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THE METHOD FOR INCREASING THE EFFICIENCY OF ASPHALT-RESIN-PARAFFIN DEPOSITS INHIBITORS

One of the principal and undesirable kinds of complications in oil production on many fields is a formation of asphalt-resin-paraffin deposits (ARPD) on the surface of inner downhole equipment. This in turn results in substantial expenses for paraffin removal and production maintenance of wells, and also to the decline of oil production and considerable shortage and losses of oil.

As it is known from experience of field exploitation of wells in the conditions of oil fields of Ukraine, about 30% of well shut-downs for conducting of production maintenance permanent repairs takes place by the reason of paraffin accumulation on the surface of tubing. That inevitably results in diminishing of diameter of flow section of pipes and to the decline of well debits by the reason of refusals of sucker rod subsurface pumping installations and other equipment.

The principal reasons, which influence on formation of ARPD are: the oil composition, that is the concentration of asphaltenes, resins and paraffins; physical parameters of the flow, that is the temperature, pressure, liquid flow velocity ; water cutting of well production and the probability of formation of emulsion and the characteristics of the surface, that is polarity and roughness.

Undoubtedly, one of the main factors, determining the conditions of germ formation and crystallization of deposits and in turn influencing on formation of ARPD is the concentration of paraffins. However, it follows from the literature sources, that the substantial part is acted also by asphaltenes and resins, which influence on the structure of deposits [1]. The determinative factor hereat is the ratio of the concentration of asphaltenes (or the concentration of asphaltenes and resins) to the concentration of paraffins. On the basis of the analysis, made by us on the ten samples of ARPD from the wells of different oil-gas-condensate fields (OGCF) the conclusion of that the more is the ratio of the concentration of asphaltenes (asphaltenes and resins) to the concentration of paraffins, then the deposits are more proof has been done. This fact is confirmed by the laboratory researches. For example, for

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the sample of ARPD № 1 (the well No 1) [2] the ratio of the concentration of asphaltenes and resins to the concentration of paraffins makes (1,1+12,8) / 8,9 = 1,56, and for the sample of ARPD No 2 (the well No 2) this ratio makes (0,66+4,06) / 3,5 = 1,35. Thus under the circumstance that other conditions are equal it is necessary to expend more time for washing of the sample № 1, than for the sample No 2. This conclusion, and also many literature sources point that independently resins do not affect the process of crystallization of hard paraffin hydrocarbons in oil. They are included in the composition of associates of asphaltenes and strengthen their action.

The paraffin falling out of oil and its covering of the walls of pipes are contributed by the decline of temperature and pressure of moving flow of fluid in the well by tubing to their defined critical values. Thus, one of the important factors, influencing on formation of ARPD, is a decline of temperature of liquid below than the temperature of saturation (to the temperature of the beginning of paraffin crystallization).This condition is the necessary condition for formation of paraffin deposits. The producing fluid (emultion) cools down because of the heat exchange with a surrounding rocks during the lifting and soil during the collection and transportation, and also as a result of phase transitions. The decline of reservoir pressure below of the pressure of saturation also brings to cooling down of the flow and change of oil composition. Hereat rare gases and lightest hydrocarbons transit to the gas area. [4]. Degassing for different oils variously influences on the paraffin saturation point. This fact is explained not only by the change of dissolving ability in relation to it but also flocculative action on micelles of asphaltenes.

From many literature sources it follows that ARPD in the hole walls can be found beginning from the depth approximately 1000 m to the depth 200...50 m (achieving a maximum here). Higher the layer of ARPD diminishes due to washing off deposits by the flow of the well fluid.

The factor, strongly influencing on the ability of ARPD formation on the surface of pipes with the change of temperature is also the liquid flow velocity. It determines the hydrodynamic regime. It is known that at the debits of oil more than 70 ton/day paraffin deposits are not observed [1, 3]. The characteristics of the surface substantially influence on the formation of deposits. The considerable roughness of the surface (height of combs of 7–9 mkm and more) helps in the formation of paraffin deposits, and high polarity of pipes' surface , vice versa, hinders formation of deposits.

Thus, except for the temperature, the principal substantial factors which result in formation of ARPD on the surface of the downhole equipment are:

1. Decline of the well pressure in below than the pressure of saturation and subsequent degassing of oils, that results in cooling down of the flow and change of oil composition;
2. The concentration of paraffins, resins and asphaltene in oil;
3. Roughness of pipes' walls and the presence of the mechanical admixtures (the liquid producing from the well cools down because of heat exchange with a surrounding rocks and available mechanical admixtures);
4. The water cutting of well production and the probability of formation of emulsion.

The amount of paraffin as far as the motion to the wellhead increases due to the fact that it transforms more intensively from the hard phase to the liquid phase and due to the bringing of it on the shells of gas bubbles from the lower coats of moving oil, where it has been crystallized. In addition it is revealed that the temperature of paraffin melting dimi-

nishes from the bottom to the top, and thus, we make the conclusion, that there are the deposits of less heat-resistant paraffins in overhead part of the tubing string and the deposits of more refractory paraffins in low part of the tubing string. And it is necessary to take into account this conclusion during conducting of the operations on the paraffin removal from field equipment. The special attention it is necessary also to pay to the fact that ARPD can be found on the outside surface of tubing and on the internal surface of flow string. During conducting of the paraffin removal from underground equipment in this case (during the injection of technological liquid to the annular space) the new problem could arise – paraffin can be washed from the places of its initial deposition and settle downward, and further the washed off paraffin reaches the pump suction, that causes the plugging of plunger, cylinder, pump valves and tubing with the subsequent jamming of well pump and formation of the paraffin plug which can fully shut off the section of pipes (then the new deposits of paraffin on the internal surface of tubing could be called the "secondary") [1].

