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2. THE PRE-TREATMENT METHODS IN REVERSE OSMOSIS SYSTEMS

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Introduction. Fresh potable water resources are the most vital reservoirs in the world. It is important for all living organisms on earth to have access to adequate clean water. Available water resources are decreasing due to world population growth, developing industries, and long-time droughts. Contaminations of natural water resources with refractory pollutants discharging from industries make the water shortage worse even in rich water area. It is possible to store rainfall streams or storm water to control water shortage for a short time, but the best way is to treat and reuse wastewaters (polluted water coming from industries, businesses, and residences) [1, 2]. That is why this article describes such a cleaning method as baromembrane method. Advantages of reverse osmosis have led to its widespread in the last 30 years in the processes of preparation of drinking and technological water, primarily desalination, and in some regions of consumption prepared reverse osmosis is 60-70 % of the total water consumption. Given that freshwater reserves in Ukraine are only 0.0003 % of the world, as well as relatively low values sustainable development indices for water consumption (national average 0.8, for abdominal regions below 0.5), studies on use of baromembrane processes for drinking and technological preparation water in the southern regions of Ukraine. Another area of application of such processes is the cleaning of utilities and industrial wastewater [3–5]. The properties of membranes for baromembrane processes depend on the type separation process and tasks.

Materials and methods. Today, four basic ones are used on an industrial scale designs of devices for carrying out baromembrane processes – flat-frame, tubular, rolled and hollow-wool. Flat-frame and Tubular membrane modules due to relatively high manufacturing cost and a relatively low specific surface area (100–400 $m^2/m^3$and up to 300 m^2/m^3, respectively) are used only in specific industries with small productivity. However, their surface is available for mechanical methods sludge removal, so these structures will not be detailed in detail. The most common design is rolled or spiral the design of the membrane module. Rolled module contains a perforated central tube around which the package is wound membrane package and mesh separator, which forms a pressure channel for movement raw materials fed from the end of the roll.

Permeate through drainage material enters the central tube, and the concentrate is removed from the opposite end roll. The advantage of such modules is the high specific surface area of the membranes (up to1000 m^2/m^3), as well as simplicity and reliability in operation and capability regeneration. Diameter of household rolled modules is 0.0445 m (1.75 inches), the length of the pressure channel – 0.26 m, height pressure channel – $0.35 \cdot 10^{-3}$ m. For industrial diameter can reach 0.25 m, length – 1.5 m, and the height of the pressure channel – 0.001 m . In the processes of microfiltration, ultrafiltration and nanofiltration membranes with a porous structure are used. At the same time the structure of reverse osmosis membranes can be considered as porous, nonporous , or intermediate between porous and nonporous (nonporous with defects).

In microfiltration processes, membranes can be used as with symmetric (isotprone) and asymmetric (anisotprone) structure structure, in other baromembrane processes asymmetric are used membranes, including composite . The vast majority of membranes are made of polymeric materials, in mainly hydrophilic (cellulose acetate, polysulfones, polyamides and others). Hydrophobic polymers can also be used membranes (usually polyvinyldenfluoride and tetrafluoroethylene) that have slightly worse separating properties and are used mainly in microfiltration processes.

Results. The most negative consequence of polarization phenomena is the formation of the surface of the membranes of sediments that occur due to the formation in the boundary layers of supersaturated solutions. In particular, as shown in reduction performance of membrane installations by 95–97 % is determined by pollution the surface of the membranes and only 3–5 % of their capillary-porous compaction structures. The most common types of sediments: mineral sediments, metal hydroxides, colloidal films of organic and biological origin, which can be localized in different parts membrane installation [6, 7]. The causes of membrane contamination are determined physicochemical and surface properties of the membrane and particles polluting phase. In works [8–10] a complex composition is noted pollution in industrial reverse osmosis plants.

The reduction of concentration polarization includes pre-treatment methods, change of hydrodynamic regimes in the membrane module, as well as modification of membrane properties. Pre-treatment methods can be divided into traditional treatment methods, membrane treatment methods (use of microfiltration or ultrafiltration as a pretreatment for reverse osmosis) as well specific methods. In addition, it demonstrates high efficiency use of antiscalants. In some cases, coagulation allows completely eliminate pollution. The combination of traditional methods, for example, is effective coagulation / flocculation and adsorption or ion exchange. However, in most cases, coagulation processes allow only mitigate pollution and in some cases they are inferior to others treatment methods, such as microfiltration and ultrafiltration. Among other methods of pre-treatment is the most commonozone treatment. Ozonation is effective only to combatorganic contamination and suitable only for inorganic membranes, as it can lead to chemical destruction of polymer membranes. Quite a simple method of preventing the appearance of inorganic contamination is the dosing into the stream of purified water atiskeilants substances that prevent crystallization (inhibit the crystallization process) of sparingly soluble compounds from supersaturated solutions, as well as, according, are able to destroy and disperse already formed crystals. But the use of antiscalants effective only when they are adapted to the specific type of membranes and them dosage is calculated. In addition, was noted that antiscalants can lead to increased levels of biopollution.

Conclusions. Microfiltration and ultrafiltration are the most common membrane pre-treatment methods in reverse osmosis systems. These processes able to consistently reduce turbidity and completely eliminate bacteria and viruses. In recent years, it has been proposed to use for pre-treatment process of direct osmosis, but the method is currently small researched.

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