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ENVIRONMENTAL ASPECTS OF ENERGY AND WATER LOSSES IN THE PROCESS OF BEER PRODUCTION AND MEASURES FOR THEIR REDUCTION

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ABSTRACT
This paper analyzes environmental aspects of energy and water losses in the process of beer production. Analysis, made for the current conditions as well as possibilities for application of measures to reduce these losses is shown for Tuzla Brewery. Processes of water and energy consumption, waste water and falling were analyzed in this case. As a result, proposal of measures is presented which could reduce losses as well as the set of best techniques for improvement of the state.
Keywords: environmental aspects, the best available techniques, water, energy, waste

1. INTRODUCTION
The most significant environmental problems related to the beer production include the following: high consumption of water, high energy consumption, increased value of hazardous and harmful substances in waste water, large volume of generated waste water, air emissions from the receipt and transport of raw materials, boiler operation, cooking the mash and wort, washing and disinfection of bottles etc., large amounts of organic and inorganic waste.
In addition, in some cases problems related to the increased level of noise and odors may also occur.

2. ENVIRONMENTAL PROBLEMS IN BEER PRODUCTION AND PREVENTIVE TECHNIQUES FOR REDUCE LOSSES OF ENERGY AND WATER
Beer production is specific because it requires large amounts of fresh water. High water consumption is typical for this type of industry due to high demand for implementation of hygiene standards. Water is primarily used as a raw material, and for washing the extract from the trop, wort cooling, beer pasteurization, washing and disinfection of technical and technological equipment and work surfaces, maintaining general hygiene, cleaning and disinfection of packaging, steam production, condensation of ammonia in refrigeration plants, cooling of air and ammonia compressors etc. [1]. Generally, water pollution implies any physical, chemical or biological changes of its quality, which makes it unusable for the desired use and detrimental to the living world [2].

Waste water is the most serious environmental problem in the brewing industry [1]. The main source of the waste water formation are processes of cleaning and disinfection of packaging, production equipment and production facilities, filtration processes, pasteurization and cooling of products,

squeezing the mash, wort clarification, blowdown of fermenter and discard of excess yeast, boiler blowdown, processes of steam condensation, cooling of compressors, sealing on vacuum pumps, lubrication of conveyor belts as well as toilets, restaurants and kitchens. These waters are loaded with a variety of pollutants, detergents and other agents used in washing. The discharge of water from the boiler regulates the concentration of salt in the boiler water, observed as the process of boiler desalting. If the boiler water has sludge, which is the case when the boiler is supplied with insufficiently softened water, or chemicals used for water softening partly deposit hardness in the boiler in the form of sludge, then water drain is used to remove the sludge, which is observed as the process of boiler blowdown [3].

Waste water needs to be purified before its discharge into the recipient. Waste waters generated in the brewing process is generally considered to be in varying composition regarding their qualitative and quantitative characteristics [4].

Steam generation also plays an important role in beer production. The aim should be to achieve the best utilization of steam, ie. reduction in water and energy consumption, used in steam generation. Therefore, insulation is an integral part of all power and industrial plants. Its main goal in industrial and energy plants is to reduce heat loss and to prevent burns to people who work and use those plant.
Beer production doesn't result in significant air pollution, which is understandable since it belongs to the food industry where raw materials are natural products, and the technological process is based on the natural process of fermentation of organic matter. Air emissions occurring as a result of basic and auxiliary processes in breweries are: waste gases from boiler plants, CO_2, ammonia vapor from the refrigeration compressors, odors, NaOH from the washing processes, organic dust and exhaust gases from the transportation [1].

The emissions from the chimney (furnace) in the boiler room are released into the atmosphere. Waste gases are generated in the process of fuel combustion in the boiler. Waste generated at the facility for the production and bottling of beer consists of waste generated during the storage of raw materials, production, storage, filling and packaging of finished products, wastewater treatment and maintenance of production equipment [1].

Main consumers of electricity are: plants for production of cooling energy, drives for filling and packaging, cooking plant, plant for the production of compressed air and a device for treatment of waste water. Thermal energy, in the form of steam and hot water, is used for processing the mash and wort boiling, production of pure yeast culture, washing containers, washing and sterilizing technical and technological equipment, pasteurisation of products, dealkoholization of beer, heating of buildings etc.

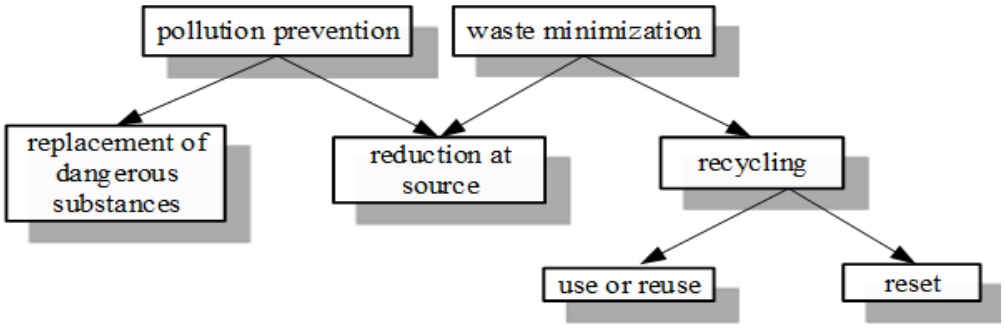

Figure 1. The sequence of pollution prevention and waste reduction [8]

Cleaner production means introduction of effective environmental management systems [5]. Cleaner production in manufacturing processes includes rational use of raw materials, water and energy, replacement of hazardous materials with more environmentally friendly ones and reduction of the amount and toxicity of emissions and waste in the water, air and land.

