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Physico-Chemical Methods of Water Purification

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Abstract: The article describes the methods of water purification. About desalination and desalination of water by distillation, physico-chemical bases of water purification by extraction, physico-chemical bases of water purification by evaporation.

Keywords: water, dryer, sun, economy, energy consumption, agriculture, organic solvents.

Desalination and desalination of water by distillation

The distillation method is based on the evaporation of water followed by condensation of vapors. The process takes place at a temperature corresponding to the given pressure and salinity of the water. The steam formed during boiling at a pressure below 4.9 MPa practically does not contain salts, so when it condenses, fresh water is obtained.

To evaporate water, it must be heated to the boiling point and then additionally report the heat of the phase transition of water into steam, the so-called latent heat of vaporization, at a temperature of 100 ° C equal to 2.26 MJ / kg. The same amount of heat must be taken away from steam to turn it into water. This heat can be recovered to a large extent, and the degree of recovery characterizes the thermal efficiency of distillation plants. For evaporation, the heat released during the combustion of fuel, the heat of steam condensation, the energy of sunlight, nuclear reactors, etc. are used.

According to the nature of the use of heat and the degree of its recovery, evaporation plants are divided into single-stage, multi-stage and thermocompression.

A single-stage evaporation plant (Fig. 6a) is an evaporator / with a heating element 2, into which heat is supplied from an external source (usually in the form of steam heat) to evaporate salt water, and a condenser 3, where salt water is used for cooling.

Multistage evaporation plants are several series-connected evaporators operating in such a way that the heat of steam condensation of the previous stage is used to reheat and evaporate water in the subsequent evaporator.

By the nature of boiling, evaporators can be film (in which boiling occurs in a film of water moving along the heat transfer surface), with boiling in the thickness of the evaporated water and with a boiling zone removed (adiabatic).

All evaporators are divided into flow, through which the evaporated water passes once, and circulation.

Physico-chemical bases of water purification by extraction

The purpose of extraction is either to remove an undesirable component of the solution (for example, impurities from water), or to isolate in a more concentrated state any valuable component of the solution.

The extraction method is used for wastewater treatment in the chemical, oil refining and pulp and paper industries. Impurities removed as a result of extraction purification, as a rule, are organic substances, since they are mostly the only ones that dissolve better in the extractants used than in water. Extraction of mineral impurities of wastewater is carried out in relatively rare cases.

Organic solvents (benzene, carbon tetrachloride, mineral oils, butyl acetate, etc.) are usually used as extractants. A number of requirements are imposed on the extractant:

• a) the solubility of the extracted impurity in it should be high compared to the solubility of cc in water;

• b) the use of extractants with a density close to the density of water should be avoided, since this slows down and complicates the process of separating the extractant and water during mixing;

• c) the dissolution of the extractant in water should be minimal.

In relation to wastewater impurities, extractants are divided into two groups. One group extracts mainly one substance or substances of the same class, these extractants are called selective. The other group is the majority of sewage impurities.

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Of the known solvents, nitrogen-containing compounds, especially secondary and tertiary amines, have the best extraction properties. The most commonly used extractants are triethylamine (TEA), mixtures of triethylamine with diethylamine (DEMA), diisopropylamine (DIPA).

The extraction process consists of two main stages:

1. Extraction proper: the initial aqueous solution and the extractant are mixed, while the substance dissolved in water is distributed between the organic and aqueous phases.

2. Separation of aqueous and organic phases.

Wastewater treatment by extraction is carried out in two main ways:

1. Treatment of the volume of water with an extractant - extraction under static conditions, periodic extraction.

2. Mixing of the extractant and water according to the principle of counterflow - extraction under kinetic conditions, continuous extraction.

Physico-chemical bases of water purification by evaporation

Osmosis is a spontaneous process of solvent (water) diffusion through a semipermeable membrane from a solution with a lower concentration to a solution with a higher concentration

Physico-chemical methods of water purification

The choice of one or another treatment method (or several methods) is made taking into account the sanitary and technological requirements for treated industrial wastewater for the purpose of their further use, as well as taking into account the volume of wastewater and the concentration of pollutants in them, the necessary material and energy resources, and the efficiency of the process.

