STUDY ON THE ENERGY BALANCE OF THE ELECTRO-PUMPS WITH CONDENSATION FOR THE ENERGY GROUPS IN CONDENSATION OPERATING WITH INFERIOR COAL

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ABSTRACT: The paper presents a case study on the energy balance of the condensate-pump with condensation from the energy groups operating with lignite. It is analyzed the group of 330 MW, composed of a steam boiler of 1035 t/h and a 330 MW turbine. The resulting condensate in the steam condenser of the energy group turbine is floated toward deaerator with 2 electro pumps step I and 2 step II..

KEY WORDS: mass flow, height of pumping, hydraulics, energy losses in electric engine.

1. INTRODUCTION

The energy group of 330 MW consists of a steam action turbine, with condensation, with four bodies on the same shaft. The steam turbine power is rated 330 MW.

The turbine comprises: a body of high-pressure, a body of medium-pressure and two bodies of low pressure. The main steam turbine systems are:
- the control systems (electro-hydraulic type), the protection system, the surveillance one (vibrations, displacement, expansion, speed) and the logic testing system of control valves and safety equipment
- oil and lubricating systems control
- Steam labyrinths system.

The thermal circuit layout includes:
- low and high pressure preheaters;
- deaerator and reservoir for water supply;
- bypass stations of low and high pressure;
- reduction-cooling stations of low and high pressure;
- turbine and electro pumps for water supply;
- primary and secondary condensate pump;
- water tanks for adding and for secondary condensate;
- condensate treatment station;
- start and atmospheric expanders.

The connections between the equipment technological scheme are made through several pipelines routes, as follows:
- The main pipelines: of high and low pressure steam, of feed water, of cooling water, of low pressure water, of steam supply and of technic water consumers;
- The secondary pipes: of steam startup purge, of drain, of vent pipes of the main service, of heating service, of cooling water and of auxiliary air.

Once it is expanded in the turbine, the steam is discharged to the condenser of the steam turbine. Here the steam is condensation using cooling water. Condensate circuit starts in the turbine steam condenser and ends in deaerator. On this circuit, there is a tartare station of the condensate and the low-pressure steam preheaters: PJP1, PJP2 and PJP3.

From the steam turbine condenser, the resulting condensate is taken up with 2 pumps step I and is sent to the condensate treatment station and then with 2 condensate pumps step II towards the pre-heaters with low pressure steam. From the last pre-heater of low pressure steam, the condensate is reaching the deaerator.

In the deaerator reaches also the secondary condensate resulted in the steam condenser of the feeding turbo pomp.

The condensate de-aeration is carried out by steam from the sampling No.4 of the turbine. From deaerator, the feed water supply of the boiler is taken with feeding pumps and sent to the high-pressure preheaters to the boiler water saver.

2.EXPERIMENTAL RESULTS

In Table 1 there are presented the measured parameters sheet for the elaboration of the real balance of the condensate pomp level I-nr1, and in Table 2 are presented the measured parameters sheet for the elaboration of the real balance sheet of the condensate pomp level II-nr1.

Were determined the condensed flow, the pressures of aspiration and discharge of the pump, the temperature of the condensate, were calculated losses in the electric motor driving the pump, hydraulic power useful, pumping height, the average density of condensate for the 2 analyzed condensate pumps.

Table 1

No	Measured parameter/ calculated	Symbol	U.M.	Operating procedure I	Operating procedure II
1	Mass flow of condensate	D_c	t/h	233,22	193,47
2	Suction pressure	p_a	bar	0,0482	0,451
3	Discharge pressure	p_r	bar	6,63	6,71
4	Power absorbed by the engine	$\mathbf{P_{mel}}$	kW	215,12	203,45
5	Average temperature	t_{mp}	°C	31,00	32,00
6	The average density of the water pump	ρ	kg/m^3	999,94	999,93
7	Increasing water pressure on the pump	Δp_p	bar	6,66	6,67
8	Pumping height	H_p	mH_2O	68,35	68,19
9	Hydraulic power (useful) theoretical	P_{ht}	kW	146,13	124,38
10	Losses in the electric motor	$\Delta P_{m.el}$	kW	50,59	47,36
11.	The degraded power of the pumping process	ΔP_{degr}	kW	13,11	27,68

Table 2

No	Measured parameter	Symbol	U.M.	Operating procedure I	Operating procedure II
1	Mass flow of condensate	D_c	t/h	233,22	193,47
2	Suction pressure	p_a	bar	6,72	6,7
3	Discharge pressure	p_r	bar	29,5 0	28,90
4	Power absorbed by the engine	$\mathbf{P_{mel}}$	kW	752,35	626,49
5	Average temperature	t_{mp}	°C	33,8	34,1
6	The average density of the water pump	ρ	kg/m^3	17,55	17,45
7	Increasing water pressure on the pump	Δp_p	bar	22,18	21,86
8	Pumping height	H_p	mH_2O	221,20	220,38
9	Hydraulic power (useful) theoretical	P_{ht}	kW	484,56	396,47
10	Losses in the electric motor	$\Delta P_{m.el}$	kW	162,37	139,35
11	The degraded power of the pumping process	ΔP_{degr}	kW	104,32	95,36

In table 3 are presented the calculation formulas used for parameters from the energy balance.

Table 3

No	**Parameter computed**	**Calculation formula**
1	Average temperature	$\frac{t_a + t_r}{2}$
2	The average density of the water pump	$\frac{p_a + p_r}{2}$
3	Increasing water pressure on the pump	$p_r - p_a$
4	Pumping height	$\frac{\Delta p_p \cdot 10^5}{\rho \cdot g}$
5	Theoretical hydraulic power (useful)	$Q \cdot \rho \cdot g \cdot H_p \cdot 10^{-3}$
6	Losses in the electric engine	$P(1-\eta_e)$
7	The degraded power of the pumping process	$P_{m,el} - \Delta P_{m.el} - P_{ht}$

In table 4 and table 5 are centralized the values resulting from the calculation for the condensate pumps level I-no 1 and no 2.

