STUDY ON THE ENERGY BALANCE SHEETS OF AIR BURNING STEAM PLANT OF GENERATORS OPERATING WITH COAL

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Abstract: The paper presents a case study on the energy balance sheet of combustion air plant from the steam generator of the 330 MW energy group. The Benson steam generator works with dust lignite. The air needed for coal combustion is provided with two axial fans horizontally arranged. Two operating functioning modes are analyzed for combustion air fans.

Keywords: Excess air ratio coefficient, fuel consumption, lower heating value, fan efficiency.

1.INTRODUCTION

The 330 MW energy units constituting of Rovinari and Turceni (Gorj county, Romania) thermal power plants belong to Oltenia Energy Complex. The 330 MW energy group is composed of a generator with a steam flow rate of 1 035 t h, a steam turbine with nominal power of 330 MW and an electric generator with nominal power of 330 MW.

The steam generator works with lignite extracted from quarries of the Oltenia Mining Basin. Preparation of lignite dust is carried by 6 hammer mill fans. The air needed for lignite combustion is provided by two axial air fans, horizontally arranged outdoors on a concrete foundation. At full load operation of the boiler, each fan provides 50% of the total amount of air circulated. The main characteristics of the drive motor of the fan air are:

- Fan type: axial, operating position horizontal, direct drive electric motor;
- Power 3100 kW;
- Intensity 6000 V;
- Frequency 50 Hz;
- rated current 357 A;
- revolution 742 rot/min;
- Yield 0,95;
- cos φ =0,88.

2.EXPERIMENTAL RESULTS

In tables 1 and 2 are presented measured values for the development of the real balance sheet of fan No.1 and fan No.2 of the energetic group no.4 from Rovinari thermoelectric plant during 2015.

Table 1

No	Measured value	Symbol	U.M.	Operating regime I	Operating regime II
1	Current drawn from the network	I_{abs}	[A]	180,1	150,2
2	Pressure differential	H (Δp_a)	[mmH_2O]	342	281
3	Coefficient of excess air	λ	-	1,372	1,476
4	Moisture contained in the air	x	[g/kg]	10	10
5	Yield of air fan	η_{VA}	-	0,43	0,42
6	Yield of electric drive motor	η_{em}	-	0,93	0,92
7	Power consumption of the drive motor	$P_{m,el}$	[kW]	1682,4	1428,5
8	Transmission efficiency air fan motor	η_{tra}	-	0,99	0,99
9	Fuel consumption	B_c	[kg/s]	124,12	95,42
10	Lower calorific value of the fuel used	H_i	[kJ/kg]	8238	8892

Table 2

No	Measured value	Symbol	U.M.	Operating regime I	Operating regime II
1	Current drawn from the network	I_{abs}	[A]	200,2	159,4
2	Pressure differential	H (Δp_a)	[mmH_2O]	348	291
3	Coefficient of excess air	λ	-	1,372	1,476
4	Moisture contained in the air	x	[g/kg]	10	10
5	Yield of air fan	η_{VA}	-	0,44	0,422
6	Yield of electric drive motor	η_{em}	-	0,92	0,90
7	Power consumption of the drive motor	$P_{m,el}$	[kW]	1871,22	1421,36
8	Transmission efficiency air fan motor	η_{tra}	-	0,99	0,99
9	Fuel consumption	B_c	[kg/s]	124,12	94,38
10	Lower calorific value of the fuel used	H_i	[kJ/kg]	8238	8892

Table 3 indicates the formulas for calculation of the values in the energy balance

No	Calculated value	Formula
1	Power absorbed by the fan air	$D_{VA} = L \cdot B_c$
2	Airflow through the circulating air fan	$L = (1 + 0{,}00161 \cdot x) \cdot \lambda \cdot L_{min}$
3	Volume of theoretical air fuel combustion	$L_{min} = 0{,}5 + \frac{0{,}241 \cdot H_i}{1000}$

4	Theoretical minimum volume of air necessary for fuel combustion	$P_{VA} = \frac{P_{th}}{102 \cdot \eta_{VA}}$
5	Air fan power	$P_{th} = D_{VA} \cdot H$
6	Technological power of the fan air	$P_{abs} \cdot (1 - \eta_{em})$
7	Losses in electric motor driving air fan	$P_{abs} \cdot (1 - \eta_{em} \cdot \eta_{tra})$
8	Losses in electric motor and fan motor transmission	$P_{u,VA} \cdot (1 - \eta_{VA})$
9	Losses in fan	$P_{u,VA} \cdot (1 - \eta_{VA})$

In tables 4 and 5 are presented the values resulting from the calculation for the 2 air fans, needed for the real balance sheet elaboration.

