Fractional composition of the waste yellow oil

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Abstract. In this article, the authors study the separation of the oily part of the waste oil yellow oil into fractions by driving it on special drive with electric heater, as well as the refractive index of the separated fractions. The fractional composition of yellow oil is given in the table. Based on the results, recommendations are given for the use of the extracted fractions in various industries.

1. Introduction
At present, one of the most pressing issues is global climate change. Today, every country has the effects of this process. Unfortunately, such changes also pose a serious threat to the development of Central Asia [1]. One way to partially prevent such global climate change is to recycle industrial and domestic wastes.

In the words of the famous Russian scientist D.I. Mendeleev, “Chemistry has no waste, only unused raw materials!”

Waste yellow oil is one of such waste, and is formed during the alkaline treatment of pyrogas (figure 1).

It is known that the process of pyrolysis is based on the production of unsaturated hydrocarbons by the decomposition of saturated hydrocarbon gases at high temperatures in the air. During the pyrolysis of ethane, dimethyldisulfite (DMDS) is added to the raw material to prevent the formation of coke in the pyrolysis furnace pipes, and water vapor is added to reduce the partial pressure of the process. As a result, pyrogas forms sour gases (H₂S and CO₂) and oxygenated organic compounds (aldehydes, ketones, acids, alcohols) [2, 3].

An absorption process is performed to clean the pyrogas. Pyrogas passes through an alkaline treatment column, where sour gases (H₂S and CO₂) are separated. Pyrogas cleaning is carried out in two stages. To achieve a purity of 1 ppm for sour gases, the pyrogas is first purified at the bottom of the column with a “weak” solution with a mass concentration of 2% free alkali. The pyrogas is then purified in the middle of the column with a 10% solution of free alkali by mass concentration [4-8]. The purified pyrogas is washed from the top of the column with water vapor condensate and alkali droplets. In the column, sour gases - H₂S and CO₂ - react with alkaline NaOH to form sulfides and carbonates [9, 10]. The used alkali from the cubic part of the column is sent to the system for the recovery and neutralization of the used alkali [11].

Yellow oil (aldol condensation product, (oligo) polymer) is formed in the cubic part of the pyrogas cleaning column. The yellow oil is collected in a pocket in the cube of the column and periodically transferred to a separator. In the separator, the yellow oil separated from the gas phase is poured into special containers [12]. Then is removed from the device area and treated as a waste of the process.
2. Research methods

We conducted the following studies to study the fractional composition of waste yellow oil and the properties of the separated fractions.

The waste yellow oil from the device (figure 2a) was initially broken down by cooling at room temperature. As a result, the yellow oil was divided into three parts (alkaline water - the lower part, the polymer - the middle part and the oil - the upper part) (figure 2b).

The studies were mainly conducted on the oily part where the yellow oil was extracted. In these studies, the fractional composition of the oily part, the refractive index of the separated fractions were determined.

Sampling of oily parts was carried out in accordance with GOST 2517-2012. Determination of the fractional composition of the oily part was carried out in accordance with the requirements of GOST 2177-99. The refractive indices of the individual fractions were determined using the process. 301-95 refract meter to the nearest ± 0.0001, the liquid fractions at 20°C and the solid fractions at 70°C.

![Figure 1. Scheme of the technological process of waste yellow oil receiving.](image1)

![Figure 2. Waste yellow oil.](image2)

a) the appearance of waste yellow oil
b) the appearance of the waste yellow oil separated into parts
3. Results

In order to study the fractional composition of the oily part, 100 ml of the sample was taken and pumped using a special electric heater (figure 3). The boiling point of the sample started at 83 °C. The driving process was carried out up to 250 °C. The fractions were expelled every 10 °C. As a result, 14 fractions were separated from the oily part with a temperature difference of 10 °C. Fractions 3, 4, 5, and 6, 7, and 8 were added for further experiments due to their low volume. The results are presented in tabular form (table 1).

Figure 3. Special driving device with electric heater: 1-thermometer; 2- driving tube; 3-asbestos material; 4-electric heating appliances; 5-stand; 6- handle to regulate the position of the tube; 7- disk for heating regulation; 8 - switch-off device; 9-open shell; 10-gauge cylinder; 11- filter paper; 12-cooling bath; 13- refrigeration pipe; 14-shell.

