ENERGY BALANCE MEASUREMENTS FOR AUXILIARY INSTALLATIONS OF LARGE POWER ENERGY GROUPS

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ABSTRACT. *The paper presents a case study concerning the energy balance measurements for auxiliary installations using steam from the turbine of the 330 MW energy group. Steam boilers of 330 MW power plants operate with lignite dust. The thermoelectric power plants Rovinari and Turceni are composed of 330 MW energy groups.*

KEY WORDS. *Flowmeter, thermocouples, turbine, pressure measurements.*

1. INTRODUCTION

The steam boiler of the 330 MW energy group operates with lignite - basic fuel, and auxiliary fuels are fuel oil and natural gas. For internal services, steam is used from the turbine sockets. The turbine of the 330 MW energy group is an axial turbine with 4 bodies and 7 steam sampling points. The turbine bodies are: a high pressure body, a medium pressure body, and two low pressure bodies. The superheated steam temperature is adjusted with two water injections. The intermediate superheated steam temperature is controlled by an injection of water. The combustion of coal in the boiler releases an amount of heat which is taken by the water supply. Following the vaporization and heating process, the supply water turns into superheated steam that is introduced into the turbine. After being released from the turbine, the steam is discharged into the turbine steam condenser. The steam taken from the turbine sockets is also used to supply auxiliary consumers. The auxiliary consumers are: the fuel oil plant, the chemical water treatment plant, the electrolysis station.

2. EXPERIMENTAL RESULTS

Figure 1 shows the schematic diagram of the 330 MW energy group, and figure 2 indicates the steam boiler diagram.

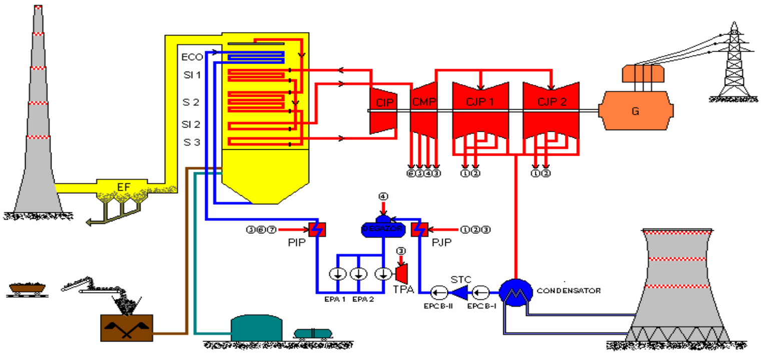

Fig. 1. Schematic diagram of the 330 MW energy group.

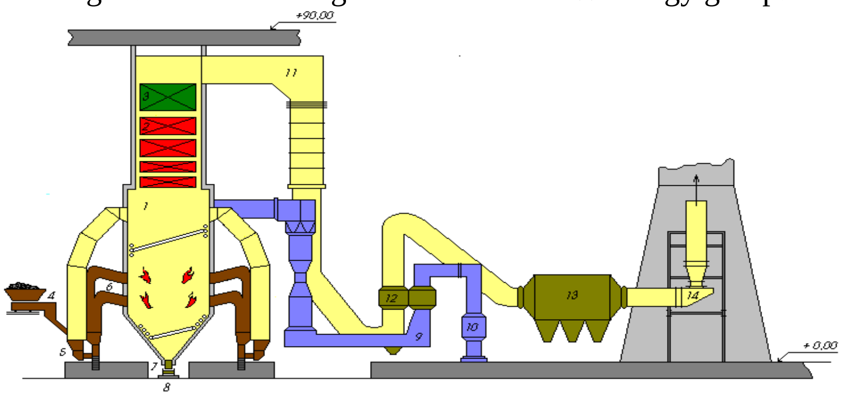

Fig. 2. Schematic diagram of the steam boiler.

During experimental measurements, were maintained the following conditions:

- the steam was taken from the socket 3, 5 and 7 of the steam turbine;
- steam was used for: fuel tanks, chemical treatment plant, electrolysis plant;
- power to generator terminals: 230 MW.

The following measuring devices were used:

- steam flow meters;
- ultrasonic flow meter;
- transducers for pressure measurement;
- thermocouples for temperature measurement.

At measuring points of the analyzed circuit, the pressure, temperature and flow were measured.

Table 1 and table 2 shows the results of measurements. Table 3 presents the results of the energy balance.

