue gas circuits. The measurement was made with type K thermocouples;

- measurement points for flue gas analysis. Testo analyzers were used;

- measurement points for determining electrical powers. The measurement was made with power transducers, accuracy class 0.03.

- measurement points for determining the grinding fineness; The coal dust was sampled through three scoops, for 3 minutes each, with the help of the isokinetic probe. Samples of coal, slag and ash were taken and analyzed by the specialized laboratory of the thermal power plant.

The results of the measurements carried out on the fuel circuit are presented in table no.1.

The results of the measurements made on the air-flue gas circuit are presented in table no.2,, the results of the measurements for the desulphurization plant are presented in table no.3, and the results of the measurements carried out on the dense fluid circuit are presented in table no.4.

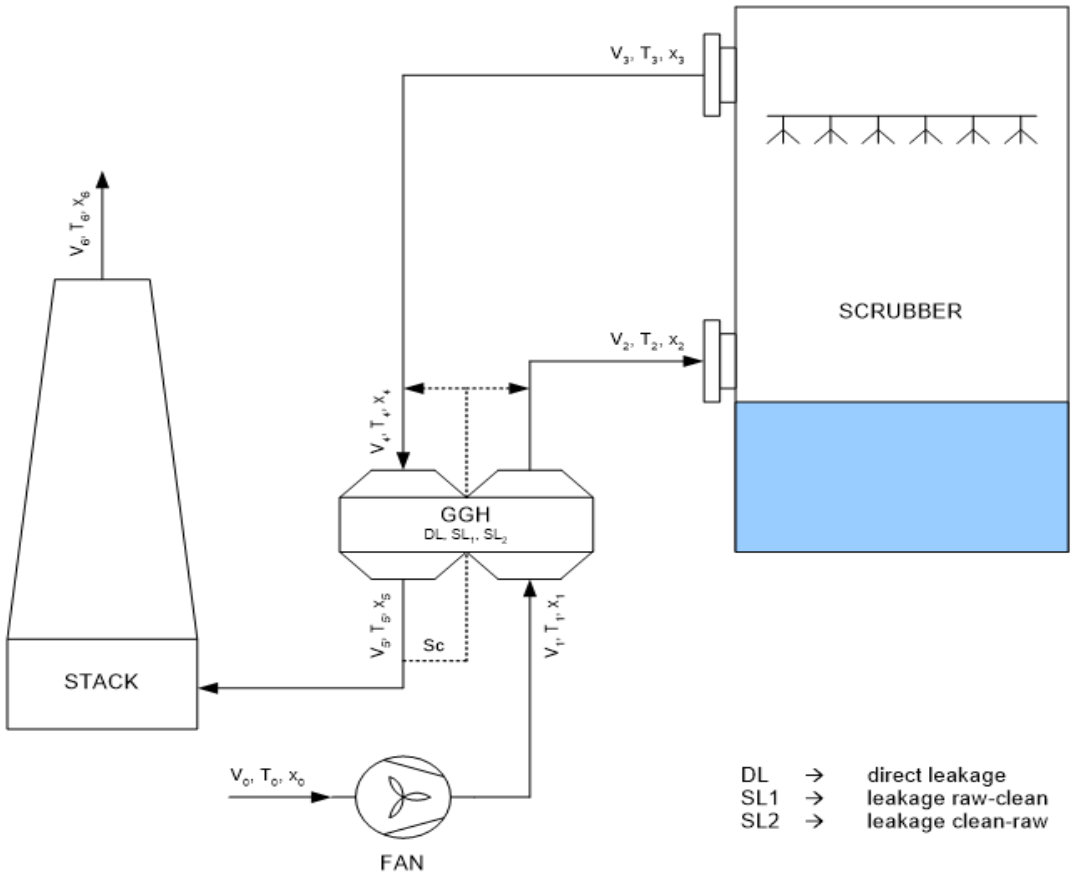

Figure 2 Balance flue gas

Table no.1

Nr.crt.	Measured size	Unit of measurement	Measured value
1	Coal flow	t/h	362,4
2	Number of coal mills in operation	-	5
3	Average coal mill flow rate	t/h	72,5
4	Lower calorific value	Kj /Kg	8963
5	Flue gas temperature at discharge coal mills	°C	168
6	Charcoal moisture	%	40,96
7	Coal ash content	%	17,84
8	Gaseous fuel flow rate	Nm^3/kg	1220
9.	Suction temperature coal mill tower	°C	912
10.	Temperature at the coal mill separator	°C	144

