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INVESTIGATION OF THE POSSIBILITY OF EFFICIENCY IMPROVEMENT FOR COMBINED HEAT AND POWER UNIT IN POWER PLANT „TUZLA"

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ABSTRACT
The paper defines the problem of reducing energy efficiency of combined heat and power unit (CHP) 200 MW installed in Power Plant Tuzla when working in the condensation regime and analyzes the possibilities of increasing efficiency in this case, especially at operate with low electrical loads from nominal.
Therefore, we analyzed the possibility of applying additional regenerative heat exchanger in the base line of condensate in order to improve the turbine cycle.
The study was performed using a dedicated simulation mathematical model that include the determination of energy indicators work.
Keywords: steam turbine, energy efficiency, regenerative heater, feed water tank, turbine cycle

1. INTRODUCTION
The subject of analysis in this paper is the thermal scheme of turbine cycle with a focus on the basic line condensate, low-pressure water heaters and regeneration pattern of heating the feed water tank. Feed water for the steam generators is taken from the condensate of waste steam from the turbine, which has been heated by steam from the turbine's regenerative extraction points.
On the basis of the thermal scheme of the power plant and steam consumption which taken (at different electrical loads) for purposes of heating the feed water tank, an analysis of the impact of this spending on the flow characteristics of the turbine, and thus the generated electrical power and specific heat consumption of the plant[1].
Power steam turbine during operation can be changed in a wide range of so-called technical minimum to nominal power. At the economic strength is achieved the highest degree of efficiency, that any deviation from these forces, any forces that increase or decrease, resulting in decreased value of the degree of utilization, if the other conditions do not change that mean increase in specific consumption of steam[2].
Since heating the feed water tank by steam from the turbine's regenerative extraction points has the effect of heat loss during operating at loads lower than the nominal (at nominal load providing steam for heating feed water by regulated heat source is a minimum or excluded), we analyzed the possible reasons using additional water heaters in the line of regenerative heating primary condensate, as well as the possibility of improving turbine cycle.
This refers to operating in condensation regime during the period when the network of water heaters does not work in city heating system. For the purpose of this analysis developed the original computer cod, based on data producers and data obtained during the power unit operation. It was used to

calculate the energetic parameters for the case of condensation regime with the existing and altered thermal scheme.

2. MODIFY THE EXISTING SCHEME OF BASIC CONDENSATE WITH ADDITIONAL REGENERATIVE HEATER

In order to increase energy efficiency, condensate is on the way from the condenser feed water to the entrance into the steam generator heating in the thermal preparation system of the feed water, which makes low-pressure heaters, tank and high pressure feed water heaters. In this way, condensing steam transfers its heat of condensation primary condensates and feed water, and the resulting condensate is returned to the main turbine cycle condensate or feed water [3].

It is known that the thermal power plants designed and constructed so that they have the best value of the technical and economic indicators in the work with nominal regime [2].

For example of 200 MW CHP unit at TPP "Tuzla", who often work in different operating regimes that differ significantly from the nominal regime, an analysis of relevant operational data and concluded that there are significant differences in the amounts of steam to be made for additional heating feed water tank at various electrical loads of the plant.

So, at different flow rates of fresh steam and steam with variable amounts of unregulated sources of heat, it is necessary to provide different amounts of steam for heating water in feed water tank with regulated heat source (II and III seizure).

Since the temperature of the incoming condensate after low pressure regeneration system changes in values of 140-156 ^{0}C and bearing in mind that the design conditions require the parameters of feed water in water tank with a temperature of 158.6 ^{0}C and pressure of 6.1 bar, it is necessary perform continuous heating.