Table 4

Electricity entered	kWh	%	**Electricity output**	kWh	%
EPCB 1 tr. a 1-a - Regime I					
Energy absorbed by the electric motor (supply)	215,07	100	Electricity useful for:-theoretical hydro-power	147,34	68,50
			Total Electricity	147,34	68,50
			Electricity losses: losses in electric motor- -loss in pump, degraded power	53,52 14,21	24,88 6,60
			Total loss of electricity	67,73	31,50
Total electricity entered	215,07	100	Total electricity output	215,07	100

Table 5

Electricity entered	**kWh**	**%**	**Electricity output**	**kWh**	**%**
EPCB 1 tr. a II-a - Regime I					
Energy absorbed by the electric motor (supply)	**750,9**	**100**	Electricity useful for:-theoretical hydro-power	484,56	64,53
			Total useful electricity	**484,56**	**64,53**
			Electricity losses: losses in electric motor- -loss in pump, degraded power	162,23 104,11	21,61 13,86
			Total loss of electricity	**266,34**	**35,47**
Total electricity entered	**750,9**		**Total electricity output**	**750,9**	**100**

3. CONCLUSIONS

Figure 1 shows the Sankey diagrams for the condensate pomp step I No. 1 and for the condensate pomp step II No. 1 for the operating regime I.

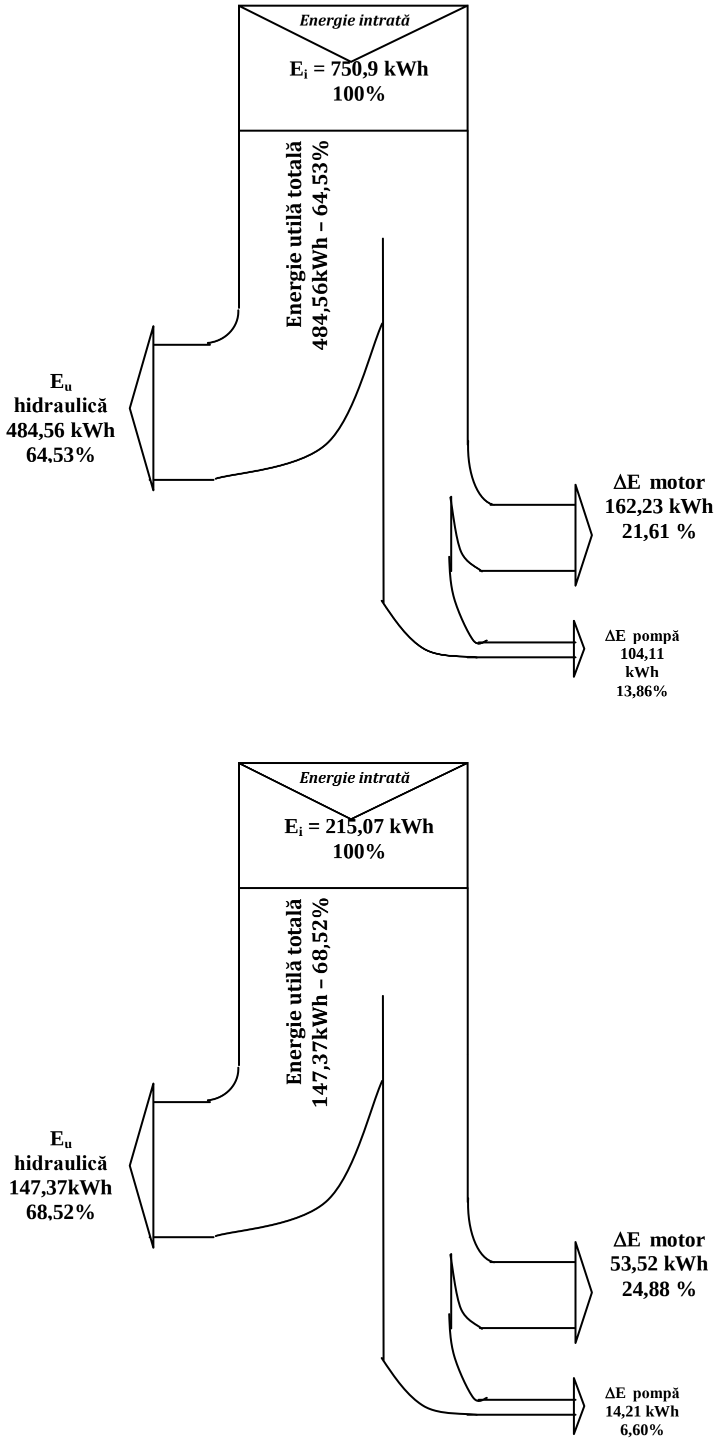

Figure 1

After analyzing the use of electricity, result the following conclusions:
- There are relatively large losses in the electrical installations, due to the influence of the seniority of machines that have the effect of increasing the technological losses
- The specific consumption of electricity of the base compensate pump EPCB 1 step 1 (315 kW) varies between 0, 98-1,79 kWh/t, and for EPCB 2 step 2 (800 kW) varies between 3,33-4,48 kWh/t.

To reduce energy consumption the recommendations are:
- Periodic cleaning of the condenser steam turbine (deposits adversely affect the loading motors and pumps);
- Reduce idling losses (for consumers at low voltage)

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