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SEPARATION OF THE POLYMER MASS FROM THE WASTE OF THE ALKALINE CLEANING PROCESS OF PYROGAS BY THE EXTRACTION METHOD

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Abstract:

Objective. Pyrogas treatment waste segregation and consists in choosing a selective extractant to extract the polymer mass from the hydrocarbon content.

Methods. Segregation of waste, determining the solubility of hydrocarbon content in various solvents and methods such as choosing the most optimal selective extractant for extraction were used.

Results. The waste is separated into two layers when it is cooled. 1 - the upper layer (light layer) is determined to be "hydrocarbon content" and 2 - the lower layer (heavy layer) is "alkaline water". Paraffin hydrocarbons have been proven to be the best extractants for separating polymer mass from hydrocarbon content. The molecular mass and density of paraffin hydrocarbons have been found to have an inversely proportional effect on the separation rate of extract and raffinate during the extraction of hydrocarbon content.

Conclusion. It was found that the most effective method of separating hydrocarbon content and alkaline water from the waste is the leaching method, and the time of leaching is 240 minutes. Paraffin hydrocarbons were selected as an extractant for the extraction of polymer mass from hydrocarbon content.

Keywords: polymer mass, hydrocarbon content, yellow oil, solvent, extraction, organic extractant, alkaline water, selective extractant, raffinate, extract.

Introduction. Among hydrocarbons, ethylene and propylene monomers are important organic chemical raw materials, the demand for which is increasing every year. The traditional method of producing ethylene and propylene is pyrolysis of hydrocarbon raw materials (ethane, propane, propane-butane fraction, gas condensate and naphtha). In order to obtain target products for the polymerization process or to process certain unreacted materials, the pyrogas coming out of the reactor must go through a series of processes: recovery, separation, purification and fractionation. In order to purify the pyrogas from sour gases, it is subjected to the absorption process. An aqueous solution of sodium hydroxide of different concentrations is used to clean pyrogas to the required level

of purity. Aldehydes and ketones are formed in the side reactions of pyrolysis of hydrocarbon raw materials. Aldehydes and ketones are converted into polyaldols due to the mechanism of aldol condensation in an alkaline pyrogas purification column. In addition, during the reaction, some diolefins or other unsaturated hydrocarbons can also generate free radicals due to small amounts of oxygen and metal ions, which form cross-linking polymers. Together with polyaldols, these are called "Yellow oil" [1-5].

Problems such as the mechanism of this waste formation and its effect on the system [6-8], suppression of waste generation in the technological process [9-11] have been studied by many scientists. However, no one has yet carried out research on the separation and extraction of hydrocarbon content by refining the waste "Yellow oil".

Methods. It is necessary to process the hydrocarbon content in order to make it possible to use it in various branches of the oil and gas-chemical industry. It is known that there are several different methods of separating hydrocarbon mixtures. For example: rectification, absorption, adsorption, separation, crystallization, extraction, etc. The choice of which of the mentioned methods depends on the composition and properties of the raw materials to be separated. Based on its composition and properties, we aimed to separate the waste "Yellow Oil" by refining it and extracting the obtained hydrocarbon content. In order to achieve the goal set in the work, the tasks of separating the waste "Yellow oil" and determining the solubility of the hydrocarbon content in various solvents, and then choosing the most optimal selective extractant for its extraction, were defined.

Waste, which is considered the object of research, "Yellow oil" is collected in a pocket in the cubic part of the pyrogas purification column and is periodically transferred to a separator. In the separator, "Yellow oil" separated from the gas phase is poured into the drums. It is removed from the device area and is considered a process waste. General information about this waste "Yellow Oil" is presented in table 1, and its properties and composition are presented in table 2.

Table 1

General information about waste "Yellow oil"

1.	Amount of annual generation of wast	100 t
2.	Origin	while cleaning the pie
3.	Type of waste	organic
4.	Aggregate status	liquid
5.	Appearance	oily liquid

Table 2

Composition and characteristics of waste "Yellow oil"

1.	Density, kg/m^3	820–830
2.	Humidity, %	< 5
3.	Composition	Hydrocarbons – 95% Sediments – 5%
4.	Solubility	Slightly soluble in water
5.	Risk class	3
6.	Degree of danger of burning	Flash point +170 °C Auto-ignition temperature +334 °C

When the waste "Yellow oil" is removed from the technological device, a part is mixed with the used alkali and comes out in the form of a suspension. One of the most optimal, cheap and effective ways to separate such mixtures is the method of separation. In this case, the components of the mixture are separated into two or more layers due to their own weight and density difference.

