ANALYSIS OF WASTEWATER COMPOSITION OF SAMARKAND DAIRY PLANT

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Annotation: This article provides an analysis of literary sources, a study of the process of purification of wastewater from the Samarkand small-scale industrial complex from organic pollution and the specific norms of wastewater disposal at a dairy enterprise, that is, in m3 for processed milk. In addition, the need for oxygen for the oxidation of organic substances was determined depending on the composition of milk and the composition of the waste water of a dairy plant.

Keywords: wastewater, dairy plant, pollution concentration, wastewater disposal, wastewater flow, pollution, oxidation, organic matter, suspended solids.

Wastewater from the dairy industry is classified as highly concentrated in terms of organic pollutants. Usually, enterprises are located in residential areas and wastewater from these enterprises is received in the municipal sewerage system. By existing standards, they must be subjected to local (preliminary) treatment on the territory of the enterprise. As a rule, treatment is limited to reducing the concentration of suspended solids and fats. This protects sewage networks from clogging and the ability to extract valuable substances from the wastewater for disposal, such as fats, proteins, and impurities that complicate the subsequent biological treatment of the entire plant and municipal sewage. If the enterprise is located outside the settlement, it is required to install an independent, enterprise owned biological wastewater treatment plant.

The enterprises use drinking quality water for technological and domestic purposes, contaminated water is removed into the sewage system and then subjected to appropriate treatment, after which it is discharged into either the city sewage system or a water body. Recycling systems at food enterprises are arranged only for cooling compressors of refrigeration machines and other units.

Thus, there is a problem with designing sewage and wastewater treatment plants for meat and dairy plants in different conditions of their dislocation in relation to settlements.

The main goal of the ongoing economic reforms in the country is the fullest satisfaction of the material and spiritual needs of the people. For the period of reforms, putting forward a broad program of social development of the country and increasing people's well-being, the task of improving the supply of the population with food was put at the forefront. The reform program provides for the wide use of the potential of our country's agriculture and all sectors of the agro-industrial complex. [1,4]

In order to significantly increase food production, we are taking measures to increase the volume of milk processing and improve the range and quality of dairy products. The implementation of these measures is connected with the realization of tasks of the agro-industrial complex and technical re-equipment of the food industry, including the dairy industry.

Technical re-equipment of the dairy industry provides for the use of high-performance technological equipment, manufacturing of sets of machines, devices and flow technological lines, ensuring an increase in labor productivity, mastering of new technological equipment and automated lines for milk bottling and equipment for packaging of dairy products.

The dairy industry has modern, highly productive equipment, including flow-mechanized and automated lines. New types of whole-milk products, cheeses, ice cream, canned milk, butter, baby food products, and whole-milk substitutes for young farm animals have been mastered. Recently, special attention has been paid to integrated milk processing and its rational use by processing skimmed milk, buttermilk and whey into various food products.

Specific wastewater consumption rates. Specific norms of water consumption and wastewater disposal for enterprises of different profiles and productivity of the dairy industry are given in Table 1. The norms given in Table 1 are valid for enterprises with modern equipment and the maximum possible degree of reuse and recycling of water in production. Actual specific consumption of consumed water and discharged wastewater at dairy plants, where there is no strict control over water consumption, insufficient degree of water reuse and recycling often exceed the normative values. The coefficients of irregularity of wastewater discharge vary depending on the capacity of the enterprise within 1.4-2.

Wastewater composition. Industrial contaminated wastewater in dairy plants is formed mainly in the process of washing equipment, containers, and cleaning production facilities. These effluents are polluted by losses of milk and dairy products, production wastes, reagents used during equipment washing, and impurities washed off from the surfaces of containers, floors, transport, etc. To reduce the number of pollutants discharged by the plant with wastewater, the technological process shall include measures to reduce losses of raw materials and products, collection and utilization of whey (by its thickening, drying, processing into milk sugar or sale as feed), collection and separation of first portions of water received from rinsing the technological equipment for the production of high-fat products, circulation and regeneration of washing solutions, etc. The number of pollutants in wastewater can be determined based on the norms of raw material losses, dairy products and specific wastewater consumption (see Table 1).

Table 1.

Specific water and **wastewater consumption rates for the Samarkand Dairy Plant (in m^3 per 1 tonne of milk processed)**

