THERMAL ENERGY BALANCE FOR THE BLOCK NO. 5 AT C.T.E. MINTIA POWER PLANT

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ABSTRACT:
This paper summarizes the thermal energy balance achieved in steam generators 5A and 5B,of the energy block no. 5, C.T.E. Mintia power plant (CTE MINTIA) in order to determine their efficiency, results and conclusions of the environmental impact assessment.

***KEYWORDS**: thermal balance, steam generators, loss of energy, pollutant, environmental impact, mixed Jiu Valley.*

1. INTRODUCTION

Energy is a vital issue of humanity, both in terms of consumption, but rather in terms of its production.

Production of electricity by burning coal is the most polluting energy, CTE MINTIA, one of the largest energy producers in the National Power Grid is, hence one of the major polluters.

C.T.E. MINTIA is a part of the Energy Complex Company Hunedoara SA,. bringing together also the Paroşeni Power Plant and 4 coal mines (Lupeni, Vulcan, Lonea and Livezeni) of the Jiu Valley coal basin (Figure 1).

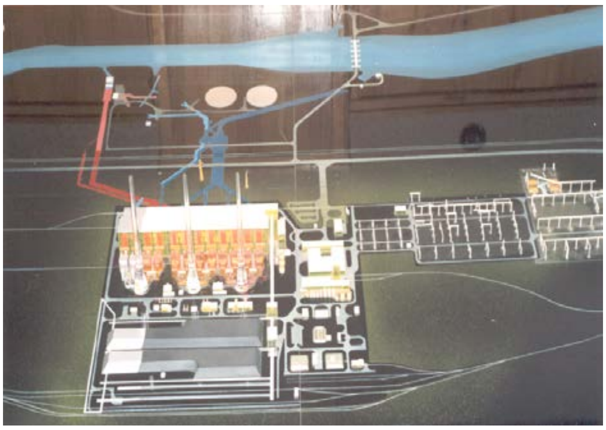

Figure 1 – MINTIA Thermal Power Plant

C.T.E. MINTIA is strategically located in the center of the country, on the right bank of the river Mures, at 9 km from Deva, Hunedoara county.

Both power plants use as basic fuel hardcoal (energetic coal), extracted from the 4 mentioned mines.

C.T.E. MINTIA is of strategic importance to the National Power Grid due to its geographical location, the 400 kV line, which carries contact with Western European network, ensuring power injection required for stable operation of the interconnected power system (Fig. 2).

C.T.E. MINTIA is also the source of heat supply for centralized heating system of Deva.

The strategic importance of C.T.E. MINTIA as well as of Paroşeni Power Plant is enhanced by their social role, being the solely consumers of the Jiu Valley coal production, keeping alive an area in great difficulty facing difficult social problems.

Figure 2 - Location C.T.E. Mintia

Hunedoara Energy Complex provides about 5% of electricity production in Romania, with an installed capacity of 1,225 MW existing six energy blocks: five blocks totaling 1075 MW at C.T.E. MINTIA and one of 150 MW at Paroşeni power plant, the only large electricity in the center and northwest of the country.

Main activity of C.T.E. MINTIA is the production of electricity and heat.

Among all energy producing facilities, particularly the coal burning power plants, due to their extent, their high coal consumption, influences the environment, sometimes leading damages to the ecological balance of the areas where they are located, so that the energy sector is considered as the main source of pollution.

By burning fossil fuels (hardcoal), the large power plants or energy blocks lead to the emission of several pollutants such as: dust (particulate matter or sediment) and gaseous pollutants (SO_2, NOX, CO_2).

The main fuel used in the combustion process of C.T.E. MINTIA are Jiu Valley hardcoal (mix energetic coal) and auxiliary fuels used are natural gas and fuel oil.

2. DRAWING HEAT BALANCE THE STEAM GENERATORS

Heat balance of steam generators was performed at energy block no. 5, using the direct method in three flow rates (charges) separate generator (minimum flow = 230 tab / h, average flow rate = 280 tab / h nominal flow = 310 tab / h) and thermal energy measurement duration for each step 4:00 boiler load, after reaching a state of thermal equilibrium.

Measuring points and read thermo energetic quantities shown in Figure 3.

