ACHIEVING BALANCE FOR STEAM GENERATOR THERMAL POWER BENSON

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ABSTRACT: The paper is based on a case study on the implementation of thermal balance for a steam generator fitted energy units of 330 MW of thermal Rovinari. Thermal balance was achieved for the steam generator of the power plant No.3 energy group. Measurements were performed with specialized equipment. Thermal balance analysis provides information on the operation of the steam generator, on which propose measures to improve efficiency.

KEY WORDS: thermal balance, generator, measurements

1. INTRODUCTION

Thermal Power Rovinari part of Oltenia Energy Complex and is a central core Power System. The plant is built at the mouth of the mine, in the middle of the surface coal mining. Currently, the plant has an installed capacity of 1320MW and is expected in the next three years to be put into operation a new energy group with the power of 600MW. The main fuel steam generators of energy groups is lignite, but steam generators are designed and operate entirely on oil. Lignite mining comes from surface and has a calorific value of 1600 - 2000 kcal / kg. [1]

2. THE STREAM GENERATOR BENSON

Benson steam generator has a nominal flow rate of 1035 t / h and a steam generator single strength crossed. Heat transfer surfaces of the boiler on the high pressure side are connected in series, the supply water flow is accomplished by means of electro-power. The design of the steam generator is taken with a single path of the flue gases. [2] Schematic diagram of the steam generator is shown in Figure 1

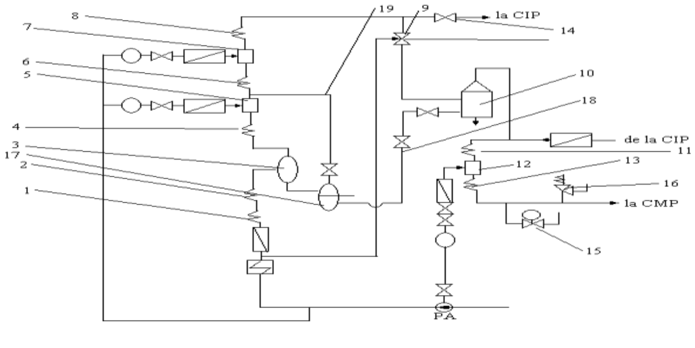

Figure 1 - Schematic diagram of the steam generator
1 - saving, 2 - evaporator, 3 - droplet separator, 4 - superheater IP1, 5 - injection no. 1, 6 - superheater IP2, 7 - injection no. 2, 8 - IP superheater 3, 9 - bypass IP-10 - starting expander; 11 - No intermediate superheater. 1, 12 - injection no. 3, 13 - No intermediate superheater. 2, 14 - valve line, 15 - valve intermediate ejections, 16 - medium pressure safety valves, 17 - container startup; 18 - duct boot are warm, 19 - Starting container vent pipe.

3. EXPERIMENTAL MEASUREMENT RESULT

Thermal balance was made for the load operation of the steam generator 250 MW . Boiler load (flow aburr) results turbogeneratorului charge . [3] In view of the experimental measurements were used following measuring devices :

- Digital thermometers ;
- Infrared thermometers ;
- Cromel-Alumel thermocouples of different lengths ;
- Ultrasonic flowmeter ;
- Static pressure sensors ;
- Differential pressure transducers ;
- Combustion gas analyzer TESTO 350 XL .

Experimental measurements were carried out according to the turbine load , respectively , of the power terminals of the generator , thereby achieving load of the steam generator 852 t / h (83.24 % Nd) . Solid fuel heat value was in the range 1720 kcal / kg - 1990 kcal / kg. All high pressure steam preheaters were funcţiune.La measurements in the furnace flame stability was ensured by the operation of two gas burners . The steam generator was operating five mills of coal and flue gas fans ensured operation in vacuum furnace . Afterburning grate speed was fixed during the whole measurement. Table 1 presents the results of experimental measurements for water flow - steam , in Table 2 presents the results of experimental measurements for air - flue gas circuit , and Table 3 presents the results of experimental measurements for fuel.

Table 1

No.	Size measured	U.M.	The measured value
1.	Boiler feed water flow input	t/h	820
2.	Input pressure boiler feed water	bar	240
3.	Pressure superheated steam stand / right	bar	178,6/178,6
4.	Medium pressure superheated steam	bar	39
5.	Live steam flow	t/h	860
6.	Cold intermediate pressure superheated steam left / right	bar	47,4/47,4
7.	Cold medium pressure superheated steam	bar	49,1
8.	Steam temperature input S1	ºC	378
9.	Superheated steam temperature output S1	ºC	380
10.	Superheated steam temperature input S2	ºC	443
11.	Superheated steam temperature output S2	ºC	530
12.	Superheated steam temperature input S3	ºC	441
13.	Superheated steam temperature output S3	ºC	530
14.	Intermediate temperature superheated steam left / right	ºC	528/528
15.	Total water flow injection	t/h	70
16.	Pressure injections left / right	bar	240
17.	Supply water temperature	ºC	240
18.	Water temperature injection	ºC	166
19.	Cold intermediate pressure superheated steam (output CIP)	bar	42,6
20.	ntermediate cold temperature superheated steam (CIP output)	ºC	335/335
21.	Hot intermediate temperature superheated steam left / right (boiler output)	ºC	528/528