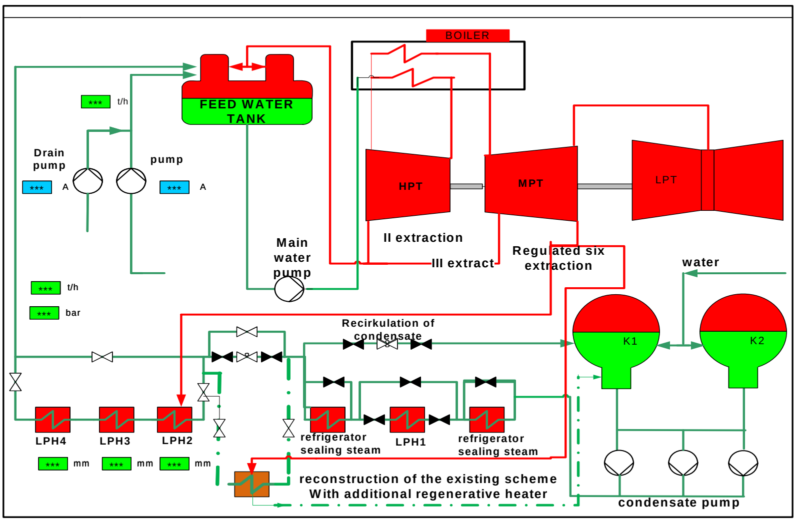

Figure 1. The scheme of primary condensate

This is practically a permanent "loss of their own" steam with relatively high parameters, which are extracted from the turbine, thus deprived of the amount of steam does not go for further expansion. Under different operate regimes and the different electrical loads are different and the value of the steam that is deducted for this additional heating, and in that sense it is necessary to analyze the impact of the scheme described in the turbine cycle energy indicators, as well as the energy block as a whole. Value of steam flow from the regulated source (the second and third extraction) measured during the normative study indicate that are reduced to a minimum at the higher electrical loads, while necessary additional heating and degassing water in feed water tank is satisfied with the unregulated heat source[1].

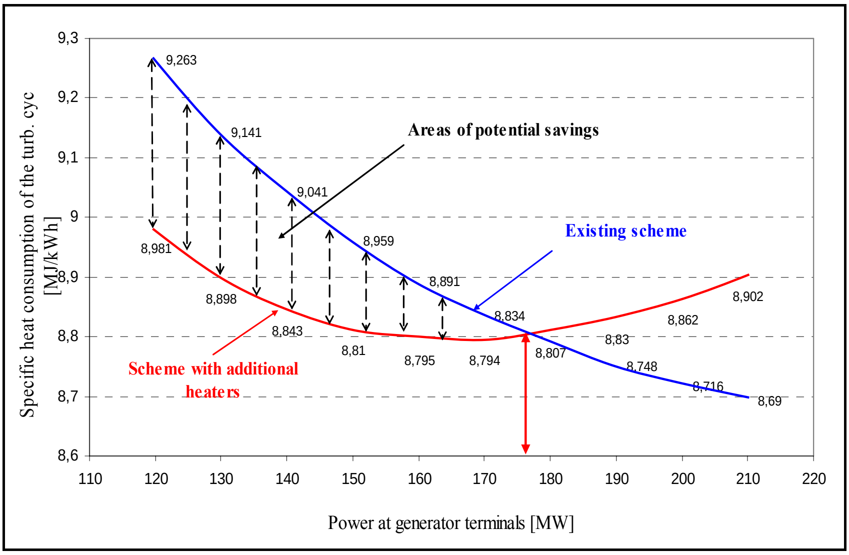

Figure 2. The specific heat consumption

From all the above, we can now conclude that in order to improve the work of power unit at varying electrical loads necessary to achieve a reduction in the amount of steam which is extracted from turbine to heating and degassing the feed water.

Of course, this is only possible with the previous reconstruction of the existing schemes of basic condensate and the provision of steam for additional regenerative heater from existing regulated extraction point of turbine with inclusion of a heater for district heating as an additional regenerative heater. Specifically, the use of such a scheme is possible when power block operate in a condensation regime and in the period of operation when the water heaters are not used for district heating. In this way, obtained the "surplus" steam would be used for further expansion in the medium pressure turbine (MPT), which will directly influence to the flow characteristics of steam turbine [1].

