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FOOD AND ENVIRONMENT SAFETY

THE QUALITY OF WASTEWATER IN THE DAIRY INDUSTRY

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Abstract: *The paper aims a comparative study of the parameters of dairy wastewater during three years namely a comparison of wastewater parameters before entering in the treatment plant and waste water parameters after treatment in the wastewater treatment plant. The indicators used to analyze the quality of wastewater from the dairy factory were: CCO-Cr, CBO_5, total suspensions, pH, chloride content, total nitrogen, total phosphorus, oils and fats. The purpose of monitoring is to produce information on the physico - chemical waste water, on treatment technologies efficiency, focusing on the disinfection process, to determine if the waste water is adequate or not in terms of the values of the relevant parameters set by law.*

Key words: *treatment plant, wastewater, dairy industry*

1. Introduction

Monitoring the quality of discharged wastewater from the food industry is a necessary condition for all food units that produce, process, store, keep, transport and selling food.

The main environmental issues in dairy industry are the high energy and water consumption, generation of waste water with a high organic content and the production and management of waste.

The most important environmental problem in the dairy industry is the generation of waste water, both for their volume and as well as polluting load associated (organic basically).

The dairy industry is a major source of pollution because of its effluents are usually rich in carbonaceous material, nitrogen containing (protein) shaping the decisive growth of CBO_5.

Thus, the amount of waste water resulting from a milk factory can find values that range from 2 to 6 l / l milk processed depending on the factors such as the size and age of the plant, equipment, handling, cleaning plans. To residue obtained after processing the milk we must add leftover of antiseptics and disinfectants used to clean the milk ducts (hypochlorite, nitric acid and detergents).

Antiseptic substances used generates in their turn certain products(disinfection of drinking water by chlorine sometimes forms carcinogenic trihalomethanes) highly toxic (4), (6). There are microorganisms such as *Cryptosporidium* spp. and *Giardia which are* resistant to chlorine disinfection and in this case the most used is a chemical coagulant such as aluminum sulfate, whose use increases the metal ion content in the treated water (5), (6). The wastewater generated in a dairy factory can be classified according to three sources of generation: processes, cleaning and cooling.

Table 1.

The main the dairy industry effluents

No	Effluent	Source	Characteristics	Observation
1	Process water	Cleaning of equipment and installations	BOD_5 , COD-Cr, suspended solids (SS), nitrogen, detergents, oils, and fats.	Depending on the size and age of the plant, equipment, handling cleaning plans
2	Clening Solutions	Sterilization	Peroxide	cleaning plans
3	Cooling water for products and heat exchangers	Maintenance of heat exchangers	Hot water with suspended solids	Pasteurisation, sterilisation
4	Sanitary waste water	Disinfection	BOD_5 , COD-Cr, suspended solids (SS), ammonia and detergents	Cleaning plans, chemical coagulants
5	Water for regeneration of ions exchange resins	Treatment of water from wells	Acidity and basicity	Acids and bases for regeneration of ions exchange resins

Waters resulting from the processing of milk are characterized by a high concentration of organic material in proteins, sugars, lipids, high concentrations of suspended solids, high consumption of oxygen demand (BOD_5, COD-Cr), high concentrations of nitrogen and phosphorus, high concentrations of oils and fats in the suspension, significant changes in pH.

Washing waters may also contain: sterilizing agent (1), (sodium hypochlorite), detergents, alkalis (sodium hydroxide) or acid (nitric acid, phosphoric acid) used for washing ion exchangers (2) or CIP installations.

2. Materials and Methods

The composition of the waste water is characterized by a high content of fat, lactose and protein. Among its components can meet and resistant thermophilic bacteria remaining on the plates of heat exchangers and other devices that can hold milk losses and chemical treatments or electrochemical disinfection (3) that can be done that will increase the degree of pollution of water. Main origin of pollution is caused losses of product in different stages of technological process (between 0.3 and 1.3% of processed). The analyzes focused on (7):

2.1. Determination of oxidizable substances in water (COD-Cr) / ISO 6060-1996

Oxidizable substances in water or chemical oxygen demand (COD-Cr) are substances which oxidize both cold and hot, under the action of an oxidant. Oxidizable substances in the water are oxidized by potassium dichromate in sulfuric acid medium, hot, and the excess dichromate is titrated with Mohr's salt in the presence of feroinei as an indicator.