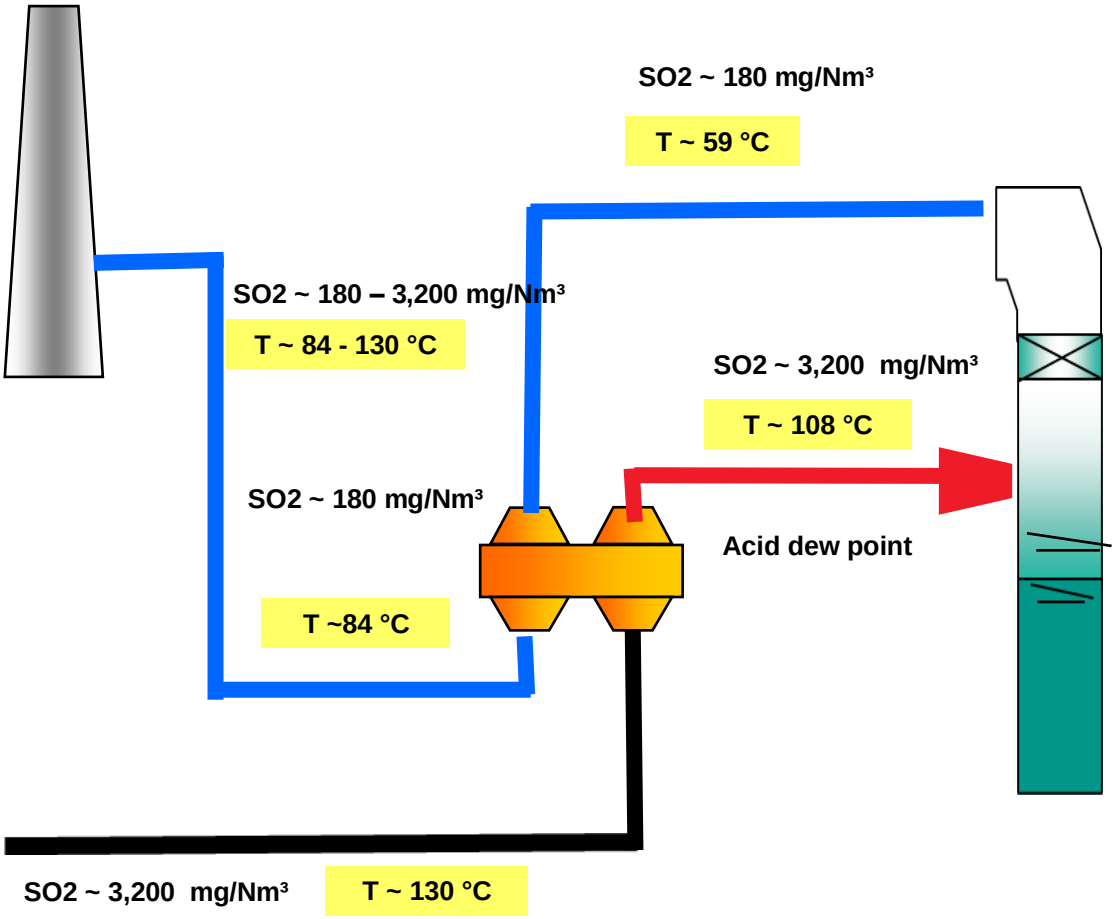

Figure 3 Installation of burnt gases

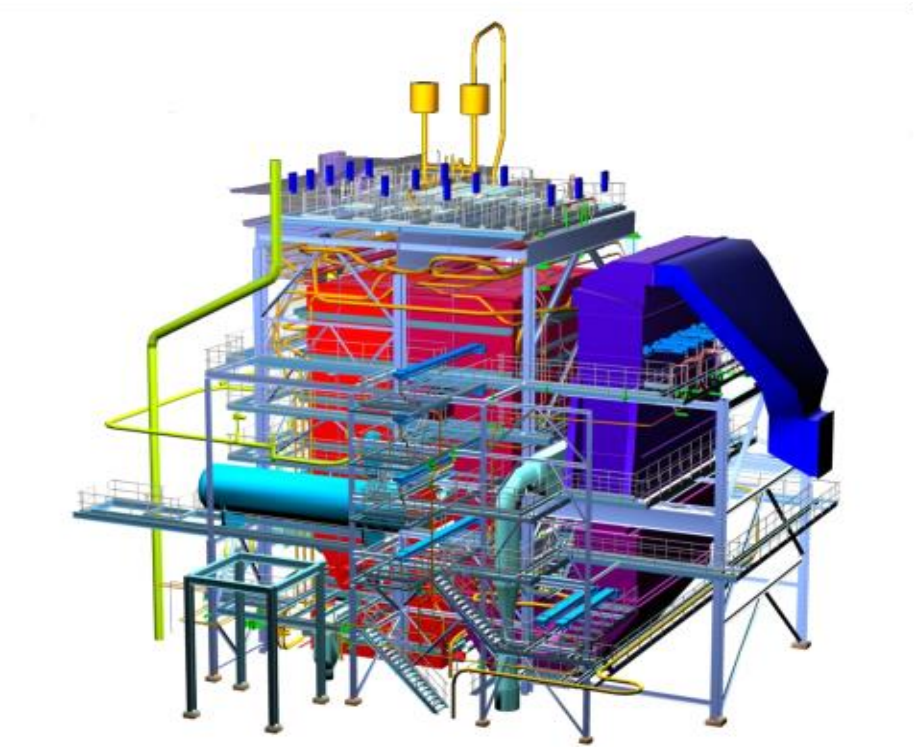

Figure 4. Selective Catalytic Reduction Technology

Table no.2

Nr.crt.	Measured size	Unit of measurement	Measured value
1	Air temperature at the air fan intake	ºC	32,4
2	Air temperature before the air preheater	ºC	48,2
3	Air temperature after air preheater	ºC	262,6
4	Flue gas temperature before air preheater	ºC	272
5	Flue gas temperature after air preheater	ºC	164
6	Flue gas temperature before gas fan	ºC	154
7	Air pressure suction air fan	mmca	-41
8	Air pressure discharge air blower	mmca	246
9	Air pressure before the air preheater	mmca	224
10	Air pressure after air preheater	mmca	132
11	Excess air before the air preheater	-	1,684
12	Excess air after the air preheater	-	1,852
13	Excess air before the gas fan	-	1,953
14	Excess air on the flue gas duct	-	2,214
15	Flue gas flow after air preheater	Nm^3/h	1942678
16	Flue gas flow through gas fans	Nm^3/h	1666915
17	Speed flue gas suction fan	m/s	13,6
18	Speed flue gas exhaust fan	m/s	15,4
19	Flow rate conveyed by the air fan	Nm^3/h	388976
20	Pressure achieved by air blower	mmca	270.9

Table no.3

Nr. crt.	Measured size	Symbol	Unit of measurement	Measured value
1	Flow rate of dry combustion gases at the entrance to the installation	V_{gai}	Nm^3/h	1666915
2	SO2 concentration in the combustion gases at the plant entrance (dry, at 6% O2)	$SO_{2\,i}$	mg/Nm^3	5543,92
3	Oxygen measured at the entrance to the installation	$O_{2\,i}$	%	8,76
4	SO2 concentration in the combustion gases at the plant entrance (dry, measured oxygen)	SO_{2imas}	mg/Nm^3	4586,27
5	SO2 flow rate at the plant entrance	$m_{SO2\,i}$	kg/h	7554
6	Flow rate of dry combustion gases at the exit of the installation	Vga e	Nm^3/h	1632859
7	SO2 concentration in the combustion gases leaving the installation (dry, at 6% O2)	SO_{2e}	mg/Nm^3	116,84
8	Desulfurization plant efficiency	η_{des}	**%**	97,95

Table no.4

Nr.crt.	Measured size	Symbol	Unit of measurement	Measured value
1	Mass ash flow	G_c	t/h	108,12
2	Mass flow of slag	G_z	t/h	19,69
3	Mass water flow	G_a	t/h	1087,46
4	Mass slurry flow	G_{sd}	t/h	1228,37
