Adsorption treatment wastewater from the production oils

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Abstract – The adsorption method of after-treatment of wastewater from the production of edible oils was investigated. The reasons of choice the activated carbon as adsorbent was justified. The statics of the absorption process by activated carbon the organic component from the wastewater of oil production after extraction cleaning was investigated. The experimental data based on the theory of Freundlich and Langmuir were processed and the main constants of the process were defined.

Keywords – wastewater, adsorption, activated carbon, isotherm, statics, kinetics.

Introduction

The production of edible oil's increases year by year in proportion to the demand, more and more enterprises of this profile emerge, thus the total amount of emissions including wastewater increasing. For Ukraine, the topic of wastewater from the production of oils is relevant because our country occupies the first place in the world ranking of growing sunflowers, consequently, the production of oil. As Ukraine is one of the major sunflower producers and their processors, the issue of wastewater treatment of the oil's production is very relevant today.

In the process of vegetable oil's production, a large amount of wastewater arises in the form of emulsions. Such systems are stable over a long period of time. They are not destroyed by the mechanical method [5, 6]. They are poorly biodegradable due to large volumes of wastewater and a significant amount of organic components in them [2-4]. In such circumstances, it is appropriate to use liquid extraction to clean such wastewater [1,7]. The feasibility of using extraction for wastewater treatment is determined by the concentration of organic impurities in them.

The absolutely insoluble liquids are absent in water, that's why in the process of extraction, the part of the extractant dissolves in wastewater and becomes a new pollutant. Therefore, it is necessary to remove the extractant from the conditionally purified water. This also needs to be done to reduce the consumption of the extractant. In addition, extraction cleaning is not always appropriate to achieve high purification efficiency. In these cases, the adsorption method of purification is used. The advantage of the method is the high efficiency, - and the possibility of purification of wastewater, which contains several substances and recovery from these substances.

Description of the problem

The adsorption method of extraction residual amount of the pollutant and the extractant was chosen for research. This method allows to removing of residual concentrations of pollutions. The activated carbon was selected as a sorbent. It has the ability to absorb pollutants of organic origin. In mixing the adsorbent with wastewater, activated carbon was used in the form of particles of 0.1 mm and less.

The adsorption of activated carbon in the form of the isotherm is shown on the graphic (Fig. 1). The isotherm describes the equilibrium between the pollutant in wastewater which must be treated and the amount of pollutant in the activated carbon.

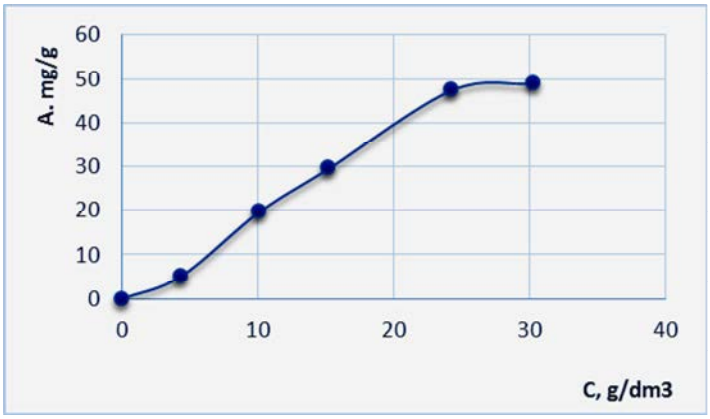

Fig. 1. The isotherm of adsorption wastewater pollutants in sunflower oil's production by activated carbon

The adsorption equilibrium in the solid adsorbent-solution system describes the equations that are given in the literature [1, 8]. We used two models that describe adsorption isotherms. One of the models is represented by the Freundlich equation.

To determine the constants of the Freundlich equation (k, n), the equation was given to the linear form by taking their logarithm:

$$lnA = lnk + 1/n \ ln\ c \qquad (1)$$

From the graph built in the coordinates ln A = f (ln c), we find tgα = 1 / n and lnk as the distance which cuts the experimental straight line on the Y-axis. Experimental data in linear coordinates ln A = f (ln c) according to Freundlich equation are presented in Fig. 2.

