DETERMINING THE HYDROCARBON COMPOSITION OF BENZINE, ITS VARIOUS FRACTIONS, AND ISOMERIZATION PRODUCTS

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Abstract: Today, the production of gasoline varieties that meet Euro requirements is considered relevant. This article examines the chemical composition of gasoline and its various fractions, the content of aromatic hydrocarbons, and the group composition of isomerization process products.

Key words: Gas condensate, Gasoline, Aromatic hydrocarbons, Adsorption, Formalin, Dearomatization, Thermometer, Mixer, Measuring cylinder.

Аннотация: Сегодня производство сортов бензина, соответствующих требованиям Евро, считается актуальным. В данной статье рассматривается химический состав бензина и его различных фракций, содержание ароматических углеводородов и групповой состав продуктов процесса изомеризации.

Ключевые слова: Газовый конденсат, Бензин, Ароматические углеводороды, Адсорбция, Формалин, Деароматизация, Термометр, Смеситель, Мерный цилиндр.

INTRODUCTION: We know that oil and its products consist of a large number of organic compounds, and studying their chemical composition is considered one of the most complex tasks. Determination of the complete individual composition is possible only for light gasoline fractions. As the molecular weight of oil fractions increases, the study of their composition becomes more complex.

In accordance with the physicochemical properties of oil and gas condensate, gasolines obtained through direct distillation from oil and gas condensate can contain aromatic hydrocarbons, alkanes, cycloalkanes, and simultaneously several heteroatomic compounds [1].

Gasoline fractions resulting from the thermocatalytic processing of petroleum raw materials (catalytic cracking, hydrocracking, visbreaking, etc.) contain, in addition to the aforementioned compounds, alkenes and alkadienes.

There are mainly two directions in determining the chemical composition of gasoline and its various fractions:

- Determination of the hydrocarbon group of gasoline, in which gasoline and its fractions—alkanes, aromatic hydrocarbons, isoalkanes, and naphthenic hydrocarbons—are collectively identified. This method allows for the determination of the content of various hydrocarbon groups in gasoline. Several methods are used here. These methods are widely used because they are simpler and easier than determining individual chemical compositions;
- Using the method of determining the individual composition of gasoline, all components in the gasoline are identified.

To determine the composition of the hydrocarbon group, the aniline point method is used, based on the mixing of aniline with gasoline and its fractions before and after the extraction of aromatic hydrocarbons [2].

There are two methods for determining the aniline point: the equal-volume method and the maximum aniline point method. In our research, the equal-volume method was used, in which the studied fraction and aniline were taken in equal quantities and the temperature was taken until their complete dissolution.

When mixing petroleum fractions with aniline at room temperature, no double layer is formed, meaning the complete dissolution of the petroleum product into aniline is not observed. If this mixture is constantly stirred and heated, when the mixture reaches a certain temperature point, the petroleum product and aniline dissolve together, and the mixture transitions into a homogeneous state. The temperature at which aniline and petroleum products dissolve completely is called the aniline point [3].

The purpose of this experiment is to determine the aniline point using the method of equal volumes of gasoline and its fractions and isomerization catalysts.

Procedure

- Determination of the aniline point of gasoline and its fractions;
- Isolation of aromatic hydrocarbons from the sample using liquid-adsorption chromatography using silica gel;
- Determination of the aniline point of de-aromatized samples;
- Calculation of the content of hydrocarbon groups in the sample in %: aromatic hydrocarbons, paraffinic hydrocarbons, isoparaffinic and naphthenic hydrocarbons.

Method for determining aniline points in equal volumes (GOST 12329-77)

Reagents and equipment:

1. Muffle tube;
2. Heat-resistant glass container with a capacity of 500 ml;
3. Thermometer;
4. Mixer;
5. Measuring cylinder;
6. Pure aniline grade "CH";
7. The fraction under study.

