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Analysis of the Effectiveness of Using Flocculants to Improve the Operation of Wastewater Treatment Plants

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Abstract

Solving environmental problems related to environmental pollution by wastewater requires improving methods and facilities for its treatment. One of the methods to improve the efficiency of wastewater treatment plants is the use of synthetic flocculants. The article analyzes the use of various types of flocculants, providing technological and economic efficiency of wastewater treatment.

Keywords: wastewater, coagulants, flocculants, oil products, technology, polyacrylamide flocculants, transport enterprises, flocculant dosage, treatment efficiency.

Natural and waste water treatment is closely connected with environmental protection and is an urgent problem of our time. In recent decades, a significant increase in the content of heavy metals, petroleum products, hard-to-oxidize organic compounds, synthetic surfactants, pesticides and other contaminants in the waters of open water bodies has been noted due to the discharge of insufficiently treated wastewater by industrial and municipal enterprises. Despite a large number of developments reflected in the literature [1-2], the problem of natural and waste water treatment cannot be considered as solved. This causes the need to improve water treatment technology, which depends significantly on the intensification of reagent and, in particular, flocculation treatment. For these purposes water-soluble high-molecular compounds are used, among which the most widespread and universal are polyacrylamide flocculants [1,3]. Their application results in removal efficiency of heavy metals up to 95 %, phosphorus compounds up to 90 %, suspended solids up to 80 %, organic substances up to 75 % [4]. In addition, flocculation water treatment is characterized by low capital and operating costs compared to other methods of water treatment [1]. Wastewater treatment is significantly influenced by the nature and concentration of contaminants, technological parameters of flocculation and molecular characteristics of organic flocculants [3, 4, 19, 54]. However, the flocculation properties of polyacrylamide flocculants in wastewater treatment have not been sufficiently studied. The main technological problems of flocculation treatment of industrial wastewater include the need to select the most effective flocculant and the creation of an optimal technological regime of its use. Insufficient study of the influence of various factors on the choice of flocculant and parameters of flocculation treatment of real wastewater, the lack of priority criteria and methodology for selecting an effective flocculant creates difficulties in optimizing the process, requires long and time-consuming research using a large number of samples of flocculants, which cannot always lead to an optimal technical solution. The problem of creating an optimal regime for the effective use of flocculants is also due to the unpreparedness of treatment plants, which are designed to use traditional inorganic coagulants. New synthetic flocculants have significantly different physical and flocculation properties, which require the use of special equipment for dissolving flocculants, creating optimal mixing regimes, flocculation. The solution to this problem is possible by upgrading the existing treatment

equipment, which generally does not require large capital expenditures. Proof of this is the introduction of flocculation technology for wastewater treatment in an oil refinery (inputs using powder flocculant Praestol 852 instead of previously used sulfuric acid aluminum (1). This required a small re-equipment of the reagent facilities.

Economic problems, on which largely depends the introduction of flocculation technologies in the practice of wastewater treatment, due to the high cost of flocculants compared with mineral coagulants, which is a deterrent to the introduction of flocculants as independent reagents.

However, given that the doses of flocculants are 30-50 times lower than doses of mineral coagulants, the economic advantages of the flocculation method are obvious even when comparing the costs of reagents (1). The environmental safety of flocculant application, evaluated by the increase in the degree of purification, reduction of the amount of secondary pollution entering the treated wastewater with the reagents, and the amount of waste generated, can also serve as a clear confirmation of the advantages of flocculation technology. The main polluting component of the dispersed phase of wastewater containing emulsified impurities is oil products. The content of petroleum products in wastewater treated with coagulants and flocculants is usually not more than 250 mg/l. The most typical representative of oily wastewater of this group is wastewater of enterprises of all types of transport. The results of studies [1-4] show that the use of flocculants of different chemical nature is effective for wastewater treatment. The treatment effect and optimum doses depending on the charge (the number of ionogenic groups) and molecular weight are 75-96% and 0.5-7 mg/l, respectively. High molecular weight anionic flocculants (PAAN) with a dosage of 0.5-1 mg/l can also be used for wastewater treatment of transport enterprises. The cleaning effect is 93-94% (Fig. 1). The possibility of using flocculants of different charge and the observed different dependences of efficiency of cleaning of negatively charged dispersed particles of pollution on the content of ionogenic groups in macromolecules of flocculants probably results from unstable and multi-component chemical composition of waste water (5-6).