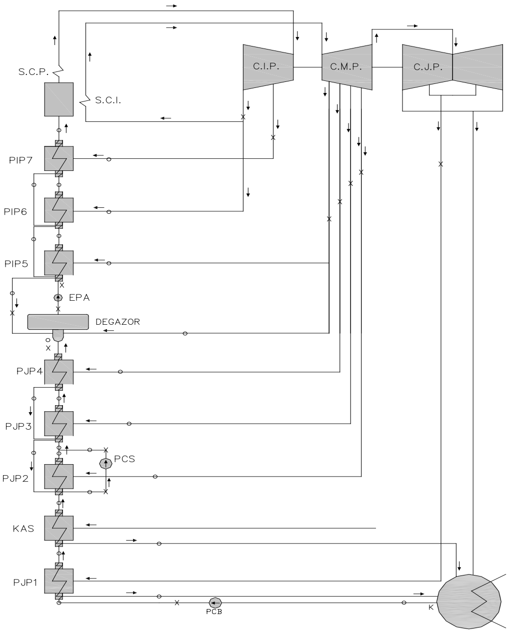

Figure 3 - **Scheme thermal measuring points**

In order to perform thermal-defined contour balance sheet, the technical characteristics of the main aggregates, Flow-chart summary of the technological process (technical parameters), setting the reference unit, measuring devices used scheme and measurement points. We determined the balance equations was performed calculation sheet components, table Sankey diagrams review and analysis of balance sheet and an action plan for energy efficiency.

The quality of a heating system's efficiency is expressed by (η -%), ie the ratio of useful heat and the heat consumed.

The maximum yield that can be obtained with ideal thermodynamic cycle is:

$$\eta_c^{max} = 1 - T_i / T_s$$

where: Ts - is the max. obtained from the hot source;
Ti - is the ambient temperature.

The role of performing thermal balance was to substantiate saving measures for energy resources, modernization of facilities and thermal energy efficiency.

Steam generators at Energy Block nr 5 - CTE (Figure 4) 55 PP generate, through forced flow of the working parameters with steam tab 2 x 330 / H, 140 bar pressure overerheated steam, the superheated steam temperature 540°C.

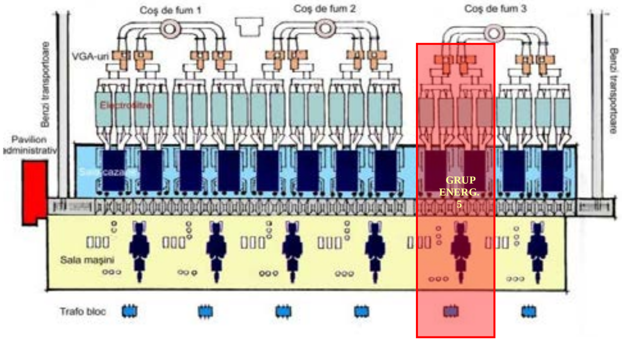

Figure 4 - **Site Plan**

No steam generator. 5 (figure 5) has two distinct bodies, arranged symmetrically, which operates in parallel with the turbine and capable of operating independently. (not return, but the balance was performed by the direct method), experimental determinations were made with the following gauges: cup anemometer, thermometer recorder Psychrometer Asmann, Testo 350 analyzer equipped with Pitot-Prandtl tube, infrared camera HIOKI 3460, ADM 6725 ultrasonic flowmeter FLEXIM, barometer.

Parallel samples were coal, slag and ash measured outlet temperature slag and coal temperature was determined from the power strip.

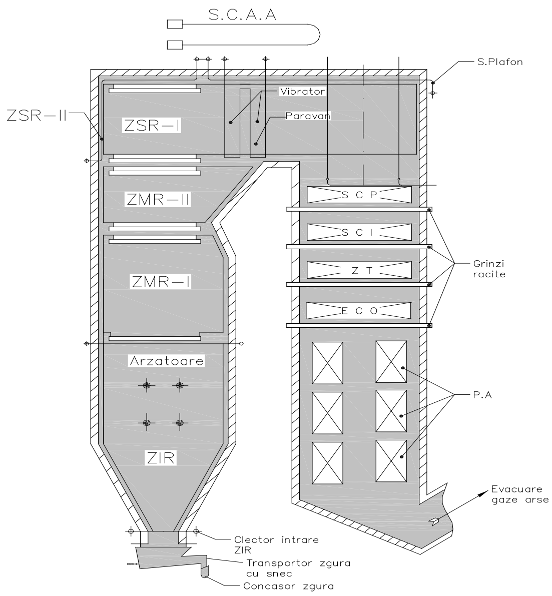

Figure 5 **- Energy Boiler Pp 55**

The comparative analysis of real-time thermal balance with optimal schedules were revealed:

- Heat Chemical analysis tasks fuel is in the range from 79.1 to 80.61% of the energy flow to the heat of the fuel physical is between 0.64 -0.77% and flow to the air from 1, 21 to 1.74% of the heat trapped;

- Energy efficiency of the generator is lower (87.58 to 89.62%) than optimal (91.09%);

- Loss of sensible heat of the flue gases are in the range from 8.86 to 10.69% of the heat trapped;

- Heat losses into the environment through the boiler walls by convection and radiation are in the range 0.2 to 0.42%;

- Heat loss through gas chemical heat is negligible 0.0002 to 0.0005%;

- Heat loss extracted clay are in the range of 0.78 to 0.98%;

Schematic diagram of the thermal cycle energy Block no. 5 is shown in Figure 6.

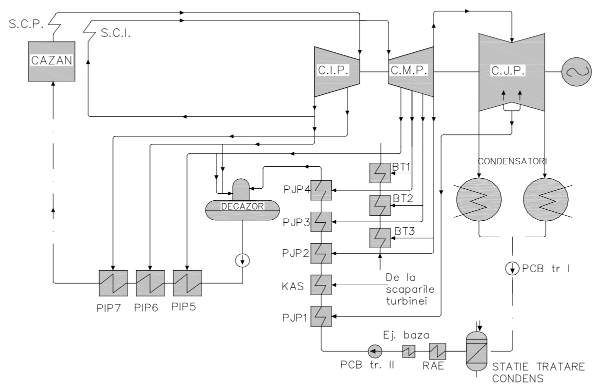

Figure 6 - **Schematic diagram of the thermal cycle**

3. IMPACT ASSESSMENT ENVIRONMENT

In real-time balance calculations based on the results to calculate the amount of pollutants discharged into the atmosphere, according to guide development and energy balance analysis.

Parameters (mean values) of coal burned in power boilers were sulfur S = 1.5%, lower calorific value Hi = 3,494 kcal / kg (14627.83 kJ / kg), the flue gas flow discharged: Vg = 7682 m3N / kg consumption: Bc = 73.784 kg / h.

Calculating the amount of pollutants discharged into the atmosphere (emission) is in accordance with energy prescription-1001/1994 - "Evaluation Methodology operative SO2, NOX and CO2,, dust thermal power plants," according to the formula:

$$E = B \cdot H_i \cdot \varepsilon \quad [kg]$$

in which: E - Is the amount of pollutants discharged into a time [kg];

B - The quantity of fuel consumed during the period [kg];

H_i - Is lower calorific Fuel kJ / kg], [kJ/m^3];

ε - emission factor [kg/kJ]

Under these conditions we have the following values in mass emissions concentration (Table 1, Figure 7 and Table 2, Figure 8):

- For **SO_2:**
  - Grade retention S: r = 0.16;
  - Emission factor: ε = 1,723x10^{-6} kg/kJ;
  - The amount of SO2 discharged to atmosphere: Eso2 = 1,859x10^3 kg/h;
  - Concentration of SO2 = 3,28x10^3 mg/m^{3}N (experimental value = 2,91x10^3 mg/m$^{3N.}$
- For **NO_X**:
  - Emission factor: ε = 2,228x10^{-7}kg/kJ;
  - The amount of NOx emitted into the atmosphere: ENO_X = 240,419 kg/h;
  - Concentration of NOx = 424,163x10^3 mg/m^{3}N (experimental value = 567x103 mg/m^{3}N.
- For **powders:**
  - The degree of retention of ash in the outbreak: x = 0.15;
  - Efficiency electrostatic y = 0.99;
  - Emission factor: ε = 2,162x10^{-7} kg/kJ;
  - The amount of NOx emitted into the atmosphere: EP = 233,305 kg/h;
  - Concentration of dust = 411,612x103 mg/m^{3}N (experimental value = 213,00x10^3 mg/m^{3}N.
- For **CO_2:**
  - Emission factor: ε = 9,337x10^{-5} kg/kJ;
  - The amount of CO_2 discharged into the atmosphere: ECO_2 = 1,008x10^5 kg/h;
  - CO2 concentration = 1,778x10^5 mg/m^{3}N; (experimental value = 1,355x10^5 mg/m$_3$N.