2.2. Determination of biochemical oxygen demand in water (BOD_5) / SR 1899 / 2-2002

Biochemical oxygen demand BOD5 is the amount of oxygen consumed by the microorganisms in a period of time, to decompose the organic substances contained in the biochemical water.

The standard time is set for 5 days at a temperature of 20^0C. The oxygen consumed is determined for 5 days by microorganisms in the water by the difference found between the quantity of dissolved oxygen in the water sample immediately and after 5 days of collection. Determination of BOD_5 is made in diluted and undiluted water sample.

2.3 Determination of total suspension / SR EN 872-2005

They are insoluble substances in water, expressed in mg suspensii/dm3. Water-insoluble substances can remain in the suspension, the more or less time depending on the weight of the particle. Colloidal substances and very light particles are permanently suspended, being in a continuous movement in the water. It is determined by separating the particles in suspension (filtration, centrifugation, sedimentation), drying and weighing them.

2.4. Determination of pH / SR EN ISO 10523-2012

Potentiometric method was used to determine pH.

2.5 Determination of chlorides / SR EN 9297-2001 (Method Mhor)

Chlorides from water come from salts of raw materials, from process or following an accidental pollution. Chloride ion is determined by Mohr method after its reaction with silver nitrate in neutral medium when form silver chloride, insoluble. End of reaction is indicated by potassium chromate.

2.6. Determination of total nitrogen / SR EN ISO 11905/1 - 2003 (Kjeldahl method)

Total nitrogen is an indicator totaling organic nitrogen in various forms (proteins and nucleic acids in various states of decay, urea, amines, etc..) and inorganic, ammonium ion NH_4^+. The Kjeldahl method to determine the total nitrogen is consisting in the mineralization of samples to form ammonium sulfate that releases ammonia, which is then distilled and determined by titration with hydroxide.

2.7 Determination of total phosphorus / SR EN ISO 6878: 2005

The method of determination is based on the reaction of ammonium molybdate, that forms with phosphate ions the phosphor ammonium molybdate, which can be reduced to molybdenum blue with an organic or inorganic reducing agent. Resulting blue complex is measured by spectrophotometry, absorption of solution being proportional to the concentration of phosphate ions from wastewater analyzed

2.8. Determination of oils and fats / SR 7578-96

The content of extractable substances with solvents, animal and vegetable fats, hydrocarbons (mineral oil, heavy hydrocarbons), combinations with hydroxyl, carbonyl, carboxylate functions, nitrogenous compounds, insecticides, soaps, waxes, resins and tars are determined by extraction with solvents.

3. Results and Discussion

In the three years, during which the study was conducted, they found a high levels of COD-Cr, in waste water, before treatment, in the spring and summer seasons, Figure 1. The high levels of COD-Cr, indicates the existence of a large amount of organic matter facilitating the chemical oxidation, and requires a high consumption of oxygen.

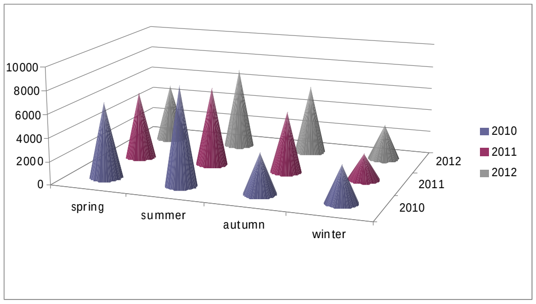

Fig.1.Values of BOD_5 from the waste water before treatment

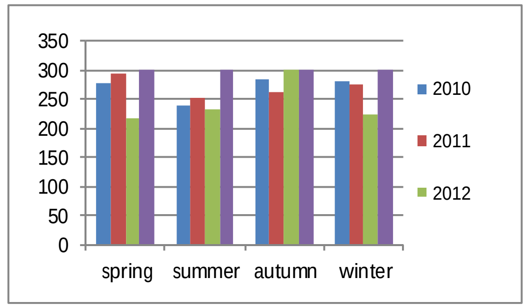

Fig.2.Values of BOD_5 in waste water after treatment

After the wastewater treatment it was a small excess of permissible limit (500 mg / l) in the summer and autumn of 2010 and 2011, Figure 2.

