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IMPROVING RESOURCE EFFICIENCY IN THE PRODUCTION PROCESS STEAM

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ABSTRACT
This paper analyzes the state of resource efficiency in the production of industrial steam within the Tuzla Brewery plant. The brewing process and the production of industrial steam have been analyzed from the point of application of best available techniques and resource efficiency. Measures to improve resource efficiency in the production of beer have been proposed and a set of preventive techniques to improve resource efficiency in the production of industrial steam has been defined. The selected technique involves the utilization of thermal energy from the water, primarily used for removing salt and sludge from the boilers, by installing a heat exchanger. This blowdown and desalting water runs through the drainage container into the heat exchanger where it heats up the prepared water for boilers.. This solution will annually save about 20% of water and 2% of boiler fuel. . The investment payback period is approximately one year.
Keywords: *resource efficiency, best available techniques, boiler blowdown and desalting*

1. INTRODUCTION
Many types of industrial production require large amounts of fresh water. One of them is the production of beer. High consumption of water is typical for this type of industry due to the demand for compliance with high sanitary standards. Thermal energy is used in the technological process of production of wort, in processes of cleaning, washing and sterilization, as well as for heating of buildings.
In the production of industrial steam, the two main resources are water and energy-generating product. For the operation of thermal power plants, it is necessary to provide sufficient quantities of good quality water - this is possible by applying the developed technological process which involves water treatment, maintenance and control of water quality in all segments of the water- steam cycle [1]. The reduction of energy consumption is usually associated with technological improvements [2].

2. RESOURCE EFFICIENCY ISSUES IN BEER PRODUCTION
In beer production, water is primarily used as raw material, as well as for purposes of rinsing the extract from the spent grain, wort cooling, beer pasteurization, washing and disinfecting technical and technological equipment and work surfaces, maintaining general hygiene, washing and disinfecting containers, steam production, cooling of air and ammonia compressors, etc. [3].
Thermal energy, in the form of steam and hot water, is used for pomace treatment and wort boiling, production of pure yeast cultures, package washing, washing and sterilization of technical and technological equipment, pasteurizing products, indoor heating, etc.

3. RESOURCE EFFICIENCY ISSUES IN STEAM PRODUCTION
In the steam production process, resource efficiency is influenced by: the quality of boiler feed water, type and cycle of boiler desalting and sludge removal, condensate recovery, oxygen content (O_2) in

flue gases, fuel temperature at the burner entrance, pipe insulation, insulation of valves, flanges, chimneys and other boiler equipment, management of the boiler load schedule, etc. [4]. The experience of developed countries shows that the appropriate organizational measures, based on continuous monitoring of energy and manufacturing flows, can help achieve energy savings up to 10-15% [5]. The water used in thermal power plants must be of high quality. The preparation of boiler feedwater consists of a series of technological processes by which raw water is treated to obtain the properties prescribed by the conditions for the quality of feedwater [6]. The quality of water used affects the operational safety, lifespan and degree of utilization of the steam boiler. Impurities in the boiler feed water may cause the following effects: the deposition of silt, formation of boiler scale, foaming of boiler water and corrosion of the boiler metal parts [7]. Sludge interferes with the boiler operation, preventing the flow of feed water through the pipe, disables proper sealing of boiler fittings and prevents heat transfer from the boiler heating surfaces to the boiler water. Boiler sludge is removed from the boiler by a blowdown process. Foaming of boiler water occurs due to high concentrations of sodium salts, hydroxide and mechanical impurities. The effects of foaming are: increased moisture of steam contaminated with impurities from which the foam is made, the deposition of impurities in the superheater pipes of the steam line and bolts, the inaccuracy of water level in the boiler. Due to the foaming of boiler water, the gauge glass indicates higher water level than the real one. The boiler can partially be left without water. The discharge of water from the boiler regulates salt concentration in the boiler water – a process commonly known as boiler desalting. Processes of blowdown and desalting represent an important part of the treatmentof boiler water and their task is to limit the concentration of salts and other undesirable substances in the boiler water [8]. The optimal level of blowdown and desalting is crucial, since excessive blowdown results in loss of thermal energy, water consumption and increase in the amount of chemicals used to treat the feed water, while low levels of blowdown increase the concentration of undesirable substances in boiler water [9]. In the process of boiler sludge removal (blowdown) and desalting, the waste water is discharged from the boiler under pressure and temperature. There are three ways of boiler blowdown and desalting: continuous, manual and automatic. Automatic blowdown and desalting achieve the best results. The frequency of desalting depends on the conductivity of the boiler water. It is a commonly accepted fact that the amount of water for desalting amounts to 5% of the steam boiler output [10]. Since water from the boiler blowdown and desalting comes out heated, heat losses are likely to occur unless the heated water is exploited (heat losses as a result of boiler blowdown usually reach 2% of the fuel cost) [4].

