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HYDROCARBON SOLVENTS ON THE HEXANE BASE FOR OIL ORGANIC DEPOSITS ELIMINATION OF THE IRELYAKH GAS AND OIL FIELD

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The group composition of asphaltene-resin-paraffin deposits (ARPD) in the Irelyakh field and their solubility in the composite solvents on the hexane base with the additives consisting of nonionic surface-active substances (NSAS) and concentrates of aromatic hydrocarbons is determined. The results of the investigations show that the additives Neonol AF-9-10 and liquid products of pyrolysis (LPP) are most efficient. The use of these additives allows to increase the efficiency of ARPD breaking and dissolving by 1,3 – 1,6 times as compared with a base solvent. It is shown that the increase in the concentration of individual additives from 0,5 to 3 % causes a decrease in the efficiency of detergent compounds.

1. INTRODUCTION

At present on the territory of Yakutia oil reservoirs of Talakansky, Sredne-Botuobinsky and Irelyakhsky fields of the Nepsko-Botuobinsky anteclise are in the experimental-industrial development. These gas and oil fields are situated in the zone of continuous distribution of permafrost rocks. That is why the regionally traced low reservoir temperatures (10 – 15 °C) and abnormally low reservoir pressures are characteristic of the producing horizons. Oils of the Nepsko-Botuobinsky anteclise are low-sulfur and have, mainly, methane composition (41-73 %), the increased content of asphaltenes (to 11 %) and resins (to 43 %) [1]. During the operation of oil-producing wells at a temperature and pressure drop, followed by oil degassing, a sharp decrease in solubility of paraffin, asphaltenes and resin matters occurs. This phenomenon in combination with the rough surface of the walls of oil well tubing (OWT) brings about the intensive deposition of ARPD on the surface of the producing equipment and in the bottom hole zone (BHZ). As a result, a decrease in the liquid inflow to the bottom zone and an increase in hydraulic resistance of wells take place.

Negative consequences of ARPD formation set conditions for developing a great number of methods for combating this phenomenon: mechanical, thermal, physical, chemical and microbiological [2, 3]. However the use of the above methods depends on the conditions of a particular field. For example, application of the biotechnological methods is restricted by high reservoir pressures, gas factors, high hydrogen sulphide content in oil and temperature being higher than 40…50 ° C. The magnetic treatment has its own requirements for the treated medium such as water hardness and mineralization of the produced water, gas factor (up to 200 m^3/m^3), etc. The electrical methods have a rather complex ground equipment used for the electric power supply in the underground heating installations. In this connection the intensive studies on breaking and removal of ARPD are carried out both in Russia and abroad [4]. As is known, hydrocarbon solvents are most efficient at removing ARPD [4, 5, 6, 7]. The main purpose of BHZ treatment with the use of solvents is breaking of water-oil emulsions in the bottom hole zone and ARPD removal. It is known that most of hydrocarbon solvents (casing-head gasoline, aromatic hydrocarbons, oil distillates, etc.) readily break water-oil emulsions as well as dissolve ARPD, formed in the oil well tubing, and do not evolve them after cooling of the solution.

At present the main procedure for ARPD control in the Irelyakh field is the periodic treatment of the reservoir by the cold condensate. But as the practical experience shows this method turned out to be ineffective for combating the organic depositions. Therefore, the most appropriate procedure for controlling the ARPD formation in the conditions of abnormally low reservoir pressures and temperatures can be the application of composite solvents.

The purpose of the investigation is **-** to evaluate the efficiency of hydrocarbon solvents on the basis of the hexane for elimination of ARPD of the Irelyakh field**.**

2. SUBJECTS AND METHODS OF INVESTIGATION

The subject of the investigation is ARPD of the oil of the Irelyakh field taken from the surface of the oil well tubing.

2.1. Determination of the ARPD group composition

The content of the main group components (hydrocarbon (HC) + hard paraffin, resins, asphaltenes and inorganic part) has been determined in the ARPD under study. Division of ARPD into group components is relevant and shows differences in solubility of these components in solvents used during the analysis of the residual oil products – the closest analogues of ARPD [8]. Therefore, investigations have been carried out with the use of the adsorption methods of analysis of the residual oil products by Marcusson [9]. The results are presented in Table 1.

