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Research Article

SYSTEM SOLVENTS BASED ON GAS CONDENSATE

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ABSTRACT

The preparation and study of the properties of solvents is a large branch of petrochemistry and influences on the development of many branches of the national economy. Considering the regional lack of production and in order to meet the demand for solvents, in this paper we consider the issues of developing a technology for obtaining and studying the properties of solvents based on hydrocarbons of gas condensate (GC), in particular, GC of the Shurtan field.

KEYWORDS

Gas condensate, natural gas, solvent, aromatic hydrocarbons, rectification column, paint-and-lacquer materials, unitary subsidiary company.

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INTRODUCTION

The paper presents the results of researching the compositions and studying the properties of selective composite solvents for the extraction of oils of modified alkyd tars, varnishes and paints, as well as the development of a technology for their production based on low-sulfur, highly aromatized gas condensate (GC) and components obtained at domestic chemical enterprises [1,2].

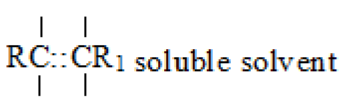
The object of study is gas condensate (GC) of the Shurtan field - a clarified mixture of natural hydrocarbons accompanying natural gas (steam-gas solution).

Research methods - all studies were carried out in accordance with GOST. Modern physico-chemical, chemical, statistical and technological research methods (IR spectroscopy, gas-liquid chromatography, etc.) were used in the experiments.

Results and their discussions. Composite solvents consist of the main carriers of systemic solvents, functionally active fillers, stabilizing additives and other ingredients. Hydrocarbon solvents are a mixture of their various varieties (aliphatic, naphthenic and aromatic). These solvents are widely used in the production of paint-and-lacquer materials (hereinafter referred to as PLM) in mechanical engineering (for flaw detection of parts and applying sealants to them), in chemical materials science (when washing and cleaning substances and products), in petrochemistry (for liquefying, clarifying and separating oil products), in the food industry, etc. [3]. Hydrocarbon solvents are obtained from light petroleum products by the method of distillation fractionation with selective selection of their required fractions with certain physical and chemical properties that meet the indicators of the relevant technical conditions.

Hydrocarbon solvents are of great importance in organic chemistry and chemical technology, in particular, in the production of individual materials and products as a component or medium, and also as means of their purification. The production and use of paint-and-lacquer materials is almost impossible to imagine without solvents, since hydrocarbon solvents play an important role as a reaction medium and as a component [4]. Sometimes for paint-and-lacquer materials hydrocarbon solvents are used as a diluent. In some cases, hydrocarbon solvents can act as both a solvent and a diluent.

Hydrocarbon solvents do not have reactive functional groups [5], but despite this, they have the property of affinity soluble mixtures and the manifestation of chemical intermolecular interactions, such as, for example, as a donor of an atom of one carbon molecule to an acceptor of hydrogen of another molecule. Moreover, such a chemical relationship is very weak, like hydrogen bonds.



Such a bound state of the solution leads to inclusion, mutually activating until the formation of their true solutions due to the uniform distribution of the solvent in the solute. Usually, such mixtures are formed due to the "related" nature of the process of dissolution in "related" hydrocarbons. Here, the solvents are low

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molecular weight hydrocarbons (M1), and the solutes are high molecular weight hydrocarbons (M2). More true solutions in such cases can be at M1 >> M2.

PLM are often oligomers of functional monomers. For example, drying oil-oxypolymerized oils combine well with hydrocarbon solvents. Such solutions of PLM form peptide bonds due to their chemical compatibility with solvents due to polypeptization of functional groups of triglycerides of hydrocarbon atoms with hydrocarbon solvents. They weaken intermolecular peptide bonds. In order to ensure effective dissolution (or dilution) of paint-and-lacquer materials, it is necessary to increase certain colloid-chemical properties of their solutions that meet the requirements of indicators of technical conditions for commercial products (varnishes, paints and other compositions) with the required final consistency.

At present, two types of PLM are produced at the Ferghana Oil Refinery: NEFRAS -S-4 (of the white spirit type), used in paints and varnishes, and NEFRAS -S-3 (of the BR-1 solvent gasoline type), used in the extraction of cottonseed oil from the respective substances.

In connection with the above, in order to improve the quality, increase the range and import substitution before their processing into motor fuel at an oil refinery, we have developed technologies for producing hydrocarbon solvents from gas condensate (GC). In terms of purity, color (according to the iodometric scale) and mobility, gas condensates of the Shurtan Gas Processing Plant (SHGPP), the Shurtan Gas Chemical Complex (SHGCC), the Kokdumalak, Mubarak and Gazli fields, the properties of which are given in the table 1, are suitable for obtaining hydrocarbon solvents as a feedstock.