4. DIAGNOSTICS OF RESOURCE EFFICIENCY IN TUZLA BREWERY

In Tuzla Brewery, the consumption of water and boiler fuel (fuel oil) is measured on a monthly basis. The consumption of steam and thermal energy in the Brewery is not measured. Boiler blowdown in Tuzla Brewery is done automatically, every 10 hours, and a single blowdown lasts for 45 seconds. The water from boiler blowdown and desalting runs into the drainage container (connected to the atmosphere via pipe). Measurements have showed that the temperature of the blowdown and desalting water from the boiler is approx. 95°C in the container. This water needs to be cooled down to a temperature of 30°C, which is the maximum permissible temperature of the water drained into the sewage, according to the law [11]. Currently, blowdown and desalting water is cooled by the urban water which is also led to a drainage container. This mixture of water is eventually discharged into the sewer. It has been established by monitoring and calculations that a maximum of $17m^3$ of blowdown and desalting water is discharged from the boiler within 24 hours. In addition, measurements and calculations have shown that, within 24 hours, $73m^3$ of urban water is needed in order to cool $17m^3$ of blowndown and desalting water from a temperature of 95°C at a temperature of 30°C [11]. According to [12], a system for utilization of blowdown water involves the installation of heat exchangers and associated piping. The boiler blowdown water runs through the drainage container and goes into the heat exchanger where it heats the prepared boiler water. The consumption of urban water used for cooling of blowdown and desalting water in Tuzla Brewery could be economized, that is, the cooling of blowdown and desalting water could be performed in the following manner described below. The blowdown and desalting water would flow into the drainage container and out of it in the blowdown and desalting water tank. The water from the tank would be pumped to the heat exchanger installed in the boiler house. Passing through the heat exchanger, this water would be cooled and would then be led to the sand filter for purification and eventually into the grey water (technical water) tank. This cooled water could be used as technical water for washing facilities. For cooling of this water in the heat exchanger, the previously softened urban water would be used. From the softener, the water would be led into the heat exchanger. In the heat exchanger, the softened urban water would cool the water coming from the blowdown and desalting water tank. The softened urban water would leave the heat exchanger heated and would be directed into the condensate tank. From the condensate tank, the water would be directed into the feedwater tank, and eventually into the boilers. The signal from the condensate tank, which is a precondition for the start-up of a water softener, should at the same time be used as a signal to start the heat pump from the blowdown and desalting water tank. Water from the softener and blowdown and desalting tank would be regulated by means of electric valves that are controlled from the electrical control cabinet (UEO). UEO collects data on the temperature and flow of the softener and desalting water. On the basis of the collected data, the UEO generates the appropriate control signals for electric valves which regulate the flow of water from the softener and blowdown and desalting tank in order to ensure the appropriate parameters of water from the heat exchanger.

