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SEPARATION OF THE MIXTURE OF SHREDDED ACRYLONITRILE-BUTADIENE-STYRENE AND POLYAMIDE BY FLOTATION METHOD USING SULPHANOLE AND SYNTHANOL AS SUFRACTANTS

A method of flotation separation of a mixture of widely used polymers acrylonitrile butadiene styrene and polyamide was analyzed. The experiments were performed on a laboratory flotation turret with air aeration of the pulp. The formulas of key indicators flotation are presented. In this case, we obtained the dependencies of the concentration of surface-active substances, and the air flow on the purity concentration and extraction of float component. The optimal conditions for the flotation process of the polymer mixture were determined. It is concluded that the flotation separation of polymers based on their selective wettability is promising for the processing of mixed plastic waste.

Introduction. Recently, the problem of plastics waste disposal has ranked an important place all over the world. It is explained by a significant increase in the production of polymeric materials and the expansion of areas of their application in various industries. Mostly, waste disposal destroy, flood, or incinerate.

However, plastic waste is additional source of raw materials and energy resources. The main tendency in waste management is to reuse plastics to produce useful products.

There are a lot of problems of polymer wastes disposal. They are specific, but they can be solved. The most complicated problem is processing and use of mixed wastes. The reason is uncompatibility of thermoplastic materials that make up household waste, which requires their stepwise selection.

Separation of mixed (household) waste products of thermoplastics is carried out by one of the following ways: flotation, separation in severe media, aeroseparation, electroseparation, chemical methods, and by the methods of deep cooling.

At present, when polymers are processed, flotation tanks are widely used for separation of materials with different relative densities, such as polypropylene and polyethylene caps, tear-off rings, labels which are lighter than water are removed from the surface. A material is deposited on the bottom, then it is passed for further processing in the washer-dryer set.

The property of preferential wettability of polymers in these tanks is not used. However, in some investigations, it is reported that the flotation separation of plastics is carried out by adding surfactants to water, that change fractionally their hydrophilic properties. [1].

Main part. The purpose of the work is to find experimentally the dependence of flotation of widely used mixtures of acrylonitrile butadiene styrene polymers and polyamide on the surfactant concentration and air flow. Acrylonitrile Butadiene Styrene (ABS) is high impact technological thermoplastic resin, its density is 1,020–1,110 kg/m^3. Application: large automotive parts, housing of household appliances, radio and television equipment, parts of electric light or electronic devices, vacuum cleaners, coffee makers, telephones, fax machines, computers, monitors, printers, calculators, and other household and office equipment, sporting equipment, etc.

Polyamide (PA) is plastic based on linear chains of amide groups, its density is 1,100–1,150 kg/m^3. They are used in mechanical engineering, automotive and textile industry, medicine and other fields. Experiments were performed in the laboratory, using the column flotation device with pneumatic aeration pulp, its scheme is shown in Fig. 1.

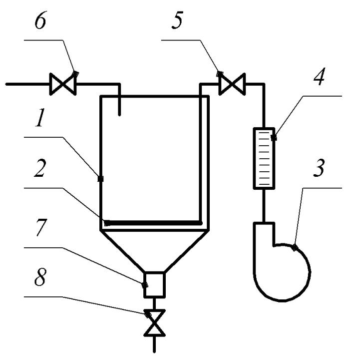

Fig. 1. Scheme of the laboratory column flotation device with pneumatic aeration pulp: *1* – tank; *2* – coil-bubbler; *3* – fan; *4* – rotameter RM–GS/0.25; *5* – valve for air supply; *6* – valve for water supply; *7* – fitting for tailings and water removal; *8* – valve for discharging tailings and water

Tank *1* is filled with water, the surfactant is introduced. The air flow is set with rotameter *4* and valve *5*. Then the tank is filled with the polymer mixture in 1:1 ratio.

The completion of the flotation process is the time, when there are no polymers between the bubbler and the foam layer. The concentrate with foam is taken onto top of the tank, tailings are taken through the fittings. Then drying and weighing of the concentrate, the final separation of ABS and weighing in concentrate is carried out.