Samarkand Dairy Plant	Specific water consumption			Specific wastewater flow rate			Non-recoverable water consumption and losses
	Reverse, repeatedly used	Fresh from the spring		total	production	domestic	
		For production purposes	For household needs				
Milk collection stations and separator units City dairy plant capacity, tonnes per day	0	2,2	0,1	2	1,9	0,1	0,3
Up to 50 Over 50 to 200	30 30,5	6,3 5,8	0,7 0,7	5,6 5,2	4,9 4,5	0,7 0,7	1,4 1,3
Condensed milk product plants with a capacity, tubes per shift							
up to 60 (180 tonnes of	25	5,2	0,3	4,4	4,1	0,3	1,1

milk per day)							
over 60 (180 tonnes of milk per day)	25,5	4,7	0,2	4	3,7	0,3	1
Dairy dry product combines (whole and skimmed milk, CKD), butter plants with drying facilities with a daily capacity, tonnes per day							
Up to 300	20	4,7	0,3	4	3,7	0,3	1
Milk processing plants for children's products Butter factories with capacity, tonnes per day	20	3,3	0,2	3	2,8	0,2	0,5
Up to 50 Over 50 to 200	21 21,5	2,8 2,3	0,2 0,2	2,6 2,1	2,4 1,9	0,2 0,2	0,4 0,4
Butter and cheese factories producing t/day Up to 50 Over 50 to 200 Cheese factories with production capacity, tonnes per day Up to 50 Over 50 to 200	20 20,5 19 19,5	4,6 4, 2 6,5 5,6	0,4 0,3 0,5 0,4	4,3 3, 8 6 5 4,3	3,9 3,5 5,5 4,6	0,4 0,3 0,5 0,4	0,7 0,7 1 1

The concentration of pollutants in the wastewater is calculated using the formula

$$C=(N_1\,C+N_{12}\,C_2+...+N\,C_{nn})/(N_1+N_2+...+N)_{,n} \qquad (1)$$

where C is the concentration of wastewater pollution, g/m^3; P_1 P_2, P_n are losses of milk and dairy products in various technological production cycles, fractions of a unit; C_1 C_2, C_n is the specific amount of pollution per unit of milk and dairy product losses, g/t; N_1; N_2; N_n is the specific wastewater consumption per unit of milk and dairy products, m /t.^{3}

The amount of COD* and BOD contamination$_{поли}$ of milk and dairy products is determined by Table 2. Knowing the losses of milk and dairy products in the plant and using the data in Table 2, the concentration of these pollutants in the wastewater can be determined by the formula.

Table 2.

Oxygen demand for oxidation of organic matter depending on the composition of milk and dairy products

Product	Dry matter %	Fat, %	Protein, %	Lactose, %	COD, kg/t	BOD$_{полн}$, kg/t

Whole milk	11,5-12,5	3-4	3,3	4,8	192,9-218,6	135,5-156,2
skim	8,3-8,47	0,02-0,06	3,3	4,7-4,9	112-115,3	72,4-75,1
Buttermilk	7,7-8,0	0,4-0,86	1	4,5-4,7	72-77	51,6-55,9
Serum	6-6,2	0,1-0,2	1	4,5-4,7	72-77	51,6-55-9
Creamer	40,4-43	33,35	2	4,7-3	871-936,5	695-747

When calculating wastewater pollution concentrations using the formula, additional pollution from spent cleaning solutions, product additives, etc., entering the sewer system must be taken into account. Actual concentrations of wastewater pollution at dairy enterprises vary widely and depend on the profile and capacity of the enterprise, production technology, type of equipment used, degree of reuse and recycling of uncontaminated wastewater, raw material losses, disposal of production wastes, etc. The obtained data on the composition of wastewater of dairy enterprises of various profiles are shown in Table 3. The temperature of wastewater of the dairy industry enterprises varies from 16 to 33°C. High temperature of waste water is caused by the use of hot water for washing equipment and cleaning of premises. The average monthly temperature of wastewater discharged by dairies is 17-18°C in winter and 22-25°C in summer. The pH value of wastewater is largely determined by the production technology and the range of products produced. For productions not connected with lactic-acid fermentation processes, the pH of effluent [2,3].

Table 3.

Composition of wastewater from the dairy industry

Businesses	Suspended matter, mg/l	COD, (mg/l)	$BOD_{полн}$, mg/l	Fats, mg/l	Chlorides, mg/l	Total nitrogen, mg/l	Phosphorus, mg/l	pH
City dairy plants	350	1400	1200	Up to 100	150	60	8	6,5-5,5
Dry and condensed milk	350	1200	100	Up to 100	150	50	7	6,8-7,4
Cheese-making plants smoke	600	3000	2400	Up to 100	200	90	16	6,2-7

Is close to neutral (6.8-7.4 for canneries, butter factories). In cheese factories, city dairies and other enterprises producing curd and sour milk products, a certain amount of whey is discharged into the sewage system, which causes the pH of the wastewater to drop to 6.2.

Fluctuations in the pH of the effluent are often also caused by the discharge of acid containing and alkaline reagents used in equipment washing. A sharp short-term increase in the pH of the total effluent up to 10-10.5 can be explained by the salvo discharge of alkaline washing solutions, which are mainly used in dairies.

Prolonged presence of wastewater under anaerobic conditions (in sewers, lagoons) causes the liquid to sour due to lactic acid fermentation and leads to a drop in pH.

Suspended solids in dairy wastewater are particles of solid milk products (pieces of curd, milk film, cheese grains, etc.) and other impurities (soil, sand) that enter the sewage system during washing of processing equipment, containers, premises.

