Promising Methods for Treating Colored Wastewater in Light Industry Enterprises

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***Abstract:** The textile industry is one of the most water-intensive sectors of the economy. A large amount of water is consumed in the technological processes of washing, dyeing, printing and finishing fabrics. As a result of the implementation of these processes, wastewater of complex composition is formed, containing mainly dyes, surface-active substances (surfactants), mineral salts and other impurities. The discharge of effluents into water bodies without bringing their composition to the accepted sanitary standards is unacceptable. The cleaning methods that currently exist in the textile industry, such as adsorption, flotation, coagulation, zonation, etc., require large capital and operating costs and do not always provide the desired effect. Most of the methods practically do not allow preserving or trapping useful components from wastewater for reuse, therefore, recently both in Uzbekistan and abroad extensive research is being carried out and new physicochemical methods for treating wastewater are being developed, among which reverse osmosis occupies a special place and ultrafiltration.*

***Keywords:** surfactants - surface-active substances, DM - dynamic membranes, MOD - membrane forming additives, NF - dispersant, Hyper filtration - reverse osmosis, Na-CMC-sodium carboxyl methyl cellulose.*

I. INTRODUCTION

Light industry is one of the largest consumers of water. At the enterprises of the textile industry, the bulk of the water is consumed in dyeing and finishing. The high water consumption per unit of output, the consumption of chemical reagents, the complex composition of wastewater, and the high demands on the quality of the water used make it an extremely difficult task to treat wastewater from light industry enterprises. One way to solve this problem is to reuse residual dye solutions, reduce the consumption of chemical reagents, improve the flushing system of processed materials, create local in-plant wastewater treatment systems that facilitate the transition to closed water consumption systems. The traditional methods of purification currently existing at light industry enterprises, for example, such as adsorption, flotation, coagulation, zonation, electrochemical purification, etc., require large capital and operating costs and, in addition, do not always provide the necessary water for recycling cleaning effect. Therefore, currently in Uzbekistan and abroad, extensive research is being conducted and new physicochemical methods for treating wastewater are being developed, among which reverse osmosis and ultrafiltration occupy a special place. The results of laboratory research and testing of experimental and semi-industrial installations show the promise of using reverse osmosis and ultrafiltration for water treatment and light industry enterprises. One of the main reasons slowing down the widespread introduction of reverse osmosis and ultrafiltration in this industry is the lack of high-performance, aggressive, heat-resistant membranes. At present, a way has been outlined to overcome these difficulties through the use of dynamic membranes, which have several advantages over existing reverse osmotic and ultra-filtration membranes. The permeability of dynamic membranes (DM) can be 1-2 orders of magnitude higher than the permeability of polymer membranes. In addition, the service life of the DM is almost unlimited. The membrane has semi-permeable properties all the time, while in the shared solution there are impurities of the dispersed material. One of the main advantages of DM over static membranes is their regenerability, i.e. in case of slight mechanical damage, self-healing of the membrane is possible due to the formation of a new layer on the substrate during the filtering process; resistance to the effects of a shared medium, since they are formed from a membrane-forming component, specially introduced, or located in the solution itself; there is no need for thorough pretreatment of water. Using DM to create closed systems for processing light effluents can provide high selectivity and water permeability of membranes, their durability, and stability over a long period of operation.

II. METHOD AND MATERIALS

In this regard, to solve the problem of wastewater treatment of dyeing shops of textile production by the method of membrane filtration, it is necessary to solve the following main issues; selection and justification of the appropriateness of using a membrane-forming additive (MOD) for the formation of DM in membrane filtration of wastewater of dyeing and finishing production through cellulose acetate filters, determining the optimal conditions for the formation of DM from MOD on cellulose acetate membrane substrates, studying the influence of technological parameters on the efficiency of wastewater treatment from surfactants and dyes using DM; development of possible schemes for membrane treatment of wastewater from the dyeing industry and their feasibility study.

Revised Manuscript Received on March 30, 2020.
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At light industry enterprises, water is used as a solvent (for the preparation of dyeing, bleaching finishing solutions and washing materials after their processing), extracting and cooling agent. About 70% of the water consumed by the production goes to the washing of raw materials and semi-finished products at different stages of the technological process.

In this regard, the wastewater generated at the enterprises can be divided into two groups: 1) concentrated - these are different waste technological solutions that contain the main amount of pollution; 2) flushing - the volume of these waters is many times greater than the volume of concentrated juicy water. Lung wastewater is a complex heterogeneous system. Contaminants present in the effluents are in a dissolved, colloidal and undissolved state. Colloidal and insoluble substances are able to form stable coarse and finely divided suspensions and emulsions. The discharge of wastewater into water bodies without bringing their composition to the appropriate quality is unacceptable, since many textile auxiliary organic substances used as intensifiers for fixing dyes on fabrics (organometallic compounds, polyalkylene glycols) and thickeners (maleic anhydrite, amides and meth acrylic acid esters). Getting into water bodies causes the death of fish. Violate the sanitary regime of water bodies, worsen organoleptic indicators of water. Deterioration in the taste and smell of water is noted when the dispersant NF, Starox - 6 (surfactant) and the OS-20 preparation get into water bodies.