Table 1

No.	Title	Symbol	U.M.	Sample no. 1
1.	Power at the terminals	N_0	MW	230,0
2.	Boiler water supply pressure	-	bar	238,0
3.	Steam inlet pressure in the turbine	P_0	bar	173,0
4.	Intermediate overheating input steam pressure	p_{CIP}	bar	34,0
5.	Intermediate overheating output steam pressure	p_{CIP}	bar	33,0

6.	Steam pressure at DS6	P_6	bar	22,0
7.	Steam pressure at PIP7	P_7	bar	33,0
8.	Steam pressure at PIP5	P_5	bar	14,0
9.	Steam pressure at the degasser	p_{deg}	bar	6,0
10.	Steam pressure at PJP3	P_3	bar	2,90
11.	Steam pressure at PJP2	P_2	bar	0,08
12.	Steam pressure at PJP1	P_1	bar	0,6
13.	Turbine entry steam temperature	t_{01}	^0C	532,0
14.	Steam temperature at CMP input	t_{CMP}	^0C	530,0
15.	Steam temperature at DS6	t_6	^0C	480,0
16.	Steam temperature at PIP7	t_7	^0C	319,0
17.	Steam temperature at PIP5	t_8	^0C	418,0
18.	Exhaust steam temperature CIP	t_{CIP}	^0C	315,0
19.	Steam temperature at PJP3	t_3	^0C	282,0
20.	Steam temperature at PJP2	t_2	^0C	173,0
21.	Steam temperature at PJP1	t_1	^0C	72,0
22.	Water temperature at the degasser output	te_d	^0C	162,0
23.	Water supply temperature at PIP5 input	t_{05}	^0C	166,0
24.	Water supply temperature at PIP6 input	t_{06}	^0C	194,0
25.	Water supply temperature at PIP7 input	t_{07}	^0C	215,0
26.	Water supply temperature at DS6 input	t_{08}	^0C	240,4
27.	Water supply temperature at DS6 output	t_{09}	^0C	243,6
28.	Collector steam pressure 13 bar	P_{abc6}	bar	3,8
29.	Pressure steam at chemical station input	p_{schim}	bar	2,5
30.	Steam pressure incoming fuel tanks	p_{rpac}	bar	2,8
31.	Steam pressure at electrolysis station input	p_{sel}	bar	0,6
32.	Steam temperature collector 6 bar	t_{abC6}	^0C	254,2
33.	Steam temperature at chemical station input	t_{schim}	^0C	169,6
34.	Steam temperature at fuel tanks input	t_{abrpac}	^0C	179,2
35.	Steam temperature at station electrolysis input	t_{absel}	^0C	150,8

Table 2

No.	Title	Symbol	U.M.	Sample no. 1
1.	Steam flow 1 at the turbine input	D_{01}	t/h	365,0
2.	Steam flow 2 at the turbine input	D_{02}	t/h	361,0
3.	Intermediate overheating steam flow in pipe 1	D_{Si1}	t/h	340,0
4.	Intermediate overheating steam flow in pipe 2	D_{Si2}	t/h	338,0
5.	Boiler water supply flow rate	D_{aal}	t/h	694,2
6.	Steam flow rate 6 bar collector	D_{abC6}	t/h	49,4
7.	Injection flow rate of total water	D_{tinj}	t/h	34,2
8.	Water injection flow rate of intermediate overheating	D_{injSi}	t/h	3,4
9.	Added water flow rate	D_{aad}	t/h	53,8
10.	Steam flow rate to fuel tanks	D_{abrezp}	t/h	26,2
11.	Steam flow rate to chemical station	$D_{abschim}$	t/h	10,3
12.	Steam flow rate to electrolysis plant	D_{absel}	t/h	1,9

Table 3

No.	Title	Symbol	U.M.	Sample no. 1
1.	Heat input with steam in the 6 bar collector	Q_{C6}	Gcal/h	33,27
2.	Useful heat at the chemical plant	Q_{chim}	Gcal/h	6,12
3.	Useful heat in the fuel oil tanks	Q_{rezpac}	Gcal/h	16,26
4.	Useful heat at the electrolysis station	Q_{sel}	Gcal/h	0,88
5.	Total heat unrecovered	Q_{pierd}	Gcal/h	1,29

3. CONCLUSIONS

After the mass balance analysis, the following results were obtained:

- a general balance sheet for the steam turbine was carried out and the amount of steam entering the collector was determined;
- there is a slight loss of steam at the collector due to steam leakage from the steam transport route.

The analysis of the heat balance shows:

- quantities of useful heat have been calculated for each consumer;
- heat loss cannot be recovered with the condensate that is formed at the consumer.

As a measure of energy efficiency it is recommended to restore the thermal insulation on the steam transport pipes.

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