

# Extraction of hydrocarbons from “yellow oil” with liquefied gas residue

*Lochin Tilloev\**, *Malikjon Murodov*, *Sherzod Ataullaev*, *Marjona Turakulova*, and *Mukhriddin Savriev*

Bukhara Engineering Technological Institute, Bukhara, Uzbekistan

**Abstract.** In order to extract the hydrocarbon content obtained from “Yellow oil” by using the liquefied gas residue collected at the bottom of the gas bottles during the distribution of liquefied gas to the local population, the properties of the liquefied gas residue were analyzed by traditional methods and the chemical composition was analyzed with the help of chromatographic methods. Based on the results of the analysis, it has been proven that it can be used as an extractant due to the fact that its composition consists of a mixture of paraffin hydrocarbons. In the extraction of hydrocarbon content, when extracting abilities of hexane and liquefied gas residue were studied, it was found that separation of raffinate from the extraction mixture is carried out twice as fast in liquefied gas residue as compared to hexane. It is recommended to use it as an extractant in the extraction of hydrocarbon content.

## 1 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. Pyrogas undergoes an absorption process to remove sour gases. 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. These are called “Yellow oil” along with polyaldols [1-6].

A large amount of “Yellow oil” produced during alkaline cleaning is a problem of oil and gas chemical enterprises, and many research works [7-10] have been conducted on its processing. In this research, processes such as separation of “Yellow oil” into hydrocarbon

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\* Corresponding author: [tilloyevl@mail.ru](mailto:tilloyevl@mail.ru)

and alkaline water by precipitation method, extraction of extracted hydrocarbon content and selection of selective extractant were studied. In this work [10], paraffin hydrocarbons were selected as the best extractant for the extraction of hydrocarbon content, and the change in the molecular mass and density of paraffin hydrocarbons was determined to be inversely proportional to the separation rate of extract and raffinate during the extraction process, and hexane was selected as the best selective extractant among paraffin hydrocarbons.

Pure hexane is economically expensive when used as an extractant. In order to achieve economic efficiency, it is advisable to choose a cheap alternative extractant that can be used as an extractant.

For this purpose, we aim to use the liquefied gas residue collected at the bottom of the gas bottles in the distribution of liquefied gas to the local population and for this, to study the composition and properties of liquefied gas residue, the study of its advantages over hexane used in the extraction of hydrocarbon content was determined as a research task.

## 2 Materials and methods

Hexane is a colorless liquid, gross formula  $C_6H_{14}$ , molecular mass 86.175 g/mol, melting point minus 95.34 °C, boiling point 68.742 °C, density at 20 °C 659.37 kg/m<sup>3</sup>, refractive index at 20 °C index 1.3749, heat of combustion 3887 kJ/mol, soluble in diethyl ether and chloroform, 0.00095 g in water at 25 °C. soluble, insoluble in liquid ammonia [11-14].

Density of liquefied gas residue GOST 3900 [15], content of aromatic hydrocarbons GOST 12329 [16] and fractional composition GOST 2177 [17] was determined using standard methods such as (Table 1).

An Agilent 6850 chromatograph device was used to qualitatively and quantitatively analyze its composition. The device was initially calibrated with n-hexane as reference substance. Then the selected sample was injected into the device using a microsyringe. The volume of the sample was 1 µl, and its evaporation started at 40 °C and ended at 250 °C. The separation of the components of the mixture was carried out in an Agilent HP-1 (30m×0.32mm×0.25 µm) capillary column (the carrier phase is helium, its flow rate is 26 ml/min., the temperature in the column is 40 °C). The appearance of the obtained chromatogram is shown in Figure 1.

Based on the results of the analysis of the liquefied gas residue by the gas-liquid chromatographic method, additional indicators were determined according to the GOST 31371.6-2008 standard [18] (Table 2).

### 2.1 Extraction of hydrocarbon content in hexane and liquefied gas residue.

Two 100 ml measuring cylinders were taken, and an equal amount of 25 ml of the hydrocarbon content was mixed well and then added to each container. 25 ml of hexane was poured onto the sample in both containers at the same time and the mouth of the container was closed with a rubber stopper. Both containers were placed on a vibrator and mixed by shaking for 5 minutes. Then it was held still and at the same time the stopwatch start button was pressed. Volumes of solids accumulated on top of both measuring cylinders were determined (Figure 2).

## 3 Results and discussion

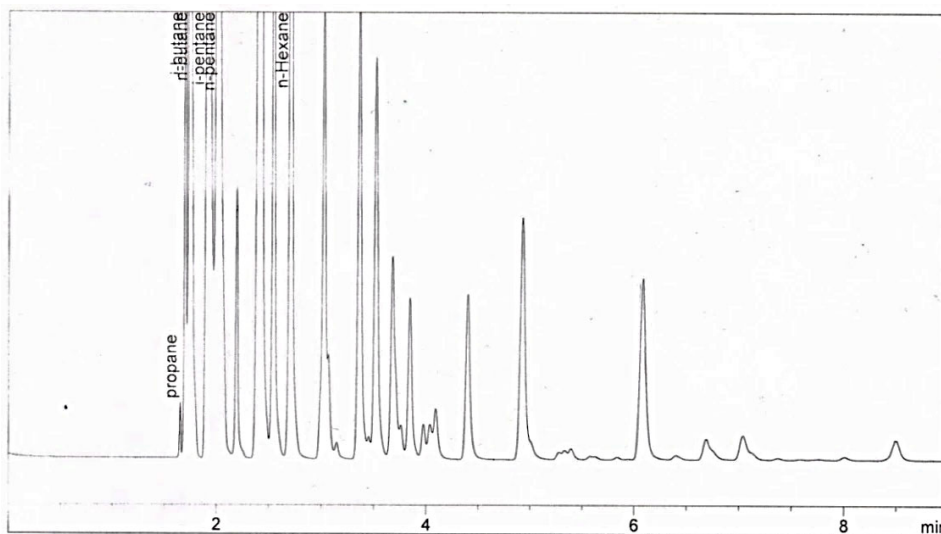
The results of the research conducted to determine the properties of the liquefied gas residue are presented in Table 1 below.