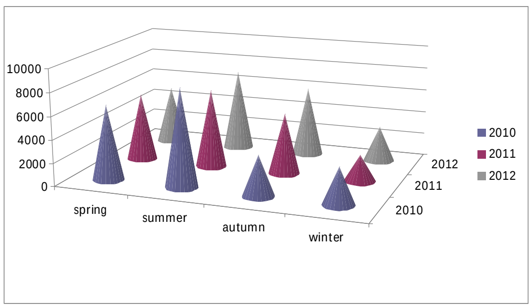

Fig.3 BOD_5 values from waste water before treatment

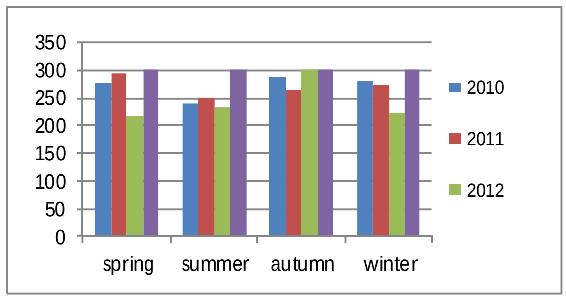

Fig.4. BOD_5 values in waste water after treatment

The highest values of BOD_5 in wastewater before treatment were recorded in summer season, Figure 3, the maximum occurring in the summer of 2010 (8480 mg / l). The lowest values of BOD_5 were found in the winter season. High levels of BOD_5 indicates that oxidation of organic matter occurs (suspended solids, waste) because of the large number of existing bacteria. After treatment, all the recorded values were integrated into the limit of value allowed (300 mg / l), figure 4.

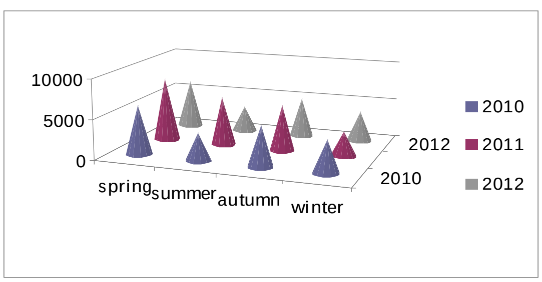

Fig.5. Values of suspended solids content in waste water before treatment

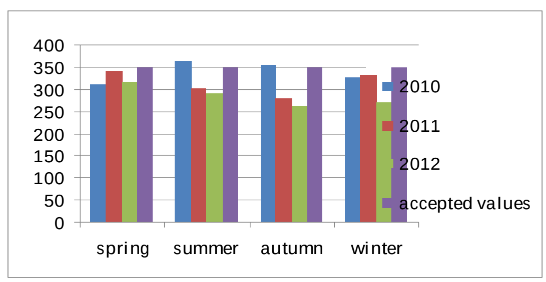

Fig.6 Values of suspended solids content in waste water after treatment

The highest values of total suspensions content of waste water before treatment, were recorded in the spring season, the highest value reached in spring of 2011 (8140mg / l), Figure 5. This is due to the presence in the waste water of a large amount of insoluble substances, in different sizes. After treatment there was a small excess of allowed limit (350 mg / l), Figure 6, in summer and autumn of 2010.