Table 1 - **Emissions of pollutants – mass**

POLLUTANT	UM	VALUE
SO_2	kg	1.859,0
NO_X	kg	240,4
DUST	kg	233,4
CO_2	kg	100.800,0

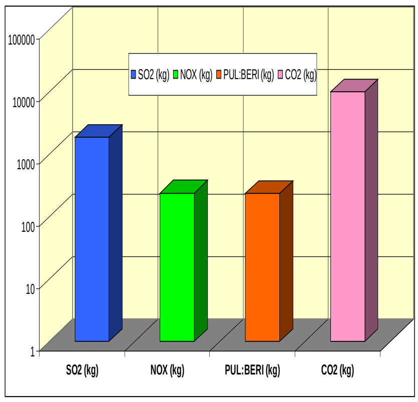

Figure 7 - **Emissions of pollutants - mass**

Table 2 - **Emissions of pollutants – concentration**

POLLUTANT	**UM**	**VALUE**	
		MEASUR.	**EXPERIMEN.**
SO_2	mg/m^3N	3.280,0	2.910,0
NO_X	mg/m^3N	424,2	567,0
DUST	mg/m^3N	411,6	213,0
CO_2	mg/m^3N	177.800	135.500,0

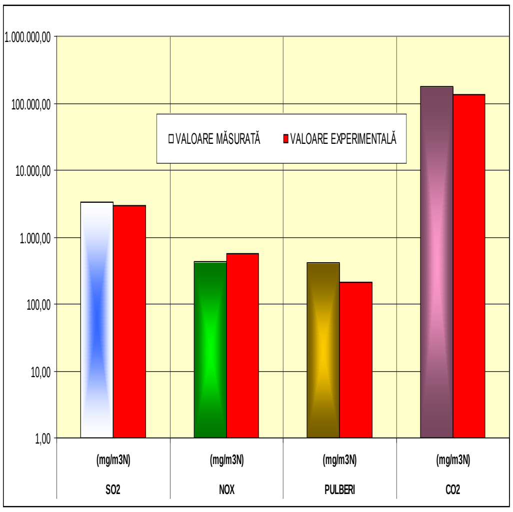

Figure 8 - **Emissions of pollutants - concentration**

4. CONCLUSIONS

Thermal efficiency of the steam generator when the actual cycle time is noticeably small compared to its maximum decrease being caused by losses and energy obtaining the upper and lower average temperatures lower / higher than Ts / Ti.

Analysis of energy balance for steam generator nr. 5 revealed that the main condenser heat losses are evacuated due to worsened vacuum, sensible heat loss of the flue gases and various losses.

Following these measurements to analyze the possibility of implementing the solution combined cycle gas - steam to achieve a thermodynamic two-stage cascade, which includes a gas cycle, followed by a steam cycle, resulting in a considerable increase in yield compared simple cycles.

By determining and comparing the maximum yield corresponding to the 2 options were set two different energy Block rehabilitation:

- Option I - Rehabilitation of the current repairs and maintenance Block to ensure properly. The effect is achieved through ensuring the optimal balance parameters that yield gross energy reaching the value of 34.22%.
- Option II - Equipment Block with two gas turbines and a heat recovery boiler to allow turning classic Block equipped with steam turbine.

Analysis equipment variants is presented in Table 3.

Table 3 **- Comparative analysis of indicators for C.C.A. and C.C.G.A.**

INDICATOR	**UM**	**VERS. CCA**	**VERS. CCGA**
Power Block	MW	200	222,5
Operating time	Ore/an	5.767	5.767
Energy produced	GWh/an	11.534	1.283
Output block	%	34	40
Consumption	T.e.p./an	163.000	134.500
Methane	T.e.p./an	14.270	34.720
	Mii m^3_N/an	17.150	41.710
Coal	T.e.p./an	148.700	99.750
	Tone/an	425.500	285.400
Cost associated with the fuel	Euro/an	30.430.000	32.040.000
Methane	Euro/an	6.601.000	16.060.000
Coal	Euro/an	23.830.000	15.980.000
Unit (fuel costs)	Euro/MWh	26,383	24,971
Investment effort	Euro	19.320.000	27.780.000

Note that the analysis does not show additional savings from environmental taxes on emissions.

Estimate calculations performed highlights the following: unit cost is reduced by 1.412 Euro/MWh, the yield is increased by 6% during the recovery of additional investment effort is about 5 years.

REFERENCES

[1]. *Berinde,T,*- Preparing the energy balance in the industry, Ed. Technique, Bucharest 1976.

[2]. *Doșa I.* - Perform audit thermal energy Block no. 5 from Electrocentrale Deva, Petrosani, 2012.

[3]. *Vaida, V.,Bereş,*- Pages of history Romanian energy. Ed. Mirton, Timisoara, 2003.

[4]. *** - Internal Technical Instructions - C.T.E. Mintia.