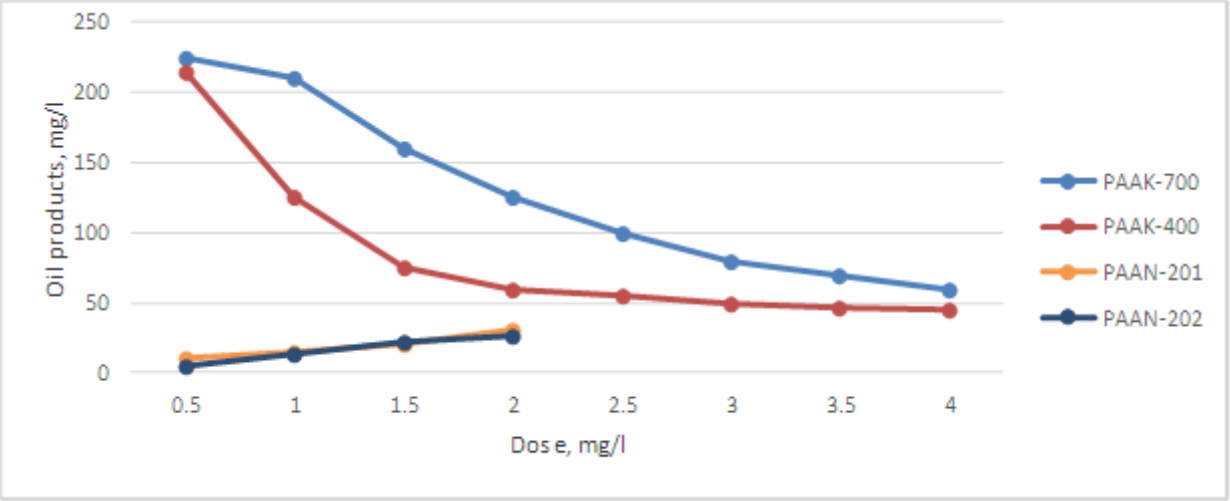

Fig. 1. Dependence of petroleum product content in treated wastewater on the dose of flocculants (C = 234 mg/l)

During the treatment of oily wastewater with the use of commercial flocculants of different companies it was shown that among the tested flocculants the most effective were high-molecular cationic flocculants Praestol 852 and K 1020, which provide approximately the same degree of wastewater treatment at a dose of 3 mg/l. The content of petroleum products in -treated water is 9-11 mg/l with the initial concentration of petroleum products 42-150 mg/l. The low-molecular-

weight strongly basic cationic flocculant VPK 402 has a lower efficiency. The residual content of petroleum products was 15 mg/l (Fig. 2-3).