Table 4

No	Measured value	Symbol	U.M.	Operating regime I	Operating regime II
1	Power absorbed by the fan air	P_{abs}	[kW]	1682,4	1428,5
2	Airflow through the fan circulating air	D_{VA}	[m^3/s]	190,27	185,12
3	Volume of theoretical air needed for fuel combustion	L	[m^{3}N/kg]	3,71	4,18
4	Minimum theoretical volume needed for fuel combustion	L_{min}	[m^{3}N/kg]	2,56	2,72
5	Air fan power	P_{VA}	[kW]	1554,3	1249,4
6	Technological power of the fan air	P_{th}	[kW]	661,12	520,25
7	Losses in electric motor driving air fan	$\Delta P_{m,el}$	[kW]	125,38	141,14
8	Losses in electric motor and fan motor transmission	$\Delta P_{m,el+tr}$	[kW]	142,6	152,4
9	Losses in fan	P_{abs}	[kW]	882,2	720,6

Table 5

No	Measured value	Symbol	U.M.	Operating regime I	Operating regime II
1	Power absorbed by the fan air	P_{abs}	[kW]	1871,22	1421,36
2	Airflow through the fan circulating air	D_{VA}	[m^3/s]	224,3	193,4
3	Volume of theoretical air needed for fuel combustion	L	[m^{3}N/kg]	3,71	4,18
4	Minimum theoretical volume needed for fuel combustion	L_{min}	[m^{3}N/kg]	2,56	2,72
5	Air fan power	P_{VA}	[kW]	1709,34	1271,35
6	Technological power of the fan air	P_{th}	[kW]	751,22	540,87
7	Losses in electric motor driving air fan	$\Delta P_{m,el}$	[kW]	121,46	126,13
8	Losses in electric motor and fan motor transmission	$\Delta P_{m,el+tr}$	[kW]	145,24	138,69
9	Losses in fan	P_{abs}	[kW]	964,32	743,19

3.CONCLUSIONS

In figure 1 is presented the diagram Sankey for No.1 and No.2 air fans analyzed.

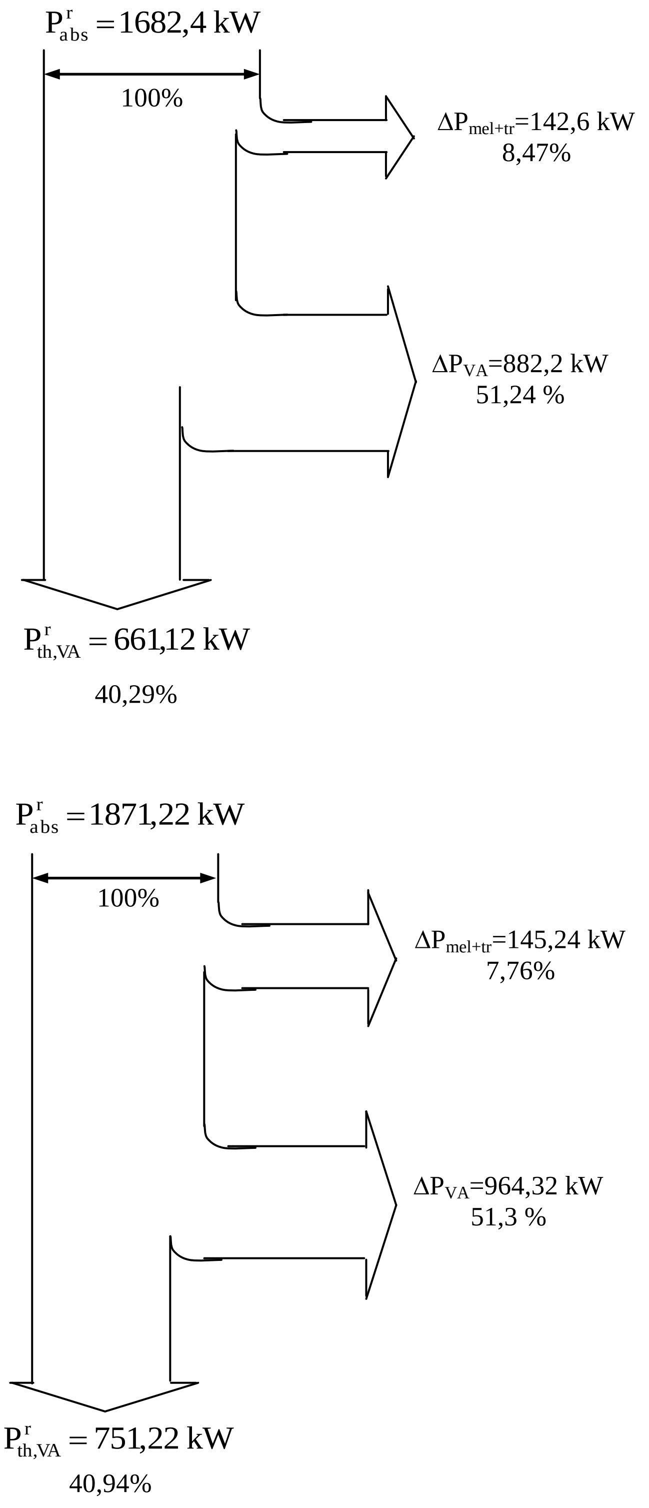

Figure 1

Analyzing the use of electricity can result the following conclusions:

- The losses in electrical installations are relatively large; it can be observed the influence of machinery life-long use, with effect in increasing of technological losses;
- Can be observed lower yields for both fans of air between 0,39÷0,43 below their project value of 0.88

To reduce energy consumption it is recommended:

- Reducing idle losses;
- Cleaning the fans to reduce the influence of scum.

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