Separation of waste "Yellow oil" by quenching. Waste "Yellow Oil" was poured into a 1 liter measuring cylinder up to the 1000 ml mark and timed to determine the pause time. The amount of precipitated substance was measured every 30 minutes. The experiment was continued until the precipitate was separated. 3 experiments were conducted in parallel. Arithmetic average values of precipitation amounts obtained every 30 minutes in all three experiments were calculated.

As a result of the research, it was observed that the waste "Yellow oil" separated into two layers, and these layers were named based on their composition. 1 - the upper layer (light layer) is called **"hydrocarbon composition"** because it contains a mixture of hydrocarbons. 2 - the bottom layer (heavy layer) this layer is called **"alkaline water"** because it exhibits a high alkaline property, which is a solution of used alkali and salts in water. The results obtained in the experiment were depicted in the graphic form presented in figure 1.

Since the hydrocarbon content consists of hydrocarbons, organic polar and non-polar extractants were chosen as extractants. For each class of organic extractants, substances that were liquid under standard conditions were obtained. Paraffins - hexane, naphthenes - cyclohexane, arenes - benzene, alcohols - ethanol and organic acids - ethanoic acid were used as extractants.

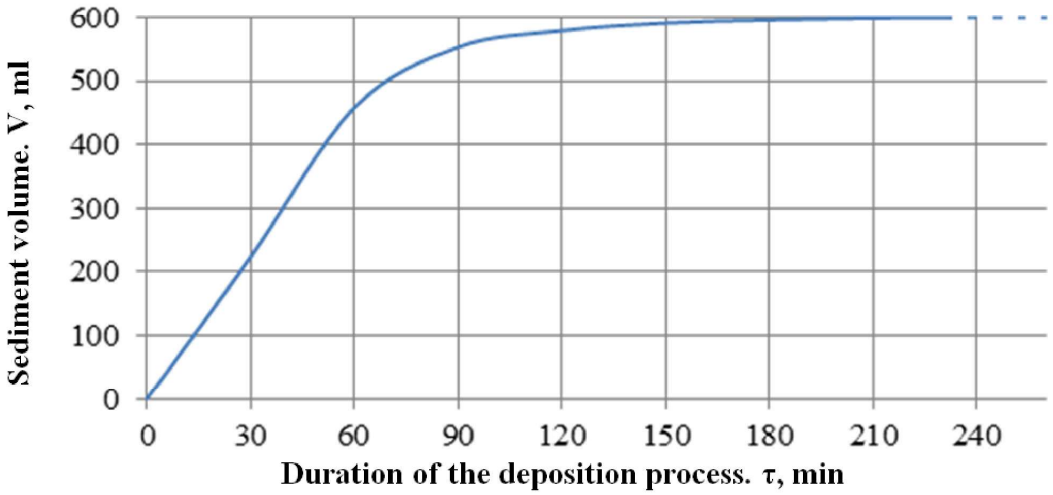

Figure 1. A graph of the time dependence of the separation of waste "Yellow oil"

Determination of the solubility of hydrocarbon content in various organic extractants. For this purpose, 5 glass test tubes were taken, 2.5 ml of hydrocarbon contents were put into them, and 5 ml of extractants were added to each of them and thoroughly mixed in a vibratory mixer, and then everything was left in a quiet state for a certain time. Paraffin hydrocarbons were selected as the best extractants based on the research results.

Selection of the optimal selective extractant for the extraction of hydrocarbon content. This experiment was conducted to determine the fastest extractant that

separates raffinate from paraffinic hydrocarbons. For this, hexane, heptane, octane, nonane and decane were selected as extractants from paraffin hydrocarbons (Fig. 2).

The results of an experiment to choose the most optimal selective extractant for the extraction of hydrocarbon content are presented in figure 2.