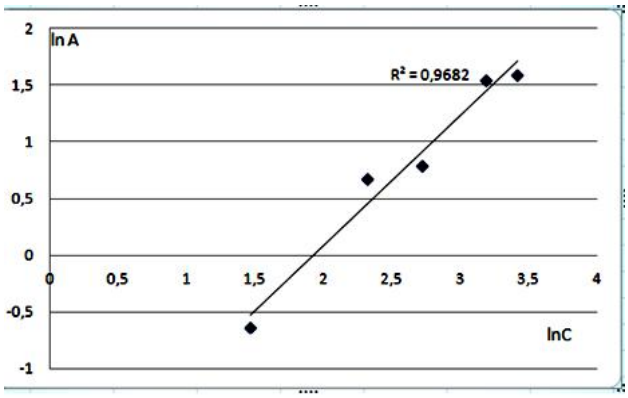

Fig 2. The isotherm of adsorption in linear coordinates

The experimental data on Fig. 2 represent a straight-line correlation and this indicates a satisfactory description of the isotherm of adsorption by the Freundlich equation. The correlation coefficient of experimental and theoretical data is 0.96, which indicating the reliability of experimental data.

The final form of the Freundlich equation for the adsorption process with using activated carbon:

$$A = 1.045C^{\,1.1836}$$

However, we believe that there is sorption in the form of a monomolecular layer of adsorbate and this process is better described by the Langmuir equation. Therefore, we have analyzed the obtained isotherms of adsorption according to this theory.

To calculate the limiting adsorption of the organic pollutant (A∞) we use the linearity Langmuir equation [2, 3].

$$\frac{C}{A} = \frac{1}{A_\infty k} + \frac{1}{A_\infty C}; \qquad (2)$$

where A∞ - the static activity of the adsorbent, which determined:

$$A_\infty = \frac{C_{init.} - C_p}{m} V \qquad (3)$$

The graph in the coordinates C/A =f(1/C) was constructed and the angular coefficient of the slope of the line k=ΔC/Δ(C/a*), which is equal to the limit of the adsorption of was find.

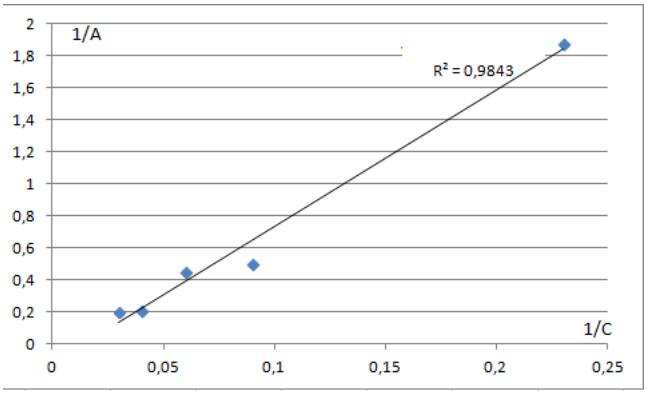

Fig 3. The Langmuir isotherm of adsorption in linear coordinates

The isotherm of adsorption pollutants from wastewater of sunflower oil's production after chemical treatment (the destruction by chemical substances of a stable emulsion "oil-water"), by activated carbon is described by the Langmuir equation:

$$A = 49.1\frac{0.97C}{1 + 0.97C} \qquad (4)$$

The correlation coefficient of the experimental and theoretical data R^2 is 0,96 …0,98, which indicates a more reliable description of the experimental data by Langmuir isotherm. The selection criterion of the theoretical model was the maximum value of Fisher's criterion (F) and the maximum value of the determination coefficient.

Conclusion

The statics and kinetics of adsorption method of after-treatment of wastewater from the production of vegetable oil was studied. The study established that the experimental isotherm of adsorption is the best described by the Langmuir equation, and the process of adsorption proceeds by the external diffusion mechanism. In such circumstances, the degree of wastewater treatment corresponds to safe hygiene practices.

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