Table 2

No.	Size measured	U.M.	The measured value
1.	VA discharge air pressure half	mmCA	300/300
2.	Open device manager VA 1/2	%	55/55
3.	The total pressure increase achieved VA 1/2	mmCA	200
4.	Air pressure after PAR 1/2	mmCA	180/180
5.	Ambient air temperature at the suction	ºC	40
6.	Air temperature after PAR 1	ºC	250
7.	Pressure combustion gases after PAR 1/2	mmCA	180/220
8.	depression outbreak	mmCA	-5
9.	The temperature of the combustion gas before the RIP 1/2	ºC	280/280
10.	RIP flue gas temperature after half	ºC	175/175
11.	VG ½ discharge gas temperature	ºC	175/175
12.	Open device manager VG 1/2	%	75/75
13.	Engine Load VG 1/2	%	65/65
14.	VG ½ Rated high speed	A	203/203
15.	RIP flue gas analysis before half - O_2 - CO_2 - CO	 % % ppm	 6,6/5,2 12,5/12,8 44/38
16.	RIP excess air before half	-	1,69/1,71
17.	Analysis of flue gas after PAR ½ - O_2 - CO_2 - CO	 % % ppm	 5,8/7,1 12,5/14,6 48/52
18.	Excess air after PAR 1/2	-	1,51/1,68
19.	speed PAR ½	rot/min	3/3
20.	Analysis of flue gas discharge VG 1/2 - O_2 - CO_2 - CO	 % % %	 8,8/10,1 11,3/11,8 35/46
21.	Excess air discharge VG 1/2	-	1,52/1,6
22.	ECO flue gas temperature after left / right	ºC	280/280
23.	Flue gas temperature before S3	ºC	760

Table 3

No.	Size measured	U.M.	The measured value
1.	Gas flow Gr.1	Nm^3/h	1800
2.	Thickness 2 gas flow Back	Nm^3/h	1800
3.	Low calorific gas	$Kcal/Nm^3$	8544
4.	caloric intake	%	5,6
5.	Gr.1 gas pressure	bar	0.38
6.	Gas pressure thickness 2	bar	0.38
7.	Volumetric analysis of gaseous fuel CO_2 CH_4 C_2H_6 C_3H_8 C_4H_{10} C_5H_{12}	% vol	 1,85 96,17 0,45 0,60 0,45 0,22

	C_6H_{14} C_7H_{16} N_2		0,13 0,10 0,03
8.	Elemental analysis of carbon (at baseline): C^i H^i S^i O^i N^i W^i_t A^i	 % % % % % % %	 21,37 1,93 1,28 9,67 0,55 42,37 22,83
9.	Low calorific coal	Kcal/Kg	1752
10.	Solid fuel consumption	kg/h	341885,8
11.	Flow clay dried, unburned	t/h	6,32
12.	Clay calorific fuel table	Kcal/Kg	
13.	Near the slag	%	31
14.	Unburned ash calorific	Kcal/Kg	7000
15.	Near ash	%	1,87
16.	Ash flow including unburned	t/h	
17.	Coal mills in service	-	5 (1/2/3/5/6)
18.	Gas burners in service	-	2
19.	Average temperature separator (the mills in operation)	ºC	150
20.	The average temperature of the combustion gas extraction tower (the mills in operation)	ºC	750
21.	Secondary air pressure	mmCA	65/75/40/40/50
22.	Loading motor die	A(%)	70/75/72/70/60
23.	The power terminals of the generator	MW	250
24.	The flow of oil equivalent	kg/h	3357436
25.	Calorific value equivalent	kcal/kg	1807

4. CALCULATION OF THE EFFICIENCY OF THE STEAM GENERATOR

Real thermal balance of a steam generator can run through two methods: direct or indirect [5].

The direct method involves direct measurement of all parameters which allow calculating the quantities of heat in, or out-of-balance-sheet accounts. [4]

The amount of heat inside, Qi, consists of:
- Chemical heat fuel Qch;
- Sensible heat of fuel, QF, cb;
- Heat sensitive water supply, Q;
- Air sensible heat into the boiler, Qf, a

The amount of heat out, Qe includes:
- Heat capacity, Qu;
- Heat loss through the sensible heat of the combustion gas QGA;
- Heat lost by incomplete chemical
- Heat loss through sensible heat of the slag, Qzg;
- Heat lost by water purged, Qp;- Waste heat recovered by cooling water, QR.