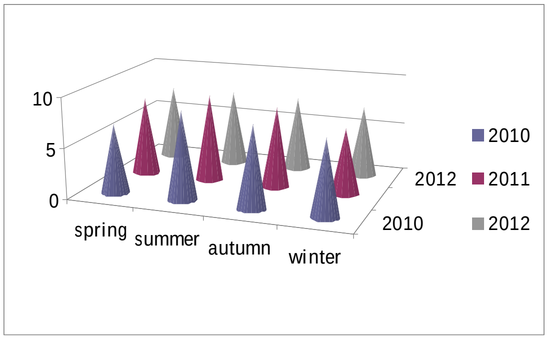

Fig.7 Wastewater pH values before treatment

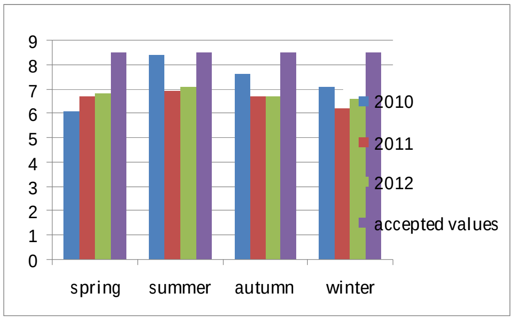

Fig.8. Wastewater pH values after treatment

Both before treatment and after treatment, the effluents had values that integrate within the range of allowed limit, 6.5 – 8.5. This is because the company uses raw materials complying with the rules of quality and to the fact that the company uses biodegradable substances for cleaning and disinfection.

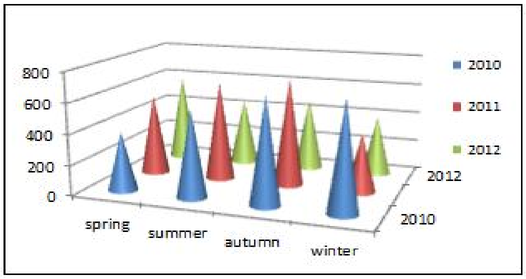

Fig.9. Values of chloride content of waste water before treatment

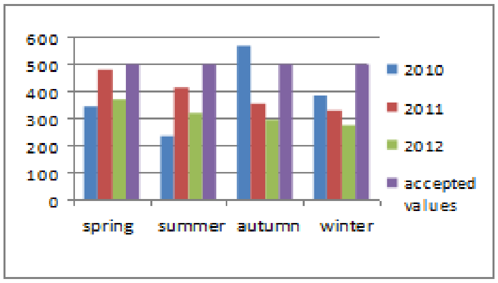

Fig.10. Values of chloride content of waste water after treatment

The highest values of chloride content in waste water before treatment were recorded in autumn season. The highest value was reached in autumn 2011 (710 mg / l), Figure 9. After treatment there was one over exceeded of allowed limit, (500 mg / l) in autumn 2010 (570 mg / l) Figure 10.

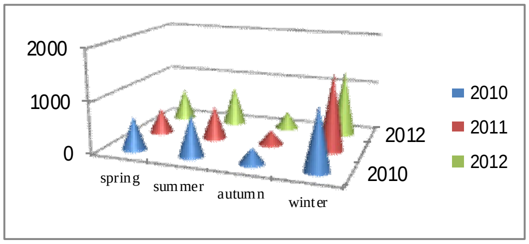

Fig.11. Values of total nitrogen content of waste water before treatment

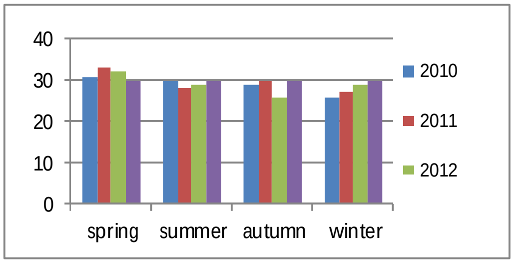

Fig.12. The values of the total nitrogen content of the waste water after treatment

The highest values of total nitrogen content of the waste water before the treatment were recorded in the winter season. The highest value reached in the winter of 2011 (1502 mg / l) Figure 11. This may be due to excessive use of cleaning agents and disinfectants rich in nitrogen (nitric acid) or raw material that had a high content of nutrients rich in nitrogen. After wastewater treatment was a very small excess of allowed limit (30 mg / l) in the spring season in 2011 (31-33 mg / l) Figure 12.