Flotation

Flotation is used to remove insoluble dispersed impurities from wastewater that spontaneously settle poorly. In some cases, flotation is also used to remove dissolved substances, for example surfactants. This process is sometimes called "foam separation" (or "foam concentration").

Flotation is also used to isolate activated sludge after biochemical purification.

The advantages of this method of purification include the following: continuity of the process; a wide range of applications; small capital and operating costs; selectivity of impurities in comparison with sedimentation; high speed of the process, lower humidity of the resulting sludge (90-95%) and a high degree of purification (95-98%); the possibility of recovery of the removed substances. Flotation is accompanied by aeration of wastewater, a decrease in the concentration of surfactants and easily oxidized substances, bacteria and microorganisms. All this contributes to the successful further wastewater treatment.

The essence of the flotation process is the adhesion of a pop-up air bubble with a solid hydrophobic particle and its rise into the foam layer formed on the surface, provided that the weight of the particle should not exceed the total lifting force of the bubble and the sticking force. The presence of surfactants (collecting reagents) in the water makes the process more efficient. Surfactants, adsorbed on particles, reduce their wettability, i.e. make them hydrophobic. The following are used as collecting reagents: oils, fatty acids and their salts, mercaptans, amines, etc.

According to some data, the optimal bubble size is 15-30 microns with particle sizes (depending on their density) 0.2-1.5 mm. Flotation can be combined with flocculation. When carrying out flotation of flakes after coagulation, it is necessary to take into account that the probability of gas bubbles sticking to freshly formed flakes is higher than to flakes having an "age" of several hours.

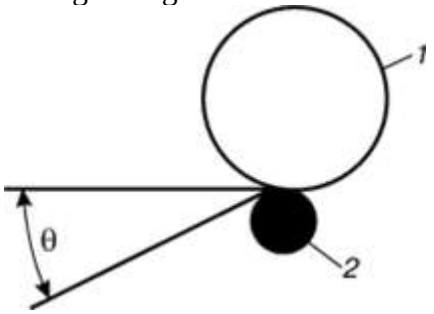

Fig. 2.13. Elementary act of flotation:
1 - a bubble of gas; 2 - a solid particle

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Of great importance is the stabilization of bubble sizes, which is achieved through the use of foaming agents that reduce the surface energy of the phase separation (pine oil, cresol, phenols, sodium alkyl sulfate, etc.). The following methods of flotation treatment of wastewater are distinguished: with the release of air from solutions; with mechanical dispersion of air; with air supply through porous materials; electric and chemical flotation.

Flotation with the release of air from the solution is used to remove very small particles of contamination. There are vacuum, pressure and airlift flotation.

During vacuum flotation, wastewater is saturated with air, and then treated with vacuum (about 225-300 mmHg). The smallest bubbles released during this treatment take out some of the impurities. Advantages of this method: the adhesion of the bubble and the particle occurs in a calm environment, energy costs are minimal. Disadvantages: an insignificant degree of saturation of the effluent with gas bubbles, limiting its use at a concentration of suspended particles (more than 250-300 mg / l), and the need to construct hermetically sealed flotators and place scraper mechanisms in them.

Biological flotation is used to seal sediment from primary settling tanks during the treatment of domestic wastewater. The precipitate is heated by steam in a special container up to 35-55 ° C and aged for several days. Gas bubbles - the result of the activity of bacteria and microorganisms - carry sediment particles into the foam layer, where they are compacted and dehydrated (~ up to 80%).

Ion flotation - the process of extracting ions from solutions by flotation - is effective at low concentrations of extracted ions (~1- (10 3-10-2) g • ion/l). This process can be used to extract metals (Mo, W, V, Pt, Ce, Re, etc.). The process goes as follows: air is introduced into the wastewater (a bubble flow is organized) and a collector (Baboons, which have a charge opposite to the charge of the impurity ion being extracted). Further, the ions of the collector and impurities are concentrated on the surface of the gas bubbles and carried out by them into the foam layer.

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