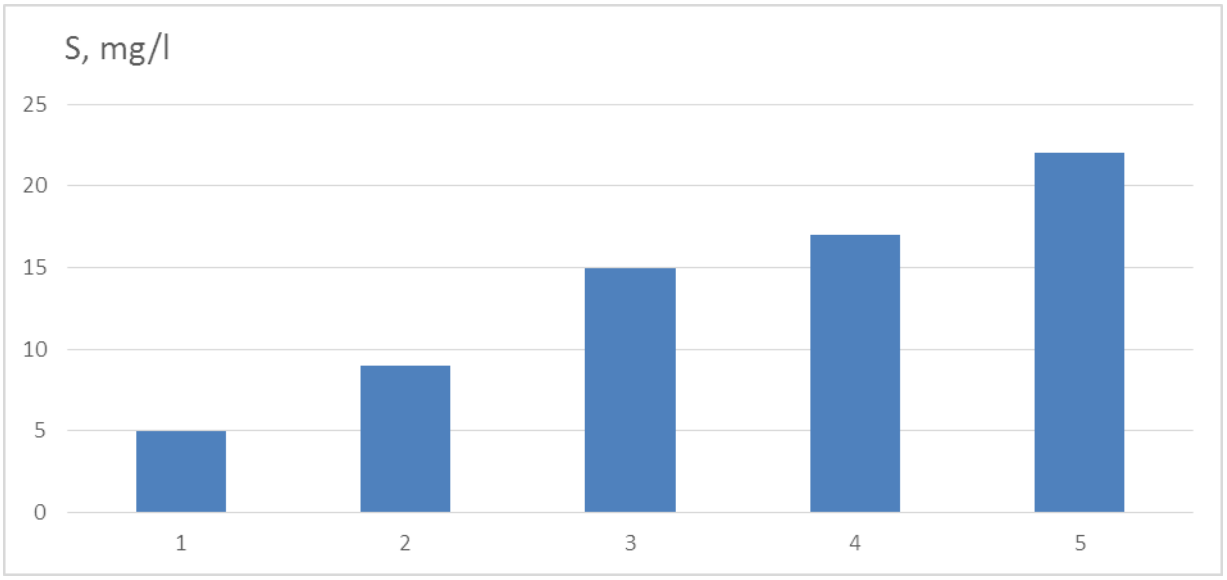

Fig. 2. Dependence of suspended solids concentration in treated water on the type of flocculant at the content in the initial flow 82 mg/l. Flocculants: 1 - Praestol 852, 2 - K-1020, 3 - VPK-402,4 - Zetag 7664, 5 - Zetag 7689.

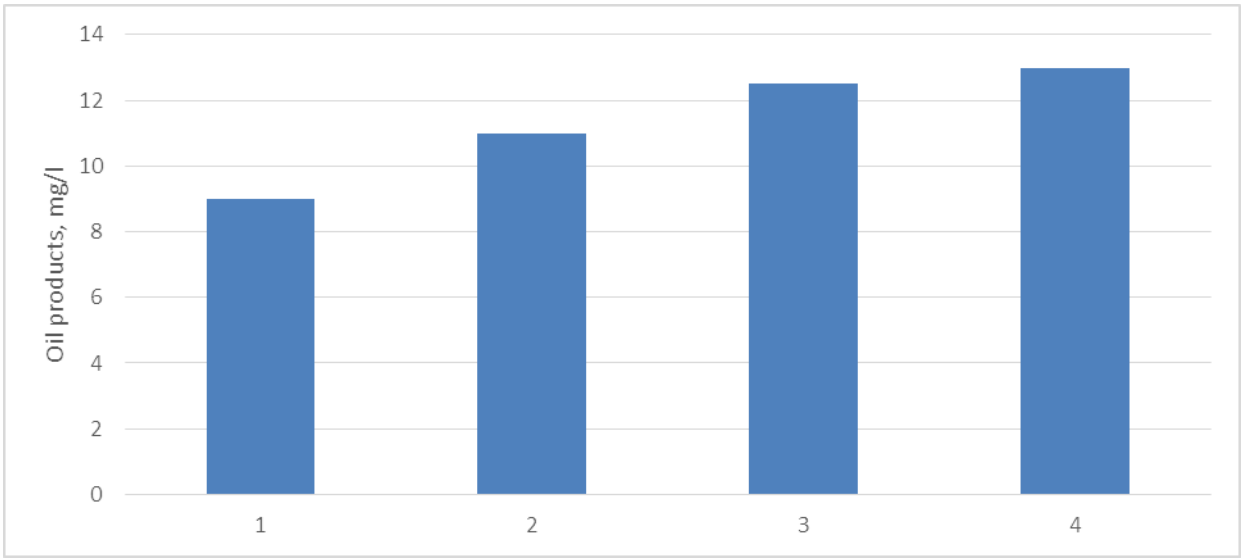

Fig. 3. Dependence of the concentration of petroleum products in treated water on type of reagent at their initial concentration of 150 mg/l. 1 - Praestol 852, 2 - K 1020, 3 - Zetag 7689,4 - Zetag 7664.