5	Ash inlet temperature	T_c	^oC	82
6	Slag inlet temperature	T_z	^oC	598
7	Water inlet temperature	T_a	^oC	14
8	Dense fluid outlet temperature	T_{sd}	^oC	19
9	Specific heat ash	c_c	kJ/kgK	0,82
10	Specific heat slag	c_z	kJ/kgK	0,80
11	Specific heat water	c_a	kJ/kgK	4,227
12	Specific heat dense fluid	c_{sd}	kJ/kgK	3,916

3. CONCLUSIONS

The slag and ash resulting from the combustion of lignite are captured and by mixing with water in a ratio of 1:10 (10 parts water) are discharged by the Bagger pumps to the slag and ash deposit. Bagger pump stations ensure the evacuation of slag and ash from the plant. The Bagger pump station for each boiler has three pumping lines, one in operation, one in reserve and one in repair. A line of bagger pumps comprises two serial centrifugal pumps. Given the temperature level in the installation, slag is the only component that has a sufficiently high temperature to allow heat recovery.

For flue gas desulphurization, wet limestone desulfurization technology is used. The limestone consumption is 13.16 t/h, and the measured value of the SO2 concentration in the flue gases discharged to the chimney is 180 mg/m^3_N , respecting the maximum limit allowed by environmental legislation (200 mg/m^3_N).

By modernizing the electrofilters, the ash emissions were classified within the maximum limit allowed by the legislation of medium (50 mg/m^3_N).

The measured value of the ash concentration in the flue gases discharged to the chimney was 42 mg/m^3_N.

The measured value for the NO2 concentration in the flue gases discharged to the chimney was 128 mg/m^3_N that fall within the maximum limit allowed by environmental legislation (200 mg/m^3_N). The reduction of carbon dioxide pollution can be solved by purchasing CO2 capture and storage technology for the energy groups at the Rovinari thermoelectric power plant, which will remain at the disposal of the National Energy System, starting with 01.01.2026 (according to the specifications in the PNNR). To reduce NOx emissions, selective catalytic reduction technology was implemented, using urea as an additive.

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