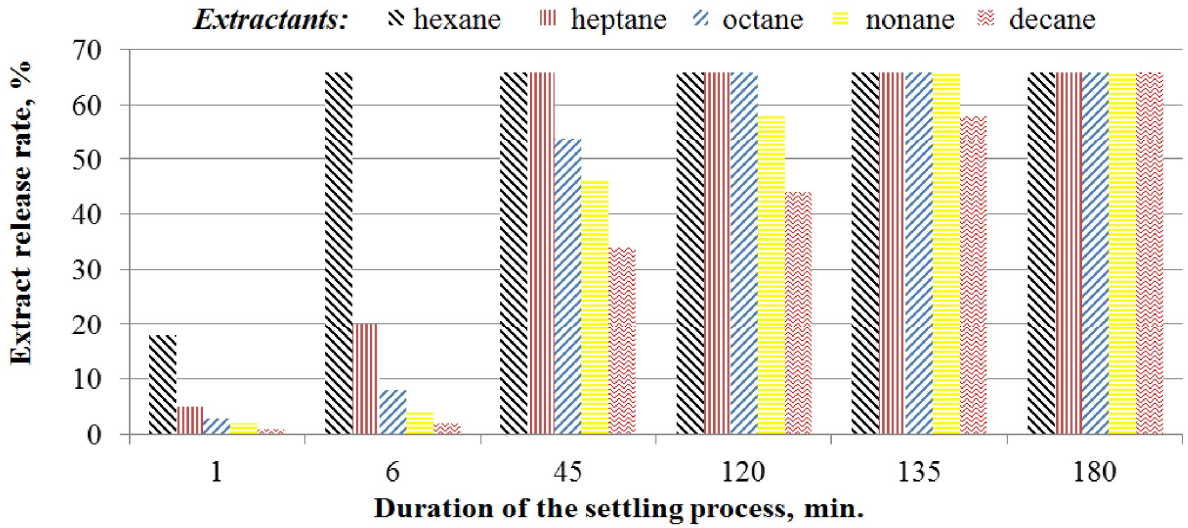

Figure 2. Time dependence of extract and raffinate separation during extraction of hydrocarbon content with paraffin hydrocarbons

Five 100-ml measuring cylinders were taken, and an equal amount of 25 ml of the hydrocarbon content was added to each container after mixing well. 25 ml of extractants were simultaneously poured over the sample in each container: hexane to the first, heptane to the second, octane to the third, nonane to the fourth, and decane to the fifth, and the mouth of the container was closed with a rubber stopper. Five samples were mixed simultaneously using a vibratory mixer. It was then placed at rest and the stopwatch start button was pressed. The volumes of the solid part collected under the five cylinders were determined.

Results. The results of the research conducted in order to determine the time of separation of the waste "Yellow oil" are depicted in the graphic view in fig. 1. In the study, the duration of waste separation was 210-240 minutes, and during this time, the mixture was separated 100%. From the graph shown in Figure 1, it can be seen that 90-95% of the alkaline water is separated in 90-120 minutes, and the remaining 5-10% is separated in 120-240 minutes.

When the waste "Yellow oil" was filtered and separated, it was found that its hydrocarbon content (mass %) is on average 40%, and alkaline water is on average 60%.

Our next research is to determine the solubility of hydrocarbon content in various organic extractants, and the results of the research are presented in table 3.

Table 3

Solubility of hydrocarbon content in various organic extractants

№	Extractive	Solubility state
1.	Paraffins	Part of it melted, a suspension appeared, and a precipitate separated (a pale yellow porcelain solution on a yellow precipitate).
2.	Naphthenes	Completely dissolved and mixed (brownish clear solution)
3.	Arenes	Completely dissolved and mixed (brownish clear solution)
4.	Alcohols	Completely dissolved and mixed (yellowish pure solution)
5.	Organic acids	It didn't melt and didn't mix at all

In this case, the state of solubility of hydrocarbon content in organic extractants was classified based on visual appearanc

It can be seen from figure 2 that as the molecular weight of paraffin hydrocarbons increases, the rate of separation of raffinate in extraction is observed, the reasons for this are:

- firstly, as the molecular mass of paraffin hydrocarbons increases, their molecular size also increases, and this prevents penetration into the hydrocarbon composition;
- secondly, an increase in the density of the extractant prevents precipitation of the raffinate separated during extraction.

Therefore, it took 6 minutes in hexane, 45 minutes in heptane, 120 minutes in octane, 135 minutes in nonane, and 180 minutes in decane for the complete separation of the raffinate.

