

CONCEPTUAL SOLUTIONS FOR WASTEWATER TREATMENT TECHNOLOGIES IN THE DAIRY INDUSTRY

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ABSTRACT

This paper describes the procedures of the formation of technological wastewater from milk production and processing industry of milk Zenica, and given conceptual solution for adequate treatment. On the base of many years of research in dairy Zenica were selected efficient and cost-effective technologies for the purification of industrial wastewater from the process of production and processing of milk, which is based primarily on the reduction of the organic load in wastewater (BOD₅ and COD), suspended solids, phosphates and other harmful substances, as well as correcting the pH value in relation to the required effluent quality and the recipient. Selected system allows adjustment of the cleaning of the load and the required quality of treated water, which is discharged into natural waters.

Key words: *quantitative and qualitative characteristics, waste water treatment technologies, dairy industry*

1. INTRODUCTION

The dairy industry produces large amounts of industrial waste water with high content of pollutants for which can significantly affect the quality of the water environment. Depending on the production program of waste water containing dairy industry remains raw and pasteurized milk, whey, butter, cheese, yogurt, parts packaging, detergents and cleaners, the remnants of different products that were on the test in the laboratory, mechanical oils and fats, oils combustion and other impurities [1, 2, 3]. Volume, concentration and composition of the wastewater generated in the dairy industry varies widely and depends on the type of product, product range, mode, design, plant, water management system, and the amount of water to be purified [2, 3].

This paper analyzes the quantitative and qualitative characteristics of wastewater from milk in Zenica on the basis of the results of many years of monitoring and their impact on the quality of the recipient - the Bosna River. Based on the results of test quantitatively-qualitative characteristics of the waste water of milk in Zenica is defined proposal technology of their purification.

2. QUALITATIVE AND QUANTITATIVE CHARACTERISTICS OF TECHNOLOGICAL WASTEWATER DAIRY IN ZENICA

In the process of production of milk and dairy products are created following wastewater:

- industrial waste water - caused by washing and disinfection of technological lines, washing machines, devices, technological equipment, working premises and surfaces, and spilling milk and dairy products, after the unit malfunctions and operational errors, etc., Which are usually loaded with organic substances, detergents, oils, fats and other pollutants,
- process wastewater - resulting cooling aggregates and heating (waste water from the boiler room),
- atmospheric stormwater - resulting from precipitation on surfaces in the industrial circle in which one can find large waste (leaves, paper, plastics ...), materials of organic and inorganic origin and free of oil, fuel and other materials,
- sanitary fecal waste water - resulting in toilets and kitchen, and are loaded with organic substances, detergents and other pollutants.

Industrial wastewater from the production and processing of milk represent a major environmental problem because of the large amount and high load pollutants. They typically have a high BOD₅, particularly waste water from the process of making cream, butter, cheese and whey, and high COD and high concentrations of suspended solids, as well as the presence of other pollutants such as phosphorus, nitrogen and chlorides. Also there may be a problem, and a wide range of pH and temperature of the waste water. The concentration of pollutants in waste water depends on the efficiency of water management at the facility (eg. Re-use of water, drainage, good governance processes, etc.) [4, 5].

Some important characteristics of wastewater from dairies:

- large living variation flow ($Q = 23-41 \text{ m}^3 / \text{day}$)
- variable pH (5.5 to 10.6)
- high biological oxygen demand (BOD₅) and chemical oxygen demand (COD),
- high content of suspended solids,
- waste water can have a high content of phosphorus if used phosphoric acid,
- presence of oils and fats,
- Increased temperature waste water etc.

Industrial wastewater from the production and processing of milk is characterized by high organic content (COD 1000-6000 mg / l), fats and oils (especially waste water from the production of butter), nitrogen and phosphorus (mainly originating from detergents and disinfectants), very variable pH value (pH 2-11), high conductivity (especially cheese containing sodium chloride) and the variation of the temperature depends on the purpose of use of water. Waste water from dairies are loaded with milk and residues of milk products, which affects the increase of BOD₅ (up to 110,000 mg O₂ / l) and COD (up to 210,000 mg O₂ / l). Losses during the production of milk on average 0.5-2.5% of the amount of received milk (and in the worst cases 3-4%), which significantly affects the amount of pollutants in waste water [2, 3].

Accordingly, the effluent from the plant for the production and processing of milk requires mandatory wastewater treatment to the required quality before it discharges into surface waters in order to protect water resources.