Overall heat balance equation is:

$Q_i = Q_e$ **[kW] sau [kJ/h]**

(1)

$$Q_{ch} + Q_{f,cb} + Q_a + Q_{fa} =$$
$$= Q_u + Q_{ga} + Q_{ga,ch} + Q_{ga,m} + Q_{cv} + Q_{zg} + Q_p + Q_R$$

(2)

The various components can be calculated as:

-All reported for determining the sensible heat:

$Q_f = D \cdot c \cdot t$ [kW] sau [kJ/h]

(3)

-where D is the water flow rate in kg / s or M3N / s, c - specific heat of the agent, in kJ / kgoC or kJ/m3N oC t - the temperature in oC.

-All chemical heats are determined by the relation:

$Q_{ch} = DH_i$ [kW] sau [kJ/h]

(4)

combustion, QGA, ch;
- Heat loss through mechanical incomplete combustion, QGA, m;
- Heat lost to the environment by radiation and convection, Qcv;

where D is the water flow rate in kg / s or M3N / s Hi - lower calorific agent kJ / kg or kJ/m3N.Randamentul gross heat boiler is determined by the relation:

$$\eta_{tb} = \frac{Q_u - Q_a + Q_p}{Q_i - \left(Q_a + Q_{fa} + Q_{f,cb}\right)} \qquad (5)$$

Table 4

No	parameter	symbol	loading 250 MW	
			Value	
			x10^{6}kJ/h	%
1.	The heat resulting from the combustion of fuel	Q_{ch}	2699,814	72,46
2.	Natural heat of the fuel	$Q_{f,cb}$	100,8	2,70
3.	Natural heat of the combustion air	$Q_{f,a}$	72,54	1,94
4.	Natural heat the water	Q_a	853,62	22,91
5.	Total heat flow to the	Q_i	3725,97	100
6.	useful heat	Q_u	3148,08	84,49
7.	The loss of heat from combustion exhaust gases discharged combustion basket to basket	q_2	398,30	10,69
8.	Heat loss through incomplete combustion of chemically	q_3	1,49	0,04
9.	Heat loss through incomplete combustion of Mechanical	q_4	117,74	3,16
10.	Heat loss by radiation and convection to the environment	q_5	26,08	0,70
11.	The loss of solid waste heat discharged from the boiler	q_6	16,02	0,43
12.	Total heat out of the contour	Q_e	3707,71	100
13.	boiler efficiency	η_{caz}	84,98%	

5. CONCLUSION

Analyzing the results of operation of the steam generator and real thermal balance shows that:
- the temperature of the flue gas after the air preheater is increased within the range of 170-175 ° C;
- return-value is below par;
- Excess air coefficient is high: 1.42 to 1.72;
- live steam produced by the boiler temperature is close to the nominal value (535 ° C);
- feed-water temperature was within normal limits ranging between 234-245 ° C;
- solid-fuel use is relatively low calorific value, the same for all three samples.

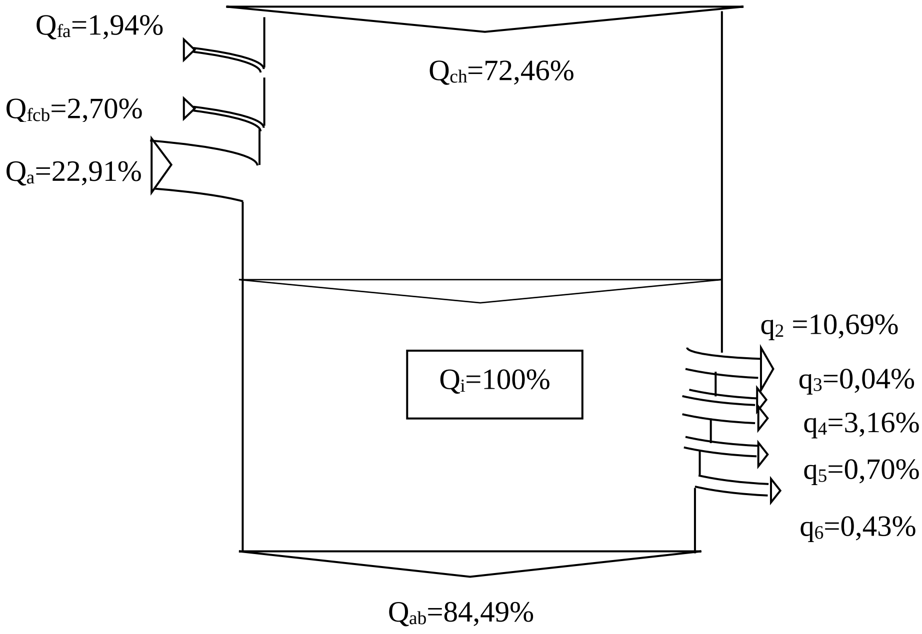

Figure 2. - Sankey diagram

In the proper functioning of steam generator is recommended:
avoid low-load operation;
-reducing the oxygen content in the flue gas after the air preheater;
- reducing the temperature of the flue gas after the air preheater;
- reduce the coefficient of excess air;
- control and maintain optimum combustion conditions [6]
- eliminating uncontrolled air infiltration;
- supervision of the technological parameters of the feed water.

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