2.2. Evaluation of the efficiency of hydrocarbon solutions at ARPD removing

Evaluation of the efficiency of the action of solvents with additives has been performed in static conditions by the methods of the RPO "Neftepromkhim" [10]. The ARPD sample is heated to the softening temperature, thoroughly mixed and shaped in the form of a cylinder 12 x 20 mm. Then it is cooled and placed into the previously weighed basket from the brass (steel) gauze with the size of a cell 1,5 x 1,5 mm. The dimensions of the basket are 70 x 15 x 15 mm. The basket with ARPD is weighed and placed in a glass hermetic cell where 100 mm of the solvent under study is poured. The experiment temperature is 10 ^{o}C. In 4 hours the basket with the residual non-destructed part of ARPD is taken out and dried to a constant weight. The destructed but undissolved part of ARPD, fallen from the basket in the cell, is filtrated, dried to a constant weight and weighed.

According to the above procedure the evaluation of the efficiency of the solvent is performed according to three indices:

1. The ability of a solvent to break ARPD into smaller fragments. This is the dispersing ability of a solvent, which is evaluated by the percentage amount of ARPD remained on a filter. This index must be optimum as at a very high dispersing ability of a solvent there is the probability of forming the fragments of ARPD, which can plug the bottom hole zone.

2. The ability of a solvent to form a real solution with the ARPD components. This is the dissolving capacity of a solvent, which is evaluated by the percentage amount of ARPD passing into the solution. The value of this index must be as large as possible.

3. The ability of a solvent to dissolve and break components of ARPD simultaneously. This is the so-called detergent power of a solvent, which is evaluated by the difference between the ARPD taken for the analysis and the residual of ARPD in the basket in % mass. This index can be considered to be the universal one. The higher is its value, the higher is the efficiency of a solvent on the whole.

3. RESULTS AND DISCUSSION

Table 1 shows the group composition of ARPD in the Irelyakh field.

Table 1

The group composition of asphaltene-resin-paraffin deposits

The place of sampling	Mass composition, %			
	Asphaltenes	Silica resins	HC+hard paraffin	Mechanical admixtures
The Irelyakh field	7,6	15,1	72,9	4,4

One can see from Table 1 that ARPD is characterized by a high content of the paraffin HC. Paraffin type of deposits and, as a result, their low polarity indicate that the base of the composite for breaking the ARPD structure must consist of a low-boiling aliphatic HC, hexane being selected as such a hydrocarbon.

Evaluation of the efficiency of solvents has been carried out according to such complex of characteristics as dispersing, dissolving and detergent abilities of the base solvents (hexane) and hydrocarbon solutions consisting of hexane and the additive (mixture of additives of different functional purpose). Concentrates of aromatic HC – polyalkylbenzene resin (PABR) [11], liquid products of pyrolysis (LPP) [12], ethylbenzene cut (EBC) [13] and butylbenzene cut (BBC) [14] have been investigated as the additive for increasing the dissolving and solvation function of the base solvent. The NSAS, produced by the home industry and representing the oxyethylated alkylphenol – Neonol AF-9-10, has been studied as the additive having the detergent-dispersing properties.

First of all the efficiency of using the individual additives at their mass content in the base solvent being from 0,5 to 3 % has been investigated. As the results obtained show, the LPP additives and Neonol AF-9-10 are the most efficient (Table 2).

Table 2

Experimental data on ARPD solubility in the Irelyakh field

Additive		Dispersing ability, % mass.	ARPD residual, % mass.	Dissolving ability, % mass.	Detergent ability, % mass.
Components	Concentration in a solvent, % mass				
Base solvent: Hexane					
Hexane		14,68	3,41	81,91	96,59
PABR	0,5	15,68	4,01	80,31	95,99
	1	18,82	7,13	74,05	92,87
	3	12,89	21,54	65,57	78,46
EBC	0,5	13,92	4,85	81,23	95,15
	1	11,35	6,25	82,40	93,75
	3	11,52	11,19	77,29	88,81
BBC	0,5	14,16	6,13	79,71	93,87
	1	14,39	8,63	76,98	91,37
	3	11,60	24,21	64,19	75,79
LPP	0,5	13,14	1,93	84,93	98,07
	1	11,89	8,00	80,11	92,00
	3	7,20	17,15	75,65	82,85
Neonol	0,5	20,03	2,59	77,38	97,41
	1	30,83	9,29	59,88	90,71
	3	55,38	14,87	29,75	85,13

The use of these additives allows to increase the efficiency of ARPD breaking and dissolving by 1,3 – 1,6 times as compared with the base solvent. The additive Neonol AF-9-10 has a higher dispersing ability in comparison with PABR, EBC, BBC and LPP. It is found out that the increase in the concentration of individual additives from 0,5 to 3 % causes the increase in the efficiency of detergent compounds. In all probability, at the concentration of additives higher than 1,0 % mass their absorption on the surface of ARPD occurs. The multimolecular layer formed in the conditions of the static regime prevents from further penetration of solvent molecules to ARPD, which is indicated by the general tendency for the decrease in the detergent ability of solvents regardless of the character of the additives being used.