Wastewater treatment is the most important element of protection of surface and groundwater. The effect of treatment differs depending on the procedure and manner of conducting the process of wastewater treatment. Each process for wastewater treatment has special characteristics and therefore making any conceptual system solutions for waste water should have a specific approach in order to achieve the best results [6, 7].

3. CONCEPTUAL SOLUTION WASTEWATER TREATMENT DAIRY IN ZENICA

To achieve the required effluent quality for discharge to surface water from wastewater treatment is necessary:

- allocate suspended solids,
- reduce the organic load,
- maintain the pH value within the limits prescribed by certain requirements,
- reduce the phosphorus content in the waste water,
- reduce the concentration of other pollutants (phosphorus, nitrogen, etc.).

The selection procedure for the treatment of wastewater from dairy processing, and selection of appropriate operation or process, as well as their combination depends on a number of factors [7]:

- quantity and quality of waste water to be purified,
- characteristics of wastewater and achieve the appropriate requirements for waste water treatment, which meet the regulations and standards,
- fulfillment of the requirements related to the quality of the recipient in that discharge waste water (hydrological data, data on the use of water downstream of the discharge data on the composition of the water above the receiver of effluent discharges)
- reliability, flexibility and efficiency of the process waste water treatment, and
- adjusting the treatment process to the load and the required quality of effluent,

- economic conditions (investment costs for equipment and maintenance, and the costs for the functioning of devices such as expenditures for energy, chemicals, sludge disposal, etc.).

Research and selection of the optimal methods of wastewater treatment aims for safety and efficient working conditions provided technology for purification. Terms discharge of treated water into surface water and also the basic design requirements for the selection of the technology are as follows [6, 8]:

- The number of discharges effluent into the natural recipient (surface water) must be reduced to technically and economically acceptable minimum.
- securing the border parameters based on prescribed standards and appropriate quality eufleta for a given class of watercourses.

To achieve the required quality of waste water in accordance with the prescribed limit values for the discharge of wastewater into surface waters, was selected a system that allows adjustment of the cleaning of the load and the required quality of treated water, which is discharged into the river Bosna.

Figure 1. shows the process flow diagram of purification of industrial waste water from the plant for the production and processing of milk in Zenica, which aims to reduce pollutants below the prescribed limit values for effluent quality and the required quality of the watercourse as a recipient at the point of waste water.