The efficiency of petroleum product treatment depends on the composition of the effluent water. As the content of the dispersed phase increases, there is a tendency to with the increase in the content of the dispersed phase, there is a tendency for increasing the dose of flocculants, regardless of their characteristics (7-9). The lack of a clear dependence of flocculant dosage on the concentration of suspended solids in the absence of a clear dependence of the flocculant aid dosage on the suspended solids concentration in the wastewater may be a consequence of the side effects of dissolved organic impurities in water and heterogeneity of the dispersed phase. Specific consumption of flocculants decreases, as shown by the example of using flocculant VPK-402 (Fig. 4).

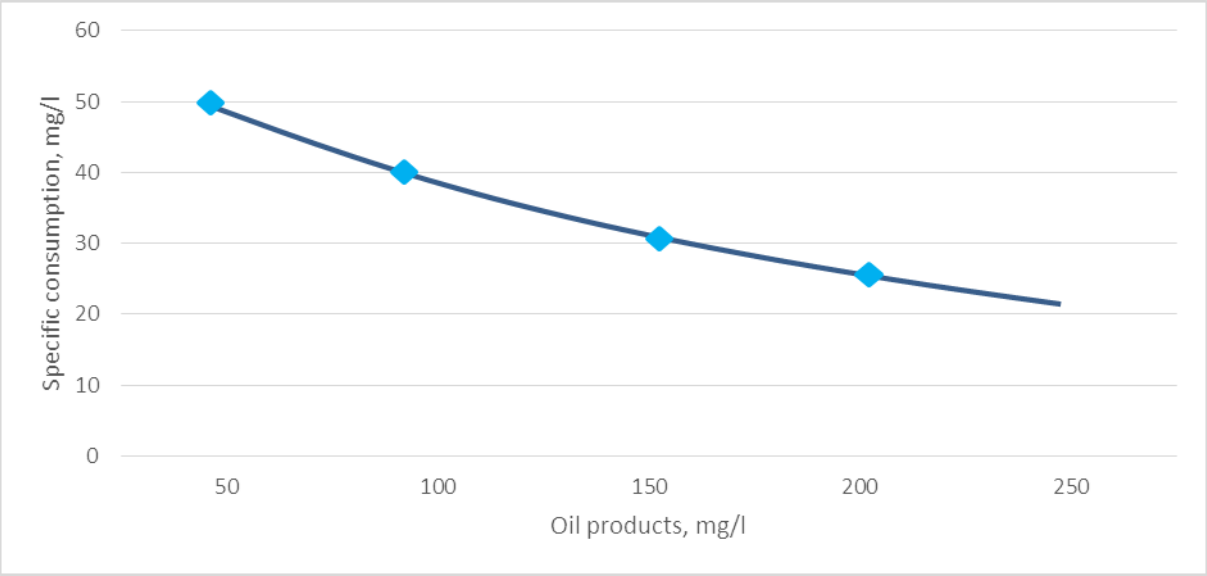

Fig. 4. Dependence of specific consumption of flocculant VPK 402 on the content of petroleum products in the waste water of the refinery.

Application of cationic flocculant Praestol in flotation treatment of waste water containing oil products will completely abandon the use of aluminum sulfate and thereby eliminate corrosion of pipelines and equipment. Mass introduction of flocculants at all stages of the technological process of wastewater treatment will increase the efficiency, reliability and stability of operation of treatment facilities with a reduction of their dimensional characteristics and minimization of capital and operating costs.

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