

The impact of the factors of oil-containing wastewater formation of Bezenchuk oil extraction plant

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Abstract. Currently, there is a boom of oil and fat industry enterprises. The article studies regularities of changes in wastewater composition, processes of wastewater formation of Bezenchuk oil extraction plant, as well as wastewater chemical and physical parameters.

Waste water of industrial enterprises contains a large amount of organic contaminants: hydrocarbon oils, vegetable and animal fats, surfactants, etc. High contaminants concentration at the enterprises makes the treatment difficult being a complex technical and scientific task. Wastewater treatment problem in food industry is largely related to the extraction of fats. Flotation methods of cleaning with the use of reagents are considered; their advantages and disadvantages are revealed.

1. Introduction

Food and processing industry is one of the strategic sectors of economy, providing a sustainable supply of population with necessary quality food. Modern food production has a negative impact on the environment. A large number of industries in large settlements influence living conditions and health of the population.

Vegetable oil production is a dynamically developing branch of food industry. In Russia, the processing of oilseeds is carried out by 59 enterprises of large and medium capacity, as well as about 1200 low-capacity plants, which is about 20 % of the total oilseeds volume of [1,3]. Oil and fat industry enterprises include oil extraction, hydrogenation, and margarine plants.

Wastewater consumption and composition of oil and fat industry enterprises are determined by the products volume and range, as well as the production technology. Wastewater consumption and composition depend on water supply system. Plants water supply is carried out from city or plant water pipes. The water used for technological needs of the enterprise is to correspond to drinking water quality. Technical water is used for cooling of vacuum equipment and compressors of refrigerating installations, as well as for external car washing and territory watering.

At the enterprises of oil and fat industry there are two types of industrial wastewater: contaminated and uncontaminated water. Contaminated wastewater is formed after washing equipment, process pipelines, road and railway tanks, flasks, glass containers, floors and panels of industrial premises. Uncontaminated wastewater is formed after the equipment cooling and, as a rule, is sent to the recycling water supply system or reused for washing equipment, containers and for other purposes.



At the enterprises of oil and fat industry wastewaters are formed due to crude oils and fats washing so there is great pollution of organic and mineral substances in the form of suspensions, emulsions, colloidal systems and molecular solutions.

Fats in wastewater can be of three aggregate states-solid, liquid and colloidal. Depending on the formation conditions and wastewater composition, fats can be in the form of fat phase forming a film on the surface of the liquid, dispersed particles in water (emulsion) and dissolved state [2]. Most often there are all three states of fat complicating the determination of its concentration.

Depending on the type of processed fat raw materials, the method of processing, certain conditions for the implementation of technological operations (temperature, pressure, oxidation, reagents, etc.) in wastewater there may be different types of fatty substances (glycerides, fatty acids, soaps), their accompanying substances (proteins, carbohydrates, glycolipids, phosphatides, free fatty acids, unsaponifiable lipids) and the products of changes present in fat raw lipids and other substances [2].

2. The impact of the of oil-containing wastewater formation

The research object is oil extraction plant of JSC "Samaraagroprompererabotka", Bezenchuk. Oil extraction plants are specialized enterprises or workshops in oil and fat plants for oilseeds processing.

Oil and fat plants produce multiple technological operations, after which various types of pollution is formed, so waste water of oil extraction production includes fatty substances, as well as gasoline, meal, phosphatides, soap, alkali, and other related substances.

Waste water is formed from water separators and sludge evaporators of the extraction section, from shop grease traps, sections of hydration, refining and packaging of oils [4,7].

In the oil press shop, waste water is formed from the press purification and extraction oil on separators, and waste water is formed from the condensation of water vapor in condensers and water separators. Gasoline vapors coming out of the sludge evaporator with water are sent to the condenser and then to the water separator. The water separator also receives waste water with a high content of gasoline from screw evaporators, distillation from meal and micelles in distillers. Waste water from water separators is sent to sludge evaporators (recuperates) to reduce the content of gasoline, after which they are discharged into the yard gasoline trap, table 1.

Table 1. The average annual amount of waste water per 1 ton of processed seeds

Water supply system	The amount of waste water per 1 ton of treated seeds (m3)
circulating	1.50
direct-flow	1.63
industrial	0.48
household	1.13

The sources of wastewater generation are as follows: wet meal, cooling and condensation of vapor-gas mixture in barometric condensers, oil washing, filter press washing, washing equipment and containers, laboratories.

At the enterprises of oil and fat industry water is also used for washing of technological equipment, pipelines, containers (tanks, flasks, bottles, etc.), washing of floors, panels of industrial premises, for work of technological and steam power installations, as well as for household needs.

3. The composition of wastewater pollution of the oil extraction plant

The wastewater of oil and fat industry is muddy, gray with a flocculent suspension. The stocks of plants for refining vegetable fats for the production of edible oils consist mainly of emulsions of contaminated fats, stabilized soaps obtained from fats and fatty acids [5]. The average value of BOD is 200-2695 mg / l, sulfates 80 mg / l. Organic and nitrogen-containing substances in drains rot easily. The active reaction of the medium is pH-6.7, BOD₅ is from 334 to 520 mg / l, fat content from 256 to 396 mg / l. In addition,

organic acids and nitrogen-containing substances are present in wastewater. They rot after neutralization forming hydrogen sulfide from decomposing of proteins and reducing sulfates. The wastewater smell is unpleasant, oxidation is low: 49-354 mg / l. The dry residue is 44-5000 mg / l, table 2.