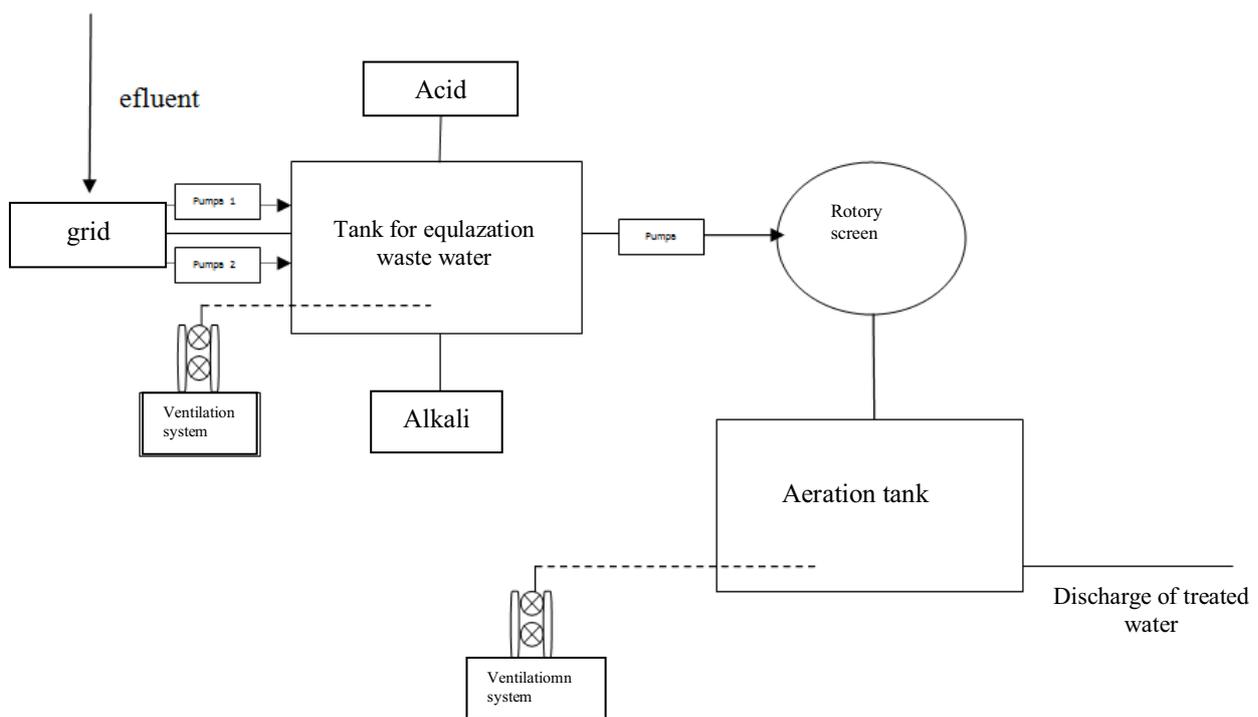


Figure 1. Scheme of the technological process of wastewater treatment from dairies.

Conceptual Solution system for waste water from the dairy industry consists of the following technological operations:

- Primary (mechanical) treatment consisting of a grid system,
- equalization of waste water with automatic ventilation and system for measuring and correcting the pH of water,
- mechanical rotary sieve to remove suspended solids and reducing BOD₅ and COD with a tank for waste,

- secondary treatment (aeration basin), with a system for aerating and pumps to drain water into the sewage system which reduces the value of BOD₅, COD, nitrogen and phosphorus.

The proposal technologies for treatment of wastewater from the dairy industry is based primarily on the reduction of the organic load in wastewater expressed through BOD₅ and COD, and the reduction of suspended solids, phosphates and other harmful substances, as well as the correction of pH values. To achieve the required quality of waste water in accordance with the prescribed limit values for the discharge of surface water, selected a system that allows adjustment of the cleaning of the load and the required quality of treated water, which is discharged into natural waters. The proposed conceptual design of the system for waste water treatment aims to achieve a degree of efficiency in the process of wastewater treatment and improve effluent quality (degree of removal of the organic load, suspended solids and other harmful substances), all in order to meet the prescribed standards for effluent quality and the recipient into which the wastewater is discharged.

4. CONCLUSION

Industrial wastewater from the production and processing of milk represent a special environmental problem due to the large volume and high load pollutants. It is therefore important to implement an efficient and cost-effective measures to reduce emissions in the wastewater and the quantity of wastewater, and make a choice of efficient and cost-effective technology of wastewater treatment prior to its discharge into the recipient, particular surface water.

On the base of many years of research in dairy Zenica were selected efficient and cost-effective technologies for the purification of industrial wastewater from the process of production and processing of milk, which is based primarily on the reduction of the organic load in wastewater (BOD₅ and COD), suspended solids, phosphates and other harmful substances, as well as correcting the pH value in relation to the required effluent quality and the recipient. Selected system allows adjustment of the cleaning of the load and the required quality of treated water, which is discharged into natural waters.

5. REFERENCES

- [1] Arsenović, B.: Prečišćavanje industrijskih otpadnih voda sa posebnim aspektom na otpadne vode galvansko-hemijskih procesa, Nezavisni fakultet Banja Luka (Fakultet za ekologiju), Banja Luka, 2014.
- [2] Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries, European Commission, August 2006.
- [3] Tehničke upute (2008): Prehrambena industrija: Sektor - Proizvodnja i prerada mlijeka (dokument prema BREF dokumentu EU tj. „Reference Document on Best Available Techniques in the Food, Drink and Milk Industries, EC, August 2006“), Sarajevo.
- [4] Sustainability in Food Industry 2012, Dostupno na: http://projects.tempus.ac.rs/attachments/project_resource/879/1159_Sustainability%20in%20Food%20Industry-158989-2009.pdf, pristupljeno: januar 2016
- [5] Šišić, I., Perviz, O., Kozlica, S. (2009): Principijelno rješenje praćenja sistema obrade otpadnih voda nastavnog centra «Grmeč», 6. Naučno-stručni skup sa međunarodnim učešćem "Kvalitet 2009", Neum, B&H, 04. - 07 juni 2009.
- [6] Goletić, Š., Petković, D.: Application of modern cleaning proceedings for hospital effluent water, PSU-UNS International Conference on Engineering and Environment - ICEE-2005, Novi Sad, Serbia & Montenegro, 19-21 May, 2005.
- [7] Goletić, Š., Imamović, N., Avdić, N. (2014): Obrada otpadnih voda, Univerzitet u Zenici, Zenica.