The discharge of waste materials in the water, air and land represent a significant loss of raw materials, as well as a potential threat to human health and the environment [6]. With the introduction of cleaner production in companies, the benefits are noticeable from two aspects: internal, ie. the aspect of economic benefits, as well as external, ie. the aspect of conservation and environmental protection [7].

3. DIAGNOSTICS OF ENVIRONMENTAL ASPECTS AND PREVENTION TECHNIQUES IN REDUCTION OF ENERGY AND WATER LOSSES IN TUZLA BREWERY

Analysis of the situation and possibilities for the application of measures to reduce losses, presented in this paper, is made for Tuzla Brewery, which applies management measures through quality management, environment and food safety. For those aspects the company is certified with ISO 9001, ISO 14001 and HACCP.

Analysis of the technique application in measurement of water consumption showed that there was one water meter installed in every production facility, while only facilities with new fermentor tanks and siloses have a joint water meter. For most facilities daily water consumptionis regularly measured, but for some of them consumption data are not processed.

In the washing facility, on the CIP plant, where cleaning solutions are prepared, dosage is not equiped with scale nor is facility for wort production. CIP unit has a built-in conductivity probe in the main pipe from process equipment and near the entrance to detergent storage.

This sensor monitors the concentration of detergent / water flowing through the pipe during the cleaning process. Automatic gauges for water turbidity used in monitoring of CIP system, for the optimization purpose of reuse of clean water, and thus minimization of resulting waste water, are not built in. Scale is also not installed in the facility for bottles washing, in order to optimize water consumption in rinsing process.

Sensors (cells with electrodes or inductive sensors), used for conductivity measurement of water from boiler room, to reduce plaque build-up on hot surfaces are used, also in bottle washers to control concentration of the alkaline bottle washing solution, as well as to measure water conductivity in plants for re-pumping of products, pasteurization, filtration and filling. In order to optimize the process and prevent the formation of products of poor quality, automatic gauges of water turbidity are built in the process of clarifying the wort, separation and filtration of beer.
Water from wort cooling is re-used, cooling takes place in a closed process and the engines are equiped with drives that reduce energy consumption. Water used for cooling of pasteurized cans are not re-used. When cleaning floors, walls, vessels, containers, open equipment and conveyors, in most cases hose nozzles are useed but workers sometimes use hoses without nozzle, which increases water consumption.

Water from sludge removal and desalting boiler is cooled with water from public water supply network and is discharged into the sewer. Water from sludge removal and desalting boilers could be used for heating of softened water and condensate which is returned from the process in the boiler house, and thus reduce water and boiler fuel consumption. This solution could lead to annual savings of water of approx. 20% and approx.2% of boiler fuel. Return period of such investment would be approx. one year [9].

The condensate is returned from the manufacturing process and is used in steam generation, which reduces water consumption and boiler fuel for steam generation.
Boiler fuel consumption is measured, as well as electricity consumption for entire company.
Waste separation for the purpose of its re-use is applied in manufacturing process to packaging waste, kieselguhr and wort residue. Waste labels are separated after washing of bottles.
Regular servicing of boilers is performed and service men measure combustion flue gases.
Equipment and pipelines are insulated with mineral wool, which is coated with aluminum sheets.
When performing work on the equipment and pipelines, insulation is removed and later re-installed.
The Company does not apply the technique of CO_2 recovery.

Table 1 Improvement measures

Type of technique	Measures to be taken
Measuring of water consumption per production facility	It is necessary to process the data on water consumption individually in all facilities and monitor whether there are losses, i.e.increased consumption of water in plants.
Measuring of water turbidity to minimize amount of wastewater resulted from process water or products which don't meet with specification.	To monitor the quality of process water with automatic water turbidity meters, as this reduces the amount of waste water, which is the biggest environmental problem in the brewing industry.
Waste labels after washing bottles separated and sent for recycling.	Waste labels to be collected in a separate container with perforated bottom that provides good drainage. After drying, labels can be placed in a container designed for waste recycling.
Using environmentally friendly detergents.	Use biodegradable detergents rather than detergents based on phosphates.
Automatic measurement of water turbidity for CIP system.	Install automatic timers for water turbidity monitoring of CIP system, to optimize reuse of clean water, and thus minimizing the resulting waste water.
CO_2 recovery	Install recovery system for CO_2
Re-use of water for cooling of pasteurized cans.	Make use of water from the cooling of pasteurized cans.
Use of water from sludge removal and desalting boilers.	Make use of water from sludge removal and desalting boilers.
Are individual devices for measurement of energy consumption installed?	Total consumption of boiler fuel and electricity is measured. There is no separate measurement by facilities.

4. CONCLUSION

Checking the level of application of best available techniques showed that Tuzla Brewery implemented several measures that contribute to improvement of resource efficiency, but there are a number of techniques that can be applied. Techniques related to improving process management (measurement of resource consumption, measuring conductivity, turbidity), recycling of labels, techniques for improving cleaning practice (use biodegradable detergents, use nozzles on hoses, installing automatic meter turbidity on CIP system), CO_2 recovery, reuse of water from cooling of pasteurized bottles/cans and using water for sludge removal and desalting boilers.

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