The study examined the aggregate states and refractive indices of individual fractions under standard conditions. In this case, it was observed that all the fractions with a boiling point in the range of 210 - 220 °C under normal conditions of the aggregate state were solid (table 1). In order to determine which hydrocarbon group the fractions belong to, their refractive indices were determined using an automatic refractometer DR 301-95 (figure 4). The DR 301-95 automatic refractometer has a refractive index of ± 0.0001 and a refractive index of 1.3 to 1.7. Before starting the measurement, the desired temperature in the device is set by the thermostat, which is then switched off during the measurement.

Figure 4. General appearance of DR 301-95 automatic refract meter.
The refractive index of liquid fractions is 20 °C, where the 3rd, 4th, 5th order fraction is boiling in the temperature range of 130 - 160 °C, and the 6th, 7th, 8th order fraction is in the temperature range of 160-190 °C. The refractive indices of the boiling fractions were determined.

Since the boiling fraction in the temperature range 210-220 °C was solid under standard conditions, its refractive index was determined at 70 °C in accordance with the standard requirements (table 1).

**Table 1. Fractional composition of the oily part and some properties of the separated fractions.**

| Sequence number of fraction corresponding to boiling point | Fraction boiling point range, °C | Output of fractions, (volume)% | Aggregate state of fractions * | Refractive index of fractions |
|-----------------------------------------------------------|----------------------------------|--------------------------------|-------------------------------|-----------------------------|
| 1                                                         | s.b.-120                         | 3                              | Liquid                        | 1.4947                      |
| 2                                                         | 120-130                          | 2                              | Liquid                        | 1.4964                      |
| 3                                                         | 130-140                          | 1.9                            | Liquid                        | 1.5074                      |
| 4                                                         | 140-150                          | 1.9                            | Liquid                        | 1.5074                      |
| 5                                                         | 150-160                          | 1.9                            | Liquid                        | 1.5074                      |
| 6                                                         | 160-170                          | 3.6                            | Liquid                        | 1.5232                      |
| 7                                                         | 170-180                          | 3.6                            | Liquid                        | 1.5232                      |
| 8                                                         | 180-190                          | 3.6                            | Liquid                        | 1.5232                      |
| 9                                                         | 190-200                          | 5.4                            | Liquid                        | 1.4721                      |
| 10                                                        | 200-210                          | 5.6                            | Liquid                        | 1.5029                      |
| 11                                                        | 210-220                          | 10.1                           | Hard                          | 1.5892**                    |
| 12                                                        | 220-230                          | 5.4                            | Liquid                        | 1.5114                      |
| 13                                                        | 230-240                          | 4.5                            | Liquid                        | 1.4959                      |
| 14                                                        | 240-250                          | 3.7                            | Liquid                        | 1.4970                      |

*Temperature 293 K(20 °C) and pressure 101.325 kPa

**Temperature 343 K(70 °C) and pressure 101.325 kPa

4. Conclusion

Based on the results of the study, it can be seen that the output of fractions up to 250 °C when driving the oily part is 45.2%, of which 76.4% are fractions with a liquid state under standard conditions. When we compare the refractive indices of the fractions with the refractive indices of the individual hydrocarbon components given in the literature, we can see that most of them are almost identical to aromatic hydrocarbons.

If we pay attention to the aggregate state, light refractive index and appearance (white-blue mixed crystalline substance) of the fraction with a boiling point in the range of 210-220 °C, it is divided into multi-ring aromatic hydrocarbons. We can tell by the fact that it corresponds to the above indicators. For example, it is close to naphthalene (melting point 80.27 °C, boiling point 217.97 °C, refractive index 1.5898).

Based on the literature and the results obtained, we can conclude that the main constituents of the oil fraction, which is separated from the yellow oil, are single-ring and multi-ring aromatic hydrocarbons.

The liquid fraction of the separated fractions up to 210 °C is used as a solvent in oil refining industry, the solid fraction in the temperature range 210-220 °C is used as a drug in the fight against insects and rodents in agriculture. We consider it expedient to use it as an adjunct to increase the resource of the parties.

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