

AMS-subject classification 61.65.91

EXTRACTION SEPARATION AND TREATMENT OF SEWAGE BY ORGANIC SOLUTIONS WITH RECIRCULATION

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Separation and treatment technology of sewage from organic compounds has been suggested and founded by extracting from water solution with isopropyl ether, then by separating and recycling. Results of researches and kinetics of liquid phase extraction of organic compounds from sewage have been given.

Keywords: liquid phase extraction, recycling purification technology of water resources

Treatment of sewage from different organic compounds is an important, complex and multi factor ecological, economical and industrial problem for many chemical productions. Treatment processes of waste waters from different organic compounds are carried out by various methods: a) adsorption of organic with the use of different zeolite adsorbents and activated coal. Adsorptive methods for treatment of waste waters are based on the sorption of both carbonized and zeolite surfaces and solution of regeneration problem increases their effectiveness; b) membrane technologies, by using different synthesized membranes [1-3], plasma membrane and high frequent plasma chemical technologies for sewage treatment from organic and radioactive compounds, other non-traditional and combined processes; c) extraction methods for treatment of industrial waste waters from different compounds, organic substances from sewage and others. Industrial waste waters are also treated by combining different above mentioned methods including extraction-membrane method and various processes and installations. The main object of the present research work is analysis of condition of some industrial technologies, such as modern paint-and-varnish industry with the aim of revealing wastes in environment and their utilization possibilities.

Liquid extraction of organic compounds from waste waters is a mass exchange process, which proceeds in inters phase film and is real-

ized in the following stages: **a)** dispersing of isopropyl ether in water medium and extracting in inter phase film, which is characterized by diffusive transfers of corresponding components to inter phase surface. Liquid drops are crushed to increase inter phase surface of a contact at big rotation rates. As it was marked in the work [4] crushing frequency of drops is proportional to rotation rate W and diameter of stirrer D , $\omega \sim W^{1/2} D^{1/3}$, but minimum size of drops $a_{\min} \sim (WD)^{1.75}$ that is by increasing crushing frequency average size of drops decrease; **b)** coalescence, coarsening of drops [5], stratifying of phases and reveal of an extract and water due to different of densities of contacting phases. As in the work [4,5] average size of drops is proportional $a \sim W^{-1.2} D^{-0.8}$, but coalescence frequency at liquid medium depends on concentrations of drops φ_0 and viscosity of medium as $\nu_c \omega \sim \varphi_0 D \left(\frac{W^3}{\nu_c} \right)^{1/2}$. Coa-

lescence of drops is energetically profitable till the formation of two layers of non-miscible liquids, which causes an effective stratifying of phases. Minimum sizes of drops, which depend on condition of mixing and physical-chemical properties of medium (density, viscosity, surface tension, energy density of dissipation), play the main role in this process ; **c)** regeneration (fractioning) of an extract for getting free isopropyl ether for additional use as a solution and raffinate – as hydrophobic organic com-

pounds and pigment type of dyeing materials.

In liquid extraction processes on surface of inter phase film as for any mass exchange processes the following boundary condition is satisfied:

$$D \frac{\partial C}{\partial r} \Big|_{r=\delta} = \beta(C - C_0) \quad (1)$$

where D -molecular diffusion factor, β -mass exchange factor, r - coordinate on width of inter phase layer, C - concentration of absorbing substance, C_0 - balanced concentration between phases, δ - width of inter phase layer, which is

proportional to $\delta \sim \left(\frac{aD}{V} \right)^{1/2}$, a - size of a drop,

V - flow rate on a drop. If setting $dr=Vdt$ for less width of inter phase film in this equation, we will change it to:

$$\frac{\partial C}{\partial t} = K(C - C_0), C|_{t=0} = C_0 \quad (2)$$

where $K = \frac{BV}{D}$ - kinetic coefficient of extraction, t - extraction time. Equation (2) is a kinetic equation for extraction processes and characterizes the rate of extraction change of absorbing substance. At permanent value of coefficient K the solution of equation (2) is :

$$C(t) = C_0[1 - \exp(-Kt)] \quad (3)$$

For researching kinetics of extraction process of hydrophobic organic solutions and component substances with isopropyl ether, we have carried out number of experiments in mixers at temperature interval 10-40°C and 5,04-10,19 ml/l residues in waste waters within 0,1-1,5 hrs. Results of researches and calculated values by formula (3) were given in fig. 1. Value of extraction factor weakly depends on temperature and hesitates at temperature interval $K=1,867 \times 10^{-4} - 2,0 \times 10^{-4} \text{ c}^{-1}$.

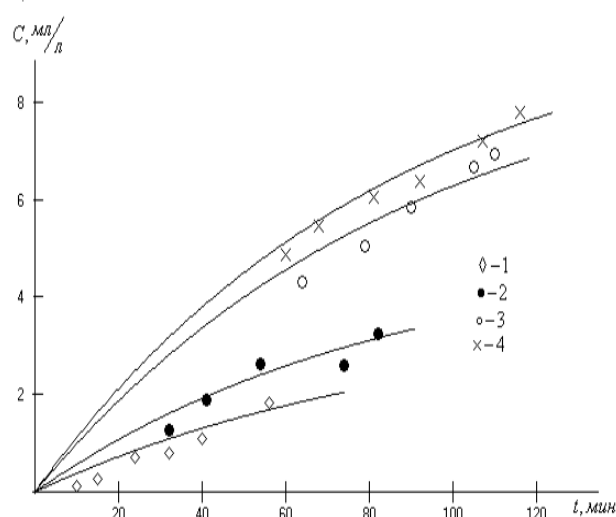


Fig. 1. Comparison of experimental and calculated values of concentrations of absorbed component in sewage at different values of its initial concentrations (ml/l) in sewage: 1-3,67; 2- 5,04; 3-9,32; 4-10,19

Dependence of volumetric flow rate of isopropyl ether v on organic solutions and component substances in sewage C , can be given by equation :

$$C_i = \frac{\alpha_0 v}{1 + \alpha_1 v} \quad (4)$$

where coefficients α_0 and α_1 are correspondingly equal to $\alpha_0=1,65$, $\alpha_1=0,2$. Comparison of equation (4) with experimental data is given in fig. 2.