Table 2. Wastewater pollution indicators

Waste water type	Fat Content (mg / L)	BOD ₅	COD
First line buffer water	3000-3400	6800-7000	7000-7150
Final Buffer Water	1050	2280	2330
After wastewater from drying the extraction oil	10	20	24

Acidic fermentation is associated with the presence of a large amount of organic compounds in the effluents that are decomposed rapidly, resulting in rotting. Unfavorable indicators of fat industry enterprises wastewater are BOD and a large amount of fats and suspensions content [6].

Preliminary treatment is necessary before the wastewater is discharged into the sewer. It consists in fat release and removal with the help of grease traps arranged like oil traps.

The composition of wastewater pollution after passing through the grease traps at the enterprises of the margarine industry at a temperature of 30 - 35 ° C is as follows: pH 7.1-7.8; suspended substances from 260 to 790 mg / l; BOD₃ 400 - 1600 mg / l. The indicators of incoming wastewater by controlled indicators are shown in table 3.

Table 3. Indicators of incoming wastewater of an oil extraction plant
JSC Samaraagroprompererabotka, Bezenchuk, mg / dm³

Parameter	Value
Suspended substances	180±9.1
BOD	8.60±0.12
Synthetic surfactants	0.017±0.006
Nitra ion	2.35±0.71
Ammonium ion	3.63±0.76
Nitrite ion	0.38±0.023
Phosphates on phosphorus	0.28±0.042
Chloride ion	950.08±39.70
Overall iron	0.78±0.23
Nickel	<0.08
Copper	0.0022±0.0012
Chromium	<0.01
Oil products	0.42±0.147
Phenol	0.002±0.001
Fats	400.2±7.4

4. Oil and fat wastewater treatment

An integral part of the sanitary systems of each enterprise is engineering facilities for the collection and disposal of contaminated treated water from the enterprise including wastewater treatment and extraction of valuable substances and impurities, as well as disinfection and neutralization.

The technology of the extraction process should ensure the absence of gasoline in wastewater. Otherwise, this will lead to a significant increase in cleaning equipment cost.

Since oil and fat industry wastewater is a dispersed system of emulsified organic substances it is necessary to create conditions that violate the stability of these systems. As a rule, the use of one of the

destruction methods of a disperse system is not enough; therefore, in practice it is advisable to use a combined cleaning method.

Contaminated wastewater is treated with domestic wastewater or wastewater of other enterprises. Self-treatment is carried out only in the absence of technical feasibility or economic feasibility of conveying to sewerage system.

Special attention in wastewater treatment should be paid to the release of valuable food components from the washout water, which at the stage of decomposition, emit highly toxic products.

Application of flotation methods of sewage treatment of oil and fat industry enterprises showed that the flotation without the addition of coagulants is ineffective, as it allows to reduce the concentration of fats only by 50-60%, COD by 35-45%, and suspended solids by 40-50%.

When aluminum sulfate or ferric chloride dose of 100 mg/l (anhydrous salt) per 1000 mg / l pollution COD at pH=6.7 purification is used as coagulants the efficiency for suspended solids is 75-80%, fat 80-90%, TBod 60-70%. However, due to high reagent dose, the complexity of the reagent economy and the large volume of sediment (up to 10% of the amount of wastewater), the reagent pressure flotation according to the authors of the handbook is not reasonable [3]. Moreover, the flotation sludge after reagent treatment contains a significant amount of metal ions, which can inhibit the subsequent process of aerobic stabilization, respectively complicating the dehydration of the flotation sludge and increasing the cost of liquid waste removal. Therefore, reagent-free flotation is preferred.

It is also experimentally proved that in schemes with further biological treatment, the use of reagent flotation leads to a sharp decrease in phosphates in wastewater, which prevents the normal flow of biological treatment processes.

However, reagent pretreatment of wastewater of oil and fat production is widely used, and research is aimed at choosing the optimal reagents and their doses.

In the operation practice of wastewater treatment facilities of oil and fat plants, aluminosilicon coagulants-flocculants treatment, modified and unmodified flocculants, biflocculants and coagulants based on agricultural waste is also applied [6].

5. Conclusion

1. Depending on the composition of fat and related substances, various physicochemical processes occur in fat-containing wastewater
2. In the wastewater treatment scheme of oil and fat processing enterprises, the separate treatment of fat-containing and not fatty wastes is mandatory. Preliminary treatment is obligatory before discharging the wastewater into the sewer.
3. The use of reagent flotation leads to a sharp decrease in phosphates in wastewater. It prevents the normal flow of biological treatment processes. However, reagent pretreatment of wastewater oil and fat production is widely used, and research is aimed at choosing the optimal reagents and their doses.

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