Separate physicochemical properties and composition of selected gas condensates suitable for the production of hydrocarbon solvents (Table 1) showed that the studied gas condensates are relatively transparent, mobile, and in their composition meet the requirements for the quality of raw materials for obtaining various hydrocarbon solvents from them. The proposed technology for the production of hydrocarbon solvents differs significantly from the traditional one in that the feedstock is fundamentally different from oil (see Table 1), and in this regard, the technological scheme for their production can be based not at an oil refinery, but directly at a gas processing plant (GPP). At the same time, gas condensate stabilization units (GCSU) and propane-butane separation units (PBSU) operate in all oil refineries at operated gas condensate gas fields. At GCSU, from the low-temperature hydrocarbon solvent separation of gas, the separated gas condensate is subjected to rectification separation from propane-butane gases dissolved in it and at PBSU, together with gases, light hydrocarbons with a temperature of 35-1400C are separated. Both processes are based on the fractional separation of hydrocarbons. To reduce the partial pressure of gas condensate, it is stabilized by removing up to 5-7% of dissolved gases in order to safely transport them to refineries for processing them into motor fuel along with oil.

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Table 1. Separate physicochemical properties and group composition of selected gas condensates suitable for the production of hydrocarbon solvents

Mining facility	Production volume, thousand tons	Physicochemical properties		Composition of hydrocarbons, %		
		n_D^{20}	D_4^{20}, g/cm³	Aromatic	Naphthenic	Paraffin
Mubarak field	510	1,4274	0,728	8,8	29,1	62,1
Kokdumalak field	1910	1,4392	0,768	12	15	73
Shurtan gas processing plant	830	1,4417	0,762	29	22	49
Shurtan GCC	210	1,4281	0,735	10	32	58
Gazli field	60	1,4460	0,765	32	23	45

For standard cleaning of gas condensates into liquefied gases used in gas-balloon vehicles as a cheap and environmentally friendly motor fuel, propane-butane separation from a wide fraction of light hydrocarbons (WFLH) is carried out.

In the lightest hydrocarbon solvents, there is a tendency for the best dissolution, which accelerates the drying of PLM on the substrate. At the same time, in order to develop a technology for obtaining solvents from the used PLM, their given characteristic indicators were taken into account.

Light and stable GC and their WFLH were subjected to fractional separation in a model laboratory rectification unit.

The obtained oil-extraction solvents had the following qualitative and quantitative composition (Table 2).

Table 2. Qualitative and quantitative indicators of solvents for the extraction of vegetable oils

Components	Boiling temperature of hydrocarbon solvents, ^{0}C	Solvents		
		GC - 30/115 WFLH	GC- ES 30/85	GC- ES 65/85

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n-pentane	36,1	0.35	0.75	0.92
2,3-dimethylbutane	58,0	2.46	2.29	2.08
2-methylpentane	60,0	3.20	14.47	19.60
n-hexane	68,0	36.50	37.24	29.97
Methyl cyclopentane	71,8	10.90	11.78	9.24
2,4-dimethylpentane	80,5	2.95	2.90	3.12
Benzene	80,1	0.05	0.07	0.08
g-methylhexane	85,2	0.92	1.20	1.01
3-methylhexane	84,0	0.31	0.38	0.41
1,2-dimethylcyclopropane	78,2	0.82	0.90	0.94
Methylcyclobutane	76,4	0.60	0.55	0.60
Other hydrocarbons	30-115	4.54	3.25	0.10
C_2 - C_{10}	<<	3.25	-	-

Light components of WFLH, which are part of GC-30/115 and GC-ES 30/85.

The qualitative composition of hydrocarbon solvents for the extraction of vegetable oils can be seen from Table-2.

Of a number of known varieties of hydrocarbon solvents for paintwork materials in our republic, only one brand is produced - NEFRAS -S-4 with 130-210 C, which does not always meet the requirements for paints and varnishes in terms of such parameters as transparency, volatility, content of harmful impurities in the composition and etc. The proposed technology for obtaining varieties of hydrocarbon solvents in GCSU at the natural gas processing plant of the Shurtan field (Unitary subsidiary company (USC) "Shurtanneftgaz") is expressed as follows (see Figure-1).