Determination of the efficiency of the action of additive composites is of a great interest. In this connection the composite additives Neonol + PABR, Neonol + LPP, Neonol + EBC and Neonol + BBC with the total concentration in a base solvent being 0,5 % have been studied (Table 3).

Table 3

Experimental data on solubility of ARPD in the Irelyakh field

Additive		Dispersing ability, % mass.	ARPD residual, % mass.	Dissolving ability, % mass.	Detergent ability, % mass.
Components	Proportion of Components				
Base solvent: Hexane					
Hexane		14,68	3,41	81,91	96,59
Neonol:LPP	100:0	20,03	2,59	77,38	97,41
	90:10	14,28	14,31	71,41	85,69
	80:20	20,05	17,55	62,40	82,45
	70:30	14,11	15,71	70,18	84,29
	60:40	17,27	14,49	68,24	85,51
	50:50	21,07	13,71	65,22	86,29
	40:60	10,31	12,30	79,38	89,69
	30:70	6,48	18,32	75,20	81,68
	20:80	9,82	22,29	67,89	77,71
	10:90	10,47	11,35	78,18	88,65
	0:100	13,14	1,93	84,93	98,07
Neonol:EBC	100:0	20,03	2,59	77,38	97,41
	90:10	40,62	10,99	48,39	89,01
	80:20	29,37	18,64	51,99	81,36
	70:30	29,59	14,19	56,22	85,81
	60:40	20,91	20,62	58,47	79,38
	50:50	24,71	14,00	61,29	86,00
	40:60	14,97	9,39	75,64	90,61
	30:70	14,37	16,04	69,59	83,96
	20:80	8,69	17,47	73,84	82,53
	10:90	14,07	13,08	72,85	86,92
	0:100	13,92	4,85	81,23	95,15
Neonol:BBC	100:0	20,03	2,59	77,38	97,41
	90:10	12,95	7,19	79,86	92,81
	80:20	13,38	11,75	74,87	88,25
	70:30	11,95	14,68	73,37	85,32
	60:40	10,76	15,12	74,12	84,88
	50:50	11,74	20,78	67,48	79,22
	40:60	9,41	13,72	76,87	86,28
	30:70	9,15	13,47	77,38	86,53
	20:80	9,72	15,29	74,99	84,71
	10:90	7,30	16,86	75,84	83,14
	0:100	14,16	6,13	79,71	93,87

Additive		Dispersing ability, % mass.	ARPD residual, % mass.	Dissolving ability, % mass.	Detergent ability, % mass.
Components	Proportion of Components				
Base solvent: Hexane					
Neonol:PABR	100:0	20,03	2,59	77,38	97,41
	90:10	20,47	14,99	64,54	85,01
	80:20	17,80	11,77	70,43	88,23
	70:30	13,65	15,79	70,56	84,21
	60:40	16,78	12,84	70,38	87,16
	50:50	16,68	21,53	61,79	78,47
	40:60	16,07	24,62	59,31	75,38
	30:70	11,54	18,00	70,46	82,00
	20:80	17,89	21,32	60,79	78,68
	10:90	10,07	12,11	77,82	87,89
	0:100	15,68	4,01	80,31	95,99

The experimental data show that the positive synergetic effect is not observed for the composites under study. The detergent ability of composite additives decreases as compared with the individually used additives.

Therefore the hydrocarbon solvent with LPP at total concentration of 0,5 % mass in a base solvent can be considered to be the most efficient for removing ARPD in the Irelyakh field. In comparison with the pure hexane this solvent has high detergent and dissolving ability. Evidently, the increase in the detergent ability occurs due to the fact that the LPP additive improves the solubility of resins, which cement separate crystals of paraffin, particles of asphaltenes and mechanical admixtures.

4. CONCLUSION

1. It is established that asphaltene-resin-paraffin deposits in the Irelyakh field are characterized by a high content of paraffin hydrocarbons.
2. It is shown that during breaking and dissolving the ARPD of the paraffin base the best effect is obtained at using the additive consisting of liquid products of pyrolysis with the total concentration in a base solvent being 0,5% mass.
3. With the increase in the total concentration of individual additives in a base solvent the efficiency of detergent compounds decreases.

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