Based on these results, the following indicators were calculated with formulas [2].

Contents of float component (purity concentration) β,%:

$$b = \frac{m_{conc.}^{\text{АБС}}}{m_{conc.}} \times 100\%,$$

where $m_{conc.}^{ABS}$ – ABS weight in concentrate, g; $m_{conc.}$ – weight of the concentrate, g.

The extracting part of the floating component (ABS) ε, %:

$$e = \frac{m_{conc.}^{ABS}}{m_{ini}^{ABS}} \times 100\%,$$

where $m_{conc.}^{ABS}$ – ABS weight in concentrate, g; m_{ini}^{ABS} – initial ABS weight, g.

The studies have been performed using sulphanole and synthanol as surfactants. Sulphanole (sodium alkylbenzenesulphanate dodecylbenzenesulphonate, linear sodium alkylbenzenesulphonate) is a mixture of sodium salts, anionic surfactant, having good properties of cleansing, moisturizing, emulsification and dispersion. Sulphanole is in the form of scaly crystals of white colour, or yellowish almost odorless pasty mass [3].

Flotation results obtained when sulphanole was used as surfactant are shown in Fig. 2 and 3.

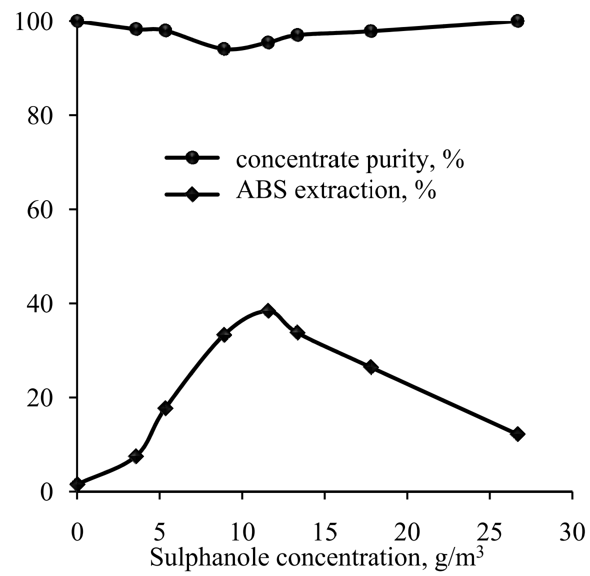

Fig.2. Dependence of the concentrate purity and ABS extraction on the sulphanole concentration with an air flow 0.06 m^3/(min·m^2)

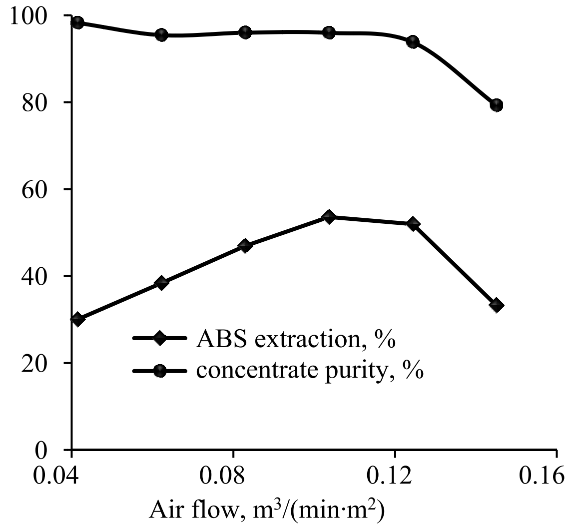

Fig.3. Dependence of the concentrate purity and ABS extraction on the air flow with sulphanole concentration 11.56 g/m^3

Synthanol is a composition of oxyethylated alcohols, which are a mixture of polyethylene glycol esters with different number of hydroxyethyl groups and the radical value. Synthanol is ethyl nonionogenic surfactant, low-foaming wetting agent, and biologically soft detergent, resistant to hard water [3]. Synthanols are used as suspension stabilizers, emulsifiers, dispersants. The obtained results while using synthanol are shown in Fig. 4 and 5.