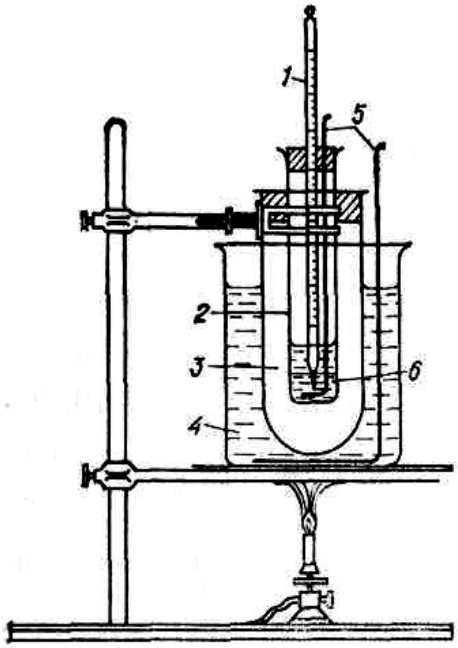

Figure 1. General view of the laboratory device for determining the aniline point: *1 - thermometer; 2 - test tube; 3 - clutch; 4 - water bath; 5 - mixer; 6 - mixture of aniline with the investigated petroleum product*

A general view of the laboratory device for determining the aniline point is shown in Fig. 1.

RESULT: In 2 clean and dry test tubes, 2 ml of aniline and the oil product under study are poured, and the tube is tightly closed with a lid with a thermometer 1 and a mixer 5 attached. Then the test tube 4 is placed in a water bath. The thermometer should be positioned so that its mercury ball is between the aniline and the part separated from the substance under study. The temperature of the water bath is gradually raised. In this case, the aniline and petroleum product must be constantly mixed. The temperature of complete mixing of the liquids (where the solution must be completely transparent) is determined, heating is stopped, and the water is slowly cooled. When the 2 test tubes begin to become cloudy, this indicates phase separation, and the mixture is stirred again in a stirrer. At the beginning of mixing, the blur disappears, but then there is a period of blur that does not disappear. This temperature is set. The aniline point is taken as the average temperature of the complete mixing of aniline and petroleum products and the turbidity of the liquid.

Extraction of aromatic hydrocarbons using silica gel

Aromatic hydrocarbons are extracted from petroleum products using silica gels in an adsorption laboratory (Fig. 2).

Equipment, reagents, materials:

1. Glass column with a height of 700 mm and a diameter of 8-10 mm;
2. Rectified ethyl alcohol;
3. Technical silica gel;
4. Porcelain cup;
5. Technical formalin (40% aqueous solution);
6. Sulfuric acid (98%);
7. Measuring cylinder.

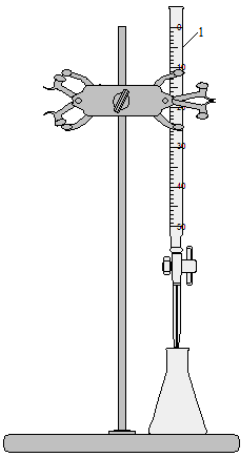

Figure 2. Laboratory adsorption column

Conducting an experiment

Fill the column with 15 g of silica gel, attach it to a stand, and place a measuring cylinder at the bottom of the column. It is advisable to use 0.25-0.5 fractions of silica gel. Before the experiment, the silica gel must be dried. The studied fraction is injected into a silica gel column in an amount of 15 ml; after the silica gel absorbs the entire fraction, 15 ml of ethyl alcohol is added as the desorbing liquid. In this case, the paraffin, isoparaffin, and naphthenic hydrocarbons are the first to exit from the lower part of the column. This is because their adsorption on silica gel is more difficult compared to aromatic hydrocarbons. A sample of 1 ml of the first fraction is taken, and the presence of aromatic hydrocarbons is determined using the formalin reaction. If the color of the formalin does not change and there are no aromatic hydrocarbons, 1 ml is taken from the second portion and the formalin is tested again using the reaction. If the second portion contains aromatic hydrocarbons, i.e., the color of the formalin changes, then only the aniline point of the first portion of the sample is detected.