**Table 1.** Properties of liquefied gas residue.

№	Indicator name	Value
1	Density, kg/m <sup>3</sup>	635
2	Amount of aromatic hydrocarbons, %	0.23-0.27
3	Boiling initially temperature, °C	23
4	Ending boiling temperature, °C	116
5	Fractions, °C	%
	0 – 30	38
	30 – 40	25
	40 – 50	17
	50 – 60	6
	60 – 70	6
	70 – 80	3
	80 – 90	2
	90 – 100	1.5
	100 – 110	1
	110 – 120	0.5
	Residue	0

It can be seen from Table 1 that the density of liquefied gas residue is about 1.03-1.04 times smaller than that of hexane, which causes it to relatively decrease the density of the extract during the extraction process and as a result, it allows the raffinate to precipitate faster from the extraction mixture. The presence of an average of 0.25 % of aromatic hydrocarbons in its composition accelerates the dissolution process during extraction due to a synergistic effect. The initial boiling point is 1.94-1.97 times lower than that of hexane and 90-92 % of the components with low boiling points mean that it can be evaporated from the extract and the raffinate without spending too much energy.

The results of the chromatographic analysis obtained from the study of the composition of the liquefied gas residue showed that its main composition consisted of a mixture of paraffinic hydrocarbons from C<sub>3</sub> to C<sub>6</sub> (Figure 1 and Table 2).



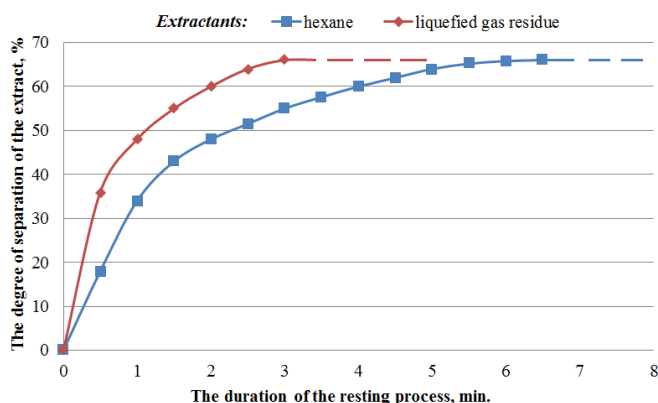
**Fig. 1.** Chromatogram of liquefied gas residue obtained on an Agilent 6850 chromatograph.

**Table 2.** Hydrocarbon composition of liquefied gas residue determined on an Agilent 6850 chromatograph.

№	Components	Quantity, mole %	High heat of combustion, kJ/mol	Heat of lower combustion, kJ/mol
1.	propane	1.27	28.11	25.87
2.	i-butane	14.68	421.14	388.68
3.	n-butane	26.93	775.22	715.67
4.	i-pentane	19.08	673.94	623.28
5.	n-pentane	29.58	1046.12	967.64
6.	hexane and above	8.46	355.07	328.88
<b>All:</b>		<b>100</b>	<b>3299.59</b>	<b>3050.88</b>

This composition means that the liquefied gas residue can be used as an extractant in the extraction of hydrocarbon content.

The time dependence of the separation of the extract and raffinate during the extraction of the hydrocarbon content in hexane and liquefied gas residue was studied (Figure 2).



**Fig. 2.** Time dependence of the separation of extract and raffinate during extraction of hydrocarbon content in hexane and liquefied gas residue.

It can be seen from Figure 2 that when extracting hydrocarbon content with liquefied gas residue, the separation time of extract and raffinate is twice as short as that of hexane. This means that it has twice the separation rate of extract and raffinate compared to hexane.

## 4 Conclusion

An Agilent 6850 chromatograph was used to determine the chemical composition of the liquefied gas residue. It is found to contain C<sub>3</sub>-C<sub>6</sub> paraffinic hydrocarbons. It was found that the amount of n-paraffins in this composition is higher than that of i-paraffins. It has been proved that the liquefied gas residue can be used as an extractant in the extraction of hydrocarbon content.

It was found that 2.5-3 minutes are needed for the complete separation of extract and raffinate when extracting hydrocarbon content with liquefied gas residue. The low density of the liquefied gas residue compared to hexane means that the raffinate particles in the extraction mixture are quickly separated by sedimentation.

It was found that the initial boiling temperature of the liquefied gas residue is 1.94-1.97 times lower than that of hexane, and the components with a low boiling temperature make

up 90-92%. The rapid separation of the extraction mixture leads to additional service costs and reduced equipment consumption.

Based on the determined properties and composition of the liquefied gas residue, it can be evaporated from the raffinate and extract separated after the extraction process at a low temperature compared to hexane. As a result, a certain amount of energy is saved.

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