As it can be seen in the following diagrams, the purity of the concentrate reaches high values in a wide range of variable parameters. This characteristic feature determines the possibility of further use of the polymer obtained in various ways, depending on the amount of impurities accidentally involved in the concentrate, which, in turn, affects the physical properties of future products.

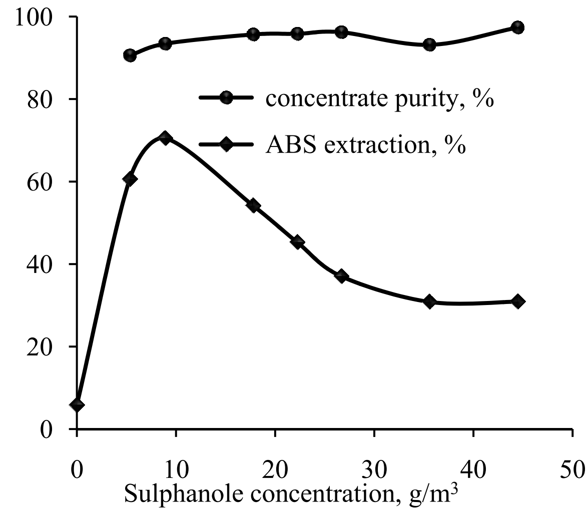

Fig.4. Dependence of the concentrate purity and ABS extraction on the sylthanol concentration with an air flow 0.06 m^3/(min·m^2).

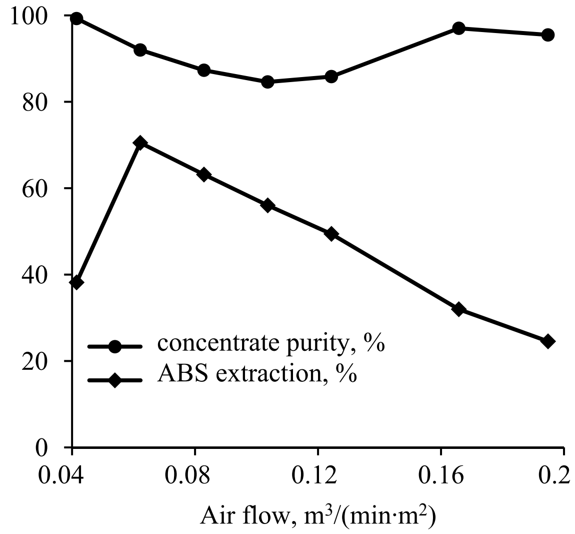

Fig.5. Dependence of the concentrate purity and ABS extraction on the air flow with synthanol concentration 8.89 g/m^3.

The ABS extraction has a pronounced maximum in a narrow range of variable parameters. Therefore, to achieve the highest extraction degree, it is necessary to exactly maintain the flotation parameters such as surfactant concentration and air flow. The positive feature is that the optimum ABS extraction is observed at low surfactant concentrations in the range of 8–12 g/m^3.

When synthanol is used the maximum ABS extraction is 17% higher than that when sulphanole is used, and it reaches 70.5%. However, the purity of the concentrate in this case is reduced by 2.5%, namely – to 93.5 %. Low values of ABS indicate the need for re-supply flotation tailings for more efficient extraction of the flotating polymer.

Conclusion. Thus, the first research of flotation separation of a mixture of widely used ABS and PA polymers in laboratory with a column flotation device with pneumatic aeration pulp showed the possibility of the implementation of the process. In this case, we obtained the basic dependencies of flotation process of polymer mixture on surfactant concentration and air flow. It is also possible to conclude that the flotation separation of polymers based on their preferential wettability is a promising direction in the processing mixed plastic waste. This will reduce the cost of manual labor in the stepwise phase separation of polymer waste. In a simple apparatus, having few surfactants and a low air flow air it is possible to create a high-productive and automated sorting process of plastic wastes

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