The main objective is therefore to achieve nominal parameters of the primary condensate, regardless of the unit operating load.

Such a redistribution of steam in the steam turbine with higher energy values would be used in addition, while needs for heating of basic condensate would be met with amount of steam which have lower energy value and extracted at the appropriate place in turbine.

3. RESULTS

One of the basic technical and economic indexes of thermal power plants, both in condensation and in heating regime, is the *specific consumption of heat* [kJ/kWh].

This indicator shows the consumption of thermal energy, entered into a cycle with fresh steam needed to produce one kWh of electricity at the generator terminals [4].

The diagram in Figure 2 shows that the specific heat consumption decreased in the case of the amended scheme at work of plant in the condensation regime with electric load lower than of 176 MW, as obtained by calculation.

To illustrate the potential beneficial effect in the case of the amended scheme of primary condensate energy indicators changes are expressed in percentages are shown in Table 1.

The red color indicated the area in which the negative effects and black color indicated the area in which the positive effects obtained in the case of the amended (new) scheme of primary condensate.

It is evident that the greatest effects are achieved at lower electric loads. The reduced flow of fresh steam through the turbine affects to the efficiency and strength of the regenerative heater, resulting in increased amounts of steam which heats the feed water tank [1].

Table1. Change of energy indicators

Power at generator	Specific heat consumption of the turbine cycle			Coefficient of usefulness			Specific heat consumption of the power unit		
	Exist scheme	New scheme	Deviation	Exist scheme	New scheme	Deviation	Exist scheme	New scheme	Deviation
MW	MJ/kWh		%	%			MJ/kWh		%
130	9,141	8,898	**2,7**	29,62	30,24	**0,62**	10,808	10,604	**1,92**
140	9,041	8,843	**2,2**	30,46	31,01	**0,5**	10,598	10,423	**1,68**
150	8,959	8,81	**1,69**	31,19	31,64	**0,45**	10,424	10,285	**1,35**
160	8,891	8,795	**1,1**	31,83	32,13	**0,3**	10,28	10,184	**0,94**
170	8,834	8,794	**0,45**	32,37	32,51	**0,14**	10,163	10,115	**0,47**
175	8,809	8,799	**0,11**	32,6	32,65	**0,05**	10,114	10,091	**0,23**
180	8,787	8,807	0,22	32,82	32,77	0,05	10,071	10,075	0,04
185	8,766	8,817	0,58	33,01	32,86	0,15	10,034	10,065	0,31
190	8,748	8,83	0,94	33,19	32,93	0,26	10,002	10,062	0,6
195	8,731	8,844	1,29	33,34	32,97	0,37	9,975	10,065	0,89
200	8,716	8,862	1,68	33,47	32,99	0,48	9,954	10,075	1,2

In the table of results can see the useful effects of plants with altered basic scheme of condensate in the case of using additional regenerative heater in the field of electric load requiring permanent heating the feed water tank (electrical load lower of 176 MW).

4. CONCLUSION

The paper pays particular attention to the problem of reducing the energy efficiency of combined heat and power unit in operation in the condensation regime and exploring opportunities to raise efficiency, when the unit operates in the summer period at low electrical loads from nominal value.

We conclude that the operation of the plants with additional regenerative heaters in the basic scheme of condensate, in the case of operation in the condensation regime, and with electrical loads lower than 175 MW, has resulted in positive effects at all the technical and economic indicators. The proposal to introduce an additional regenerative heater in the base scheme condensate deserves attention, and it is necessary to consider all possibilities for its application in the near future.

Satisfying energy needs while at the same time protect the environment is one of the biggest challenges of this century. Thermal power plants are today, and will in the foreseeable future, the main producer of electricity. Accordingly, each at least a little improvement in terms of structure or technological scheme of the plant has resulted in improving their energy efficiency and lead to significant economic savings.

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