Formalin reaction (qualitative reaction for determining aromatic hydrocarbons)

5-6 drops of 98% colorless sulfuric acid are poured into a small porcelain vessel, and 1-2 drops of formalin and the same amount of the oil fraction under study are added. In the absence of aromatic hydrocarbons, the mixture remains colorless or yellowish less. A sharp change in color indicates the presence of aromatic hydrocarbons in this mixture.

Calculation method

First, the aniline point of the incoming fraction is t_1, then aromatic hydrocarbons are separated, and the aniline point t_2 is determined again for the de-aromatized petroleum fraction. The mass fraction of aromatic hydrocarbons A, in %, is determined as follows:

$$A = K(t_1 - t_2) (1)$$

where: K is the coefficient of the percentage content of aromatic hydrocarbons leading to a decrease in the aniline point for every 1 0C of the dearomatized fraction (Table 1).

Table 1

150 ^{0}The coefficient for determining the content of aromatic hydrocarbons in gasoline fractions boiling to C is K [4; 1-10 p.]

Faction, ^{0}C	**Mass fraction of aromatic hydrocarbons, %**	
	up to 20	**20-40**
60-95	1.15	1.14
95-122	1.20	1.18
122-150	1.26	1.22

The mass fraction of cycloalkanes N was calculated using the following formula:

$$N = (100 - A) N_1 / 100 (2)$$

where: N_1 is the amount of cycloalkanes in the dearomatized fraction,%.

N_1 is determined by a known aniline point t_2, as shown in Table 2. The mass fraction of alkanes in P % is calculated using the following formula:

$$P = 100 (A + N) (3)$$

where: A - mass fraction of aromatic hydrocarbons, %; Mass fraction of N-cycloalkanes, %.

Table 2.

Dependence of the mass fraction of cycloalkanes in the de-aromatized gasoline fraction on the aniline point, %. Aniline to Fraction ratio 1:1

Aniline point, ^{0}C	Faction, ^{o}C			
	60-95	95-122	122-150	150-200
78	-	-	-	0
77	-	-	-	5.
76	-	-	-	10
75	-	-	-	15

Continuation of Table 2

74	-	-	-	20
73	-	-	0	25
72	-	-	4.	30
71	0	0	9.	35
70	3.	4.	13	40
69	6.	8.	18	45
68	9.	12	22	50
67	12	16	26	55
66	15	19	31	60
65	18	23	35	65
64	21	27	40	70
63	24	31	44	75
62	27	34	48	80
61	30	38	52	85
60	33	42	56	90
59	36	45	60	95
58	39	49	65	100
57	42	53	69	-

56	45	56	73	-
55	47	60	77	-
54	50	63	81	-
53	52	67	85	-
52	55	70	88	-
51	58	74	62	-
50	61	77	96	-
49	64	81	100	-
48	67	84	-	-
47	70	87	-	-

Continuation of Table 2

46	73	90	-	-
45	75	93	-	-
44	77	97	-	-
43	80	100	-	-
42	82	-	-	-
41	85	-	-	-
40	87	-	-	-
39	90	-	-	-
38	92	-	-	-
37	95	-	-	-

Conclusion As a result of the conducted research, the following was studied: The chemical composition of gasoline and its various fractions, the aniline point, and the isomerization process catalysts were determined using the equal-volume method. Aromatic hydrocarbons were isolated using silica gel; aromatic hydrocarbons were isolated from petroleum products using silica gel in an

adsorption laboratory unit; the quality reaction of aromatic hydrocarbons was studied using the formalin reaction, and the dependence of the mass fraction of cycloalkanes on the aniline point in the de-aromatized gasoline fraction was determined, in %.

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