The main part of the suspended matter (up to 90 %) is organic matter, usually of protein origin. The concentration of suspended solids varies widely depending on the production cycle. Fluctuations in suspended solids concentrations in the wastewater of dairies are also observed by hours of the day; the greatest amount of suspended solids is received during the initial period of equipment washing. Values of COD and BOD of waste water of dairy plants also vary widely and on the average for urban milk plants are 1400 and 1200 mg/l, respectively ; for cheese factories - 3000 and 2400 mg/l. It was established that between indices of COD and $BOD_{полп}$ (fig. 1) for sewage water of dairy plants there is a direct correlation BODpoln = (0,80-0,84) COD. Using this relationship based on COD value (which analytical determination takes 2-3 hours) we can roughly calculate BODpd of waste water of any dairy plant that greatly facilitates the analysis of waste water composition and monitoring of sewage treatment plants. It should be noted that there is no clear relationship between BOD5 and $BOD_{полн}$, as well as between BOD and COD, therefore, the value of BOD for wastewater of dairy plants is not an objective indicator of wastewater pollution.

The fat content in wastewater from dairy plants is mainly determined by the range of products produced and the production technology. Depending on these factors, not only the concentration of fat in the effluent but also the type of contamination varies. Wastewater from whole-milk production contains fat in the same form as natural milk, as milk wastage is the main contaminant in these wastewaters. Milk fats are tiny globules surrounded by a hydrated protein shell, which float up extremely slowly when the wastewater settles.

The production of high-fat products (cream, sour cream, butter) extracts large fat globules from milk, causing them to stick together and enlarge, as well as destroying the protein shell. Therefore, fat impurities contained in wastewater from such production facilities differ significantly in type and concentration from similar contaminants in wastewater from other dairies. The separation of fatty impurities from the effluent from high-fat production, for example by sedimentation of the liquid, is much faster and more efficient than from the effluent from other industries.

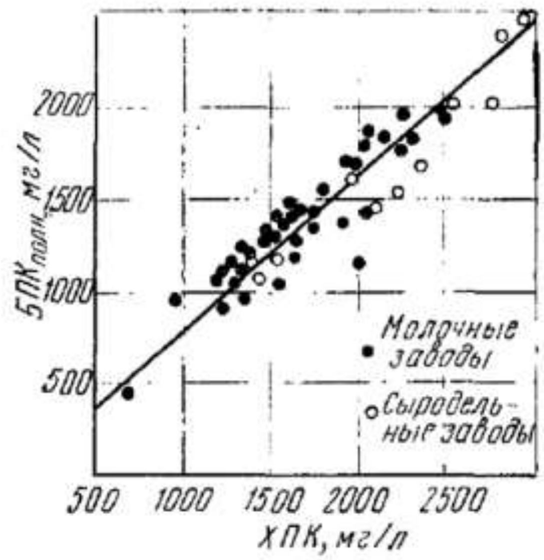
In sanitary wastewater analysis, the content of fats and fat-like substances extracted with ether or chloroform is determined. The concentration of extractable substances in wastewater from plants and workshops specialized in the production of high-fat products is 200-400 mg/l, in wastewater from other types of production usually does not exceed 100 mg/l.

In wastewater from dairies, nitrogen is mainly in the form of amino groups of protein compounds. Nitrogen from ammonium salts from ammonia compressors also enters the effluent in small quantities. The content of total nitrogen in wastewater of municipal dairy plants, milk canneries, butter plants is 50-60 mg/l, or 4.2-6% of $BOD_{полт}$ cheese factories - 90 mg/l, or 3.7% of BOD. Phosphorus concentration is 0.6-0.7% of $BOD_{полт}$.

Concentrations of salts of nitrogen and phosphorus are sufficient for the normal course of the biological treatment of wastewater from dairy plants and the growth of bacteria involved in the oxidation of pollutants in these effluents. In the biological treatment of wastewater from cheese factories nitrification processes are less intense than in the treatment of wastewater from other dairy enterprises, due to the lower content of nitrogen salts in relation to BOD.

The presence of chlorides in wastewater from dairies is due to the use of table salt in production, the ingress of cooling brines into the sewage system, and the presence of chlorides in fresh water, milk and washing solutions. Chloride concentrations in wastewater from dairies reach 800-1000 mg/l and average 150-200 mg/l. A sufficiently high chloride content makes it possible to apply electroflotation and electrocoagulation methods for wastewater treatment in dairies.

Figure 1. Relationship between $BOD_{полн}$ and COD of wastewater from dairy plants



Conclusions:

The analysis of literature sources in the study of wastewater treatment process of dairy plant from organic pollutants is given, specific norms of water consumption and water disposal at Samarkand dairy plant, i.e. in m^3 per 1 m of processed milk are determined. In addition, it was determined that there is a direct correlation between $COD_{полн}$ and $BOD_{полн}$, $BOD_{полн}$ =(0.8÷0.82)COD.

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