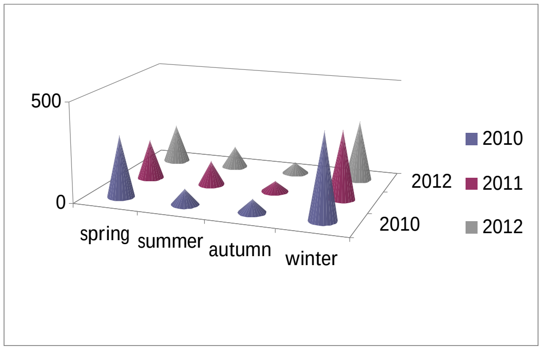

Fig.13. Values of total phosphorus content of waste water before treatment

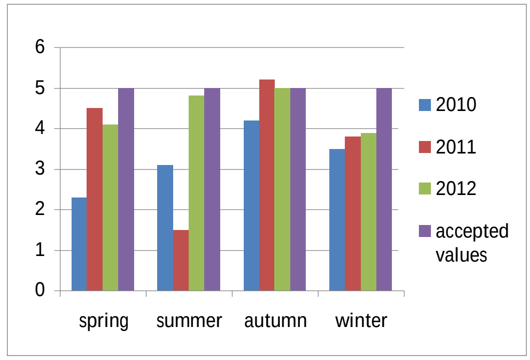

Fig.14.Values of total phosphorus content of waste water after treatment

The highest values of total phosphorus content of waste water before treatment were recorded in winter season. The highest value was reached in the winter of 2010 (425mg / l). This may be due to excessive use of cleaning agents and disinfectants rich in phosphorus (phosphoric acid) or milk has a high content of nutrients rich in phosphorus.

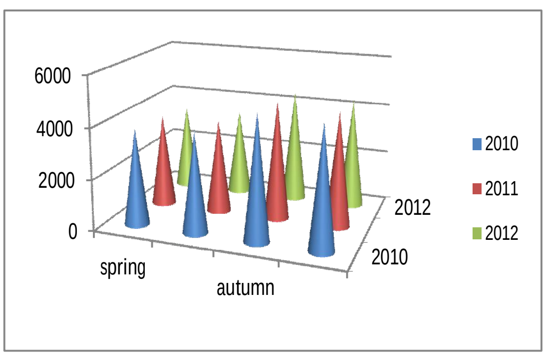

Fig.15 Values of oils and fats content from waste water before treatment

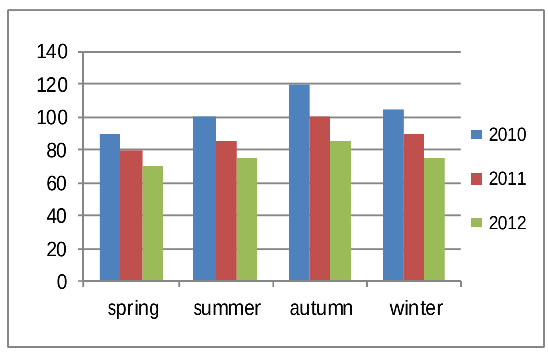

Fig. 16. Values of oil and fats content from waste water after treatment

The highest values of oil and fats content from wastewater before treatment, were recorded in autumn and winter seasons. The highest value was reached in autumn 2010 (4900 mg / l), Figure 15. This is due to the high content of milk fat in autumn and winter. After wastewater treatment it was a slight excess of allowed limit value (100 mg / l) in autumn and winter seasons of 2010 (120 mg / l and 105 mg / l) Figure 16.

4. Conclusions

After performing this study the conclusions were that wastewater parameters analyzed before treatment far exceed the limit values allowed by the rules in force, which now oblige in taking measures to reduce their values. The values of parameters analyzed after treatment plant proves its effectiveness and the fact that wastewater discharged into the city sewer system is adequate.

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