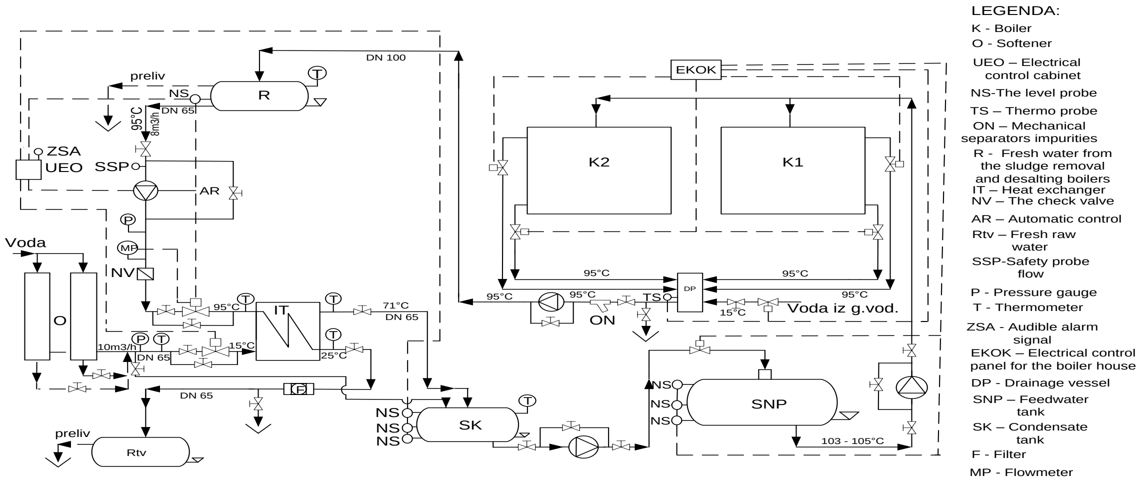

Figure 1. Scheme for blowdown water treatment and desalting boilers - proposed state

Thus, the maximum daily savings of blowdown and desalting water amounts to 17 m^3 and maximum daily savings of urban water for cooling amounts to 73 m^3. Accordingly, the total maximum daily water savings amounts to 90 m^3. Due to the potential reduction in water pressure in the system and in the boilers and due to the frequent standstill in the boiler operation because of the reduction in steam production, the total daily water savings are estimated at 60 m^3. Calculations have shown that boiler fuel savings, by utilization of heat from the blowdown and desalting water, annually amounts to 21.778,38 kg/yr which in relation to the total consumption of boiler fuel in 2012, amounts to 2,57 %. Therefore, it could be concluded that the overall boiler fuel savings, by utilization of heat from the blowdown and desalting water, would annually amount to 2%. By utilization of the blowdown and desalting water, and by savings in water for cooling of the blowdown and desalting water, the overall water savings would annually amount to 21,70%. If the system for utilization of blowdown and desalting water is implemented alone, the annual savings (of water and boiler fuel) would amount to 101.491,80 BAM. The cost of implementation would amount to 74.805,50 BAM, which means that the investment return period would be less than a year. In addition to the utilization of blowdown and desalting water, other measures can be used to influence the increase in resource efficiency, ie. the reduction of water and fuel consumption.

The characteristics of the boiler feedwater are measured in the Tuzla Brewery and the measured values are within tolerable limits. The recovery of condensate from the process is performed. The regularly measured parameters are: oxygen content (O_2) in the flue gases, flue gases temperature and fuel temperature at the entrance to the burner. The aforementioned values are within tolerable limits. A review of the insulation and measurements performed by thermal imaging camera on the boiler equipment has indicated the need for the following repairs: fixing of the insulation above the valve on the 8 bar steam manifold in the boiler house and insulating of valves in the mash tuns 1 and 2 in the cooking plant. In order to check the level of sludge removal from the boilers, it is necessary to install the feedwater meter. The amount of steam produced is not measured in Tuzla Brewery, which poses an obstacle to the optimal use of boilers and to the determination of the optimal boiler load, which can be determined on the basis of the consumption of steam and boiler fuel. The implementation of a system to improve operational procedures and boiler load management, requires the installation of meters for measuring the amounts of steam produced and the consumption of boiler fuel. The implementation of the complete system has been proposed, ie. the utilization of blowdown and desalting water and installation of meters for measuring the amounts of steam produced, the consumption of fuel oil and consumption of feedwater. The total annual savings would amount to 137.112,00 BAM, and the cost of implementation would amount to 142.458,40 BAM. Thus, the investment return period would be little over a year (1,04 years).

5. CONCLUSION

This paper deals with resource efficiency in the production of industrial steam. The Brewery Tuzla has been taken as an example. The survey of the current state has been performed in the boiler house, on the steam distribution equipment as well as at the very steam plants, with particular reference to the boiler blowdown and desalting. The final ¸remarks contain proposed measures to save energy, water and boiler fuel. Every improvement of systems for the production and distribution of steam and condensate recovery has direct impact on: transfer of heat to the end users, efficiency of the boiler and ancillary equipment operation, energy savings, water savings and reduction in the need for chemical treatment of water. Recommendations for saving of resources in the steam production have been elaborated and a feasibility analysis of the recommended techniques has been performed for Tuzla Brewery. In regard to the Tuzla Brewery, certain investments as well as measures of good hospitality behaviour can increase resource efficiency of the steam production and distribution system. The short investment return period indicates the validity of investment in the proposed measures.

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