Hydrocarbon content was separated into extract and raffinate when extracted using paraffin hydrocarbons (Fig. 3).

a) refined **b) extract**

Figure 3. Appearance of raffinate and extract from hydrocarbon extraction

Raffinate is a substance insoluble in paraffin hydrocarbons (Fig. 3a). The extract is a mixture of substances dissolved in paraffin hydrocarbons containing hydrocarbon content (Fig. 3b).

The concepts of diffusion coefficient and separation factor are used in the study

of hydrocarbon extraction. The ratio of the equilibrium concentration of the desired component in the extract to the equilibrium concentration of this component in the raffinate is called the diffusion coefficient:

$$m = \frac{y'}{x},$$

here, y' – the equilibrium fraction of the diffusible component in the extract; x – equilibrium fraction of the propagating component in the raffinate.

The extraction capacity of the solvent can be determined by the value of the diffusion coefficient. The greater the value of m, the higher the ability of such a solvent to extract the desired component from the liquid mixture. In extraction systems, the value of m varies from 1 to 10000. The following ratio is used to estimate the separation ability of a solvent:

$$\frac{m_1}{m_2} = \frac{y_1'/x_1}{y_2'/x_2} = \frac{y_1' x_2}{y_2' x_1} = \frac{y_1'}{y_2'} : \frac{x_1}{x_2} = \beta,$$

here, m_1 – is the diffusion coefficient of the first component in the mixture; m_2 – is the diffusion coefficient of the second component in the mixture.

The quantity β is called the extraction separation coefficient or factor. This coefficient indicates how many times the equilibrium concentrations of the separated components in the extract are greater than the equilibrium concentrations in the raffinate. This coefficient is similar to the relative volatility of the components in the rectification process. In real conditions, the value of β should not be less than 2.

Conclusions. It has been found that the most effective method of separating hydrocarbon content and alkaline water from waste is the quench separation method. In this case, the time of tinib separation was 240 minutes.

The hydrocarbon content was found to be highly soluble in naphthenic hydrocarbons and aromatic hydrocarbons and alcohols. In paraffin hydrocarbons, the hydrocarbon content was observed to split into two. Paraffins have been proven to be the best selective extractants for the separation of polymer mass from hydrocarbon content by extraction method.

It was found that the molecular weight and density of paraffin hydrocarbons have an inversely proportional effect on the rate of separation of extract and raffinate during the extraction of hydrocarbon content. It has been proven that the smaller the mass and density of the extractant, the faster the extraction process.

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EFFECT OF TEMPERATURE ON PHOTOELECTRIC PARAMETERS OF THREE-WAY ILLUMINATED SOLAR CELLS

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Abstract:

Objective. Increasing the efficiency of solar cells and reducing the amount of material used in its production is one of the important tasks of today.

Methods. A 3-way sensitive solar cell was designed for this purpose. Compared with one surface, the efficiency of three surfaces increased by 2,81 times and two surfaces by 1,72 times. One of the main parameters of the environment is temperature. The daily temperature changes according to the seasons. Therefore, it is important to study the effect of temperature on solar elements.

Results. In this scientific work, the effect of temperature on the photoelectric parameters of a three-way sensitive silicon-based solar cell was studied. It was found that the temperature coefficients of the photoelectric parameters of the three-way sensitive solar cell do not change when different areas are illuminated.

Conclusion. It was determined that the temperature coefficient of the operating voltage is $2{,}52\times10^{-3}$ V/K, and the temperature coefficient of the filling factor is $1{,}8\times10^{-3}$ K^{-1}. In addition, when the temperature changed from 300K to 350K, the short-circuit current in the three-side light state decreased by 4%.

Keywords: Three-way sensitive, solar cell, silicon, modeling, sunlight.

Introduction. Along with the increase in the need for energy, the use of renewable energy sources is also increasing. Because renewable energy sources are the best solution to today's energy shortage without harming the environment [1]. According to the International Energy Agency, in 2021 the volume of renewable energy sources reached 276 GW. Among renewable energy sources, solar energy is widely used to obtain heat and electricity [2]. Solar cells are mainly used to convert solar energy into electricity. 85% of solar cells produced in industry are silicon-based solar cells [3]. Therefore, a silicon-

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