III. DISCUSSION AND RESULTS

At the same time, some of the reagents used in the technological process are expensive chemical cheese, which, from an economic point of view, is advisable to return to production. A comprehensive solution to the problems of wastewater treatment of light enterprises (reduction of wastewater discharge into water bodies, return of treated water and valuable chemicals to production) is possible when creating closed water circulation systems at enterprises of the industry. The determining factor in choosing methods for treating industrial wastewater is the dispersed phase state of impurities contained in wastewater. For the treatment of wastewater from light industries, they are used both in water treatment and in chemical technology processes: filtering, settling, filtering, chemical recovery, adhesion, adsorption, destruction by strong oxidizing agents, flotation, etc. The following methods have become prevalent in water systems of light industry enterprises: foam flotation for the release of synthetic surfactants, dyes, and suspended solids from industrial wastewater; adsorption on aluminum and iron hydroxides to isolate high molecular weight colloidal and suspended solids; chemical reduction (using iron chips in an acidic environment and subsequent alkalization and clarification of the liquid): chemical destruction of persistent suspensions of wool-washed succulent water; liquid-phase oxidation of organic matter of concentrated wastewater; evaporation, biochemical destruction of organic matter. The essence of flotation is the molecular interaction of water impurities with bubbles of finely dispersed air and the emergence of the resulting systems of a floated particle - an air bubble in the form of foam. The floatability of synthetic surfactants is related to their foaming ability: the higher the foaming ability of a surfactant, the greater its floatability from a liquid. The effectiveness of the method increases significantly if surfactants present in the solution only contribute to foaming, but also interact with other non-foaming pollution components. The nature of the interaction should be such that the resulting flotation units can concentrate on the water-air phase separation and create a stable foam. Foam flotation can be used to isolate such components of wastewater contamination as cocking, dyes and finishes. Wastewater treatment of dyeing and finishing workshops using dynamic membranes DM is high permeability, reaching hundreds of liters per square meter per hour, which is much more than the permeability of cellulose acetate membranes. The service life of the DM is almost unlimited. The membrane has semi-permeable properties all the time, while in the shared solution there are impurities of the dispersed material. In the case of slight mechanical damage, self-healing of the membrane is possible due to the deposition of a new layer on the substrate. If during operation the characteristics of the membrane deteriorate, then it is possible to restore the previous characteristics by removing the adsorbed layer by supplying solvent from the opposite side, and then again forming the membrane. Currently, there is enough experimental material confirming the possibility of the successful use of DM for demineralization and wastewater treatment. DMs can be formed under conditions when one or several components of the solution being purified are able to precipitate on substrates, forming DMs. This phenomenon is called self-retention, it occurs during filtration through porous substrates of wastewater, as well as polluted natural waters. The effectiveness of the phenomenon is confirmed by an experiment conducted by us. It was established that DM obtained as a result of self-retention possess satisfactory characteristics. These characteristics can be significantly improved if specially prepared substrates with a more uniform pore size distribution are used as a porous base. Laboratory studies were carried out on prayer solutions, laboratory reverse osmosis unit by continuous circulation of the initial solution simulating the composition of wastewater after dyeing. A semi-permeable layer formed on the surface of a porous substrate as a result of sorption of dispersed particles is in most cases in dynamic equilibrium with the solution. The time to reach equilibrium depends on the experimental conditions and is usually several hours. Sometimes, for the rapid formation of a membrane, an increased rate of additive is introduced into the solution.

Therefore, after the first positive results about reverse osmosis in DM, the latter were investigated for the wastewater treatment of textile enterprises and, above all, dyeing shops. After establishing constant separation characteristics, the concentration of the additive is reduced to the minimum values required to maintain these characteristics. Recently, reverse osmosis and ultrafiltration have been used for wastewater treatment of textile enterprises. One of the advantages of the processes is that separation occurs without phase transformations at ambient temperature, which leads to a significant reduction in energy consumption than when, for example, using such a method of deep wastewater treatment of textile enterprises as adsorption on activated carbon followed by heat regeneration of the latter. But, however, the requirements tighten the working conditions of reverse-osmotic and ultra-filtration membranes, unsuitable for high temperature (more than 60 ℃).

IV. CONCLUSION

Based on a review of literature data, the use of DM for the solution of the problem of membrane treatment of dyed textile wastes is shown to be promising.

The first established the possibility of improving the characteristics of the membrane process in the separation of colored wastes of textile production due to the formation of cellulose acetate ultrafilters DM from polymer additives. The most effective and technologically advanced additive is Na-CMC. The effect of the initial characteristics of cellulose acetate ultrafilters on the characteristics of DM Na-CMC was studied, and data were obtained for a reasonable choice of ultrafilters as the basis for DM.

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