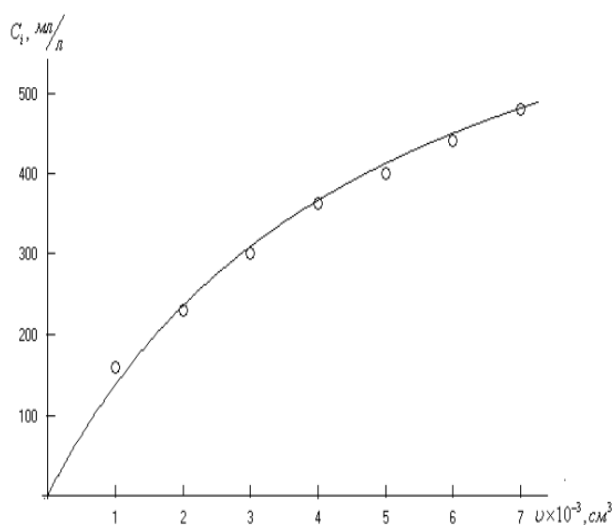


Fig. 2. Comparison of calculated and experimental values of costs v for isopropyl ether from content of organic compounds in sewage

Technology of sewage treatment includes the following stages:

a) preliminary treatment of electrolyte residue after electrochemical process by filtering dyeing materials from mechanical and non-soluble suspended particles in electrolyte of inorganic type; b) further extraction of water-soluble and non-soluble component organic solutions, as well as other substances with isopropyl ether; c) separation and stratifying of liquid phases and revealing isopropyl alcohol by fractioning for recycling. It must be added that extraction process is realized in summer period at $T=20^{\circ}\text{C}$ and in winter period at $T=40^{\circ}\text{C}$, that provides capturing at a range of 98-99% (mass), but treatment of sewage up to 0,002-0,003% (mass) from water-soluble organic residues.

Emulsion content of such compositions changes considerably, but pH media tends to alkali.

Electrolyte must be neutralized up to $\text{pH}=7$ before extracting both basic and component hydrophobic organic solutions from water.

Ratio of electrolyte and ratio of extraction essentially influences on effectiveness of the process by using isopropyl ether. Apparatus of extraction process depending on temperature can be installed by the following way: if the process is realized at $T=20-60^{\circ}\text{C}$ (summer period), then total volume of an extractant should be better to distribute that in the first stage of extraction 50%, on the second and third by 25% from the whole extractant, but at $T=5-20^{\circ}\text{C}$ (winter period) correspondingly 60% and by 20 % of total volume of an extractant.

Under these conditions by the method practically all hydrophobic organic solutions are fully extracted from water electrolyte solutions. According to data of atom-adsorption method effluent contained 0,003-0,004 g/l total quantity of organic hydrophobic solutions, that corresponds to standard of maximum acceptable sanitary norms.

From the other side at a great temperature diapason of extraction ($T=60-70^{\circ}\text{C}$) 1 l high solvating isopropyl ether is enough to extract 600-700 ml organic compounds of waste elec-

trolyte compositions from 30 l water emulsion organic electrolyte.

Recirculation of isopropyl ether and recycling as an extractant form a condition for economical practicality of the present technology.

Result and discussions

We have proposed the new technology for treatment of sewage from organic solution and non-soluble admixtures by isopropyl ether with recirculating and recycling products (isopropyl ether) as an extractant and water containing toxic substances in acceptable norms. The proposed non-waste treatment technology of sewage from organic admixtures, has many advantages:

- low energy-costs for realization of technology, the processes, used in the technology, proceed at soft regimes (ordinary temperature and pressures), such processes as high temperature processes of decomposition, heating are not required;

- extraction treatment of sewage has essential ecological value, wastes, which pollute environment, are sterilized, the proposed process is non-waste, because organic compounds are additionally used in production, but isopropyl ether is reused as an extractant.

In conclusion it must be added that depending on productivity of the process some changes can be made in the proposed technological scheme, in particular, the use of countercurrent cascade extractors with stirrer in each section, mire effective sediment systems for stratifying with electric field and so on.

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SU MƏNBƏLƏRİNİN ÜZVİ HƏLLEDİCİLƏRDƏN EKSTRAKSIYA ETMƏKLƏ RESİRKULYASIYALI AYRILMASI

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Məqalədə su mənbələrinin üzvi həlledicilərdən ekstraksiya etməklə resirkulyasiyalı ayrılması texnologiyasına baxılmışdır.

Açar sözlər: maye faza ekstraksiyası, su mənbələrinin üzvi həlledicilərdən resirkulyasiyalı ayrılması

ЭКСТРАКЦИОННОЕ РАЗДЕЛЕНИЕ СТОЧНЫХ ВОД ОТ ОРГАНИЧЕСКИХ РАСТВОРИТЕЛЕЙ РЕЦИРКУЛЯЦИЕЙ

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Рассмотрены технологические аспекты рециркуляционного разделения сточных вод от органических растворителей в условиях жидкофазной экстракции.

Ключевые слова: жидкофазная экстракция, технологии рециркуляционного разделения органических растворителей от сточных вод