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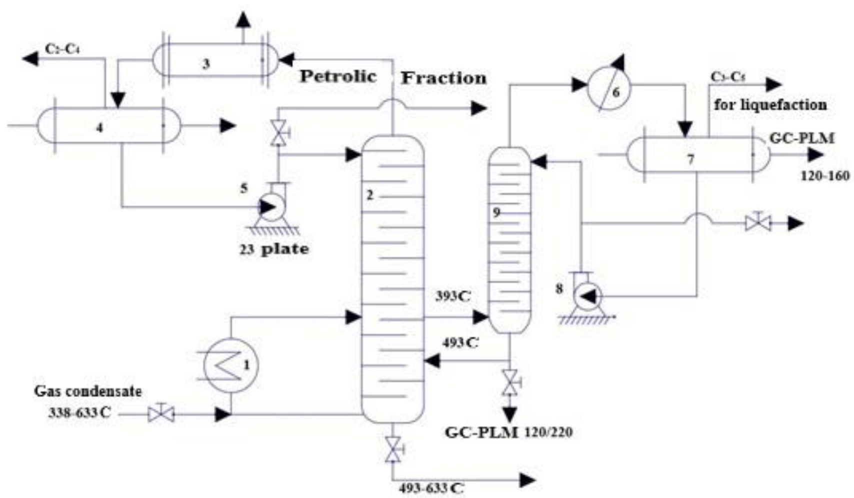

Fig. 1. Principal technological scheme for obtaining solvents of gas condensate of the Shurtan gas field, taking into account the conditions of GCSU "Shurtanneftgaz": 1-furnace; 2-rectification column; 3-heat exchanger; 4,7-degassers; 5.8 pumps; 6-refrigerator; 9-side strengthening column.

At the gas condensate stabilization distillation column, consisting of 40 hydrocarbon separation plates, at the level of 17-20 plates, a fraction of 120-185 C (white spirit) with a volume of 3-5% is selected for the processed gas condensate, which is no more than 10 thousand tons per year of quality solvent of gas condensate of paint-and-lacquer materials 120/210. From 3-5% of the condensable fractions of hydrocarbons, 2/3 of the volume is subjected to reflux (separation of liquid from water during the distillation process) for irrigation of the 23rd plate of the same fractional column. There is a clear separation of the specified solvent.

Comparative indicators of the obtained solvents from gas condensate according to the proposed technology are given in Table 3. As can be seen from Table 3, the quality indicators of gas condensate for PLM are much superior to their counterparts obtained from oil.

Table 3. Comparative physical and chemical parameters of oil and gas condensate solvents

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Indicators	Notable petroleum solvents				Solvents from gas condensate		
	White-spirit	Solvent	NEFRAS S-3	NEFRAS S-4	GC-PLM 120/220	GC-PLM 120/160	GC-ES 65/85
Density at 20^0C, kg/m^3, no more	795	865	695	790	780	845	700
Initial boiling temperature ^{0}C	130	120	72	130	120	120	65
Final boiling temperature ^{0}C	210	160	98	98	220	160	85
Residue in the flask, %	2	3	1	2	0,5	-	-
Aromatic hydrocarbons, % not less than	16	65	4	16	18	42	-
Mass fraction of sulfur, %	0,02	0,04	0,025	0,08	0,01	-	0,001
Flash temperature, ^{0}C	-23	-20	-22	-32	-30	-24	-27
Xylene volatility	4,5	5-6	2,5-3	6	4-6	3-4	2-2,5
Solvent color	Light red	Light yellow	Transparent	Light yellow	Transparent	Transparent	Transparent

For system solvents of paint-and-lacquer materials from gas condensate, separate colloid-chemical and operational properties are given on the example of their solutions with drying oil K-3 (Table 4).

Table 4. Properties of olefin solutions

Solvents	Colloidal-chemical properties				Performance properties	
	Viscosity, centipoise	Surface tension, Dyne/cm^2	Adhesion on the substrate, %	Kauri-butanol point, g	Aniline point, K	Xylene volatility, ^{0}C
GC-GC-PLM 120/160	35	33	96,5	54	357	2,0
GC-PLM 160/220	28	34	98,0	34	393	3,0-3,5
GC-PLM 120/210	34	38	97,2	44	368	2,5-4

The above indicators of the properties of solutions of drying oil K-3 are quite acceptable when they are used to form high-quality protective coatings on a wooden substrate.

Conclusion. It should be noted that in order to meet the demand of a number of target industries for higher-quality and inexpensive system solvents, it can be obtained on the basis of gas condensate.

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