The principal methods of ARPD fighting may be divided into the three groups:

1) the mechanical methods (the application of the stationary or mobile scrapers);
2) the thermal methods (the pumping of hot water, steam, oil, the application of warming cable and etc);
3) the chemical methods (the application of the surfactants, solvents, the inhibitors of paraffin formation) [5].

It is possible also to prevent and fight against the paraffin deposits by the use of the combination of the several methods (the complex methods) and by the application of different coverings on the tubing and magnetic paraffin removal devices.

For the conditions of the fields of Ukraine, on which the samples of deposits were withdrawn the most expediently for fighting ARPD is to use the chemical method, that is the use of inhibitors of ARPD formation as this method is the most economically advantageous, accessible and tested method.

It is suggested to use as the ARPD inhibitor the reagent which is also the surfactant – Tween 80. It is the emulsifier in cosmetic, textile, food and pharmaceutical industry, solubilizer of hydrocarbons, defoamer, dispersant and stabilizer of dispersions, moistening agent and the addition to detergents [2, 6]. It well dissolves in water, ethanol, toluene, methanole and ethyl-acetate. By its' appearance Tween 80 is the oily liquid of the colour from lemon to amber with light specific odour.

The mechanism of action of Tween 80 in relation to prevention of ARPD formation consists in that in the presence of water Tween 80 contacts with microcrystals of paraffin, moistens them, hinders their sticking together and depositing on the walls of pipes. The adding of Tween 80 to the flow of oil-water emulsion results in oleofobization of pipes (thus Tween 80 does not form the film on the surface of pipe). Actually, thanks to dispersing, solubilizing and moistening ability at the adding of Tween 80 a paraffin is created not on the walls of the equipment, but in the flow of the treated liquid.

For the increasing of fighting ARPD efficiency it is suggested to use the solution of Tween 80 in alkali. Hereat the consideration has been used about the fact that the increase of pH value of the medium which the ARPD inhibitor is in leads to the increasing of the efficiency of inhibitors of deterging and dispersing action. By that, by adding of alkaline solution of Tween 80 to the reservoir liquid, withdrawn from the wells of OGCF, and by the increasing of pH value of water phase from 5,2 (for the well No 1) and 4,7 (for the well

No 2) to 8 (hereat the ratio of alkaline solution of Tween 80 to the reservor water has been changed from 1 : 19 to 2 : 3) the value of the ARPD washing off percentage has been substantially increased as compared with the medium of mixture of reservoir water with the solvent white-spirit with the adding of Tween 80 to it.

The results of the laboratory research testify that the ARPD washing off percent at the temperature of 20°C and the time of the laboratory tests 12 hours increases on 6,16% for the well No 1 and on 7,54% for the well No 2 as compared with the medium of the mixture of reservoir water with white-spirit with adding of Tween 80 to it in the amount of 0,5% (the mass.). Hereat the ratio of the sample of deposit to the mixture of the reservoir water with alkaline solution of Tween 80 (or to the mixture of the reservoir water with solution of white-spirit with adding of Tween 80 to it) is 1 : 50. The laboratory research have been conducted also at the temperature of 40°C. Figures 1 and 2 show the dependence of the ARPD washing off percentage on the pH value of the medium for the conditions indicated higher at the temperature of 20°C for the wells No 1 and No 2 accordingly.

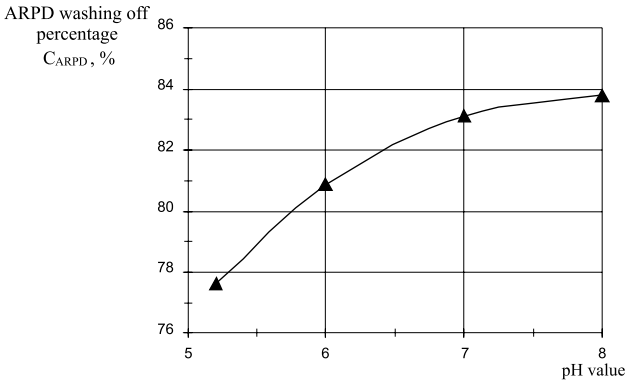

Fig. 1. The dependence of the ARPD washing off percentage on the pH value at the time of the laboratory tests 12 hours and the temperature of 20°C for the well No 1

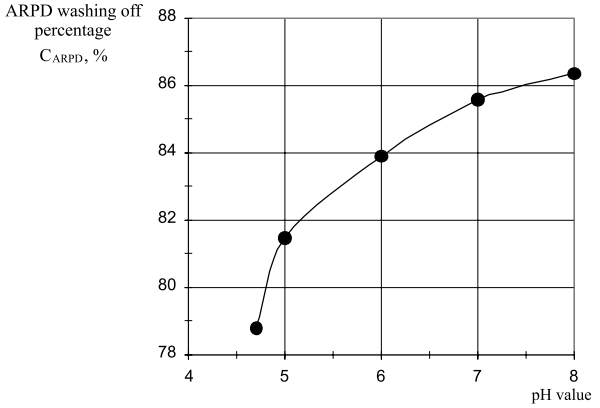

Fig. 2 . The dependence of the ARPD washing off percentage on the pH value at the time of the laboratory tests 12 hours and the temperature of 20°C for the well No 2

CONCLUSIONS

1) The reasons, features and the mechanism of formation of ARPD on the walls of wells have been analysed and the considerable attention has been payed to the probleme of existence of so-called “secondary” paraffin deposits and the necessity of further researches of this question for the purpose of the effective fighting against them.
2) The most rational and expedient method of fighting ARPD for the conditions of OGCF has been grounded.
3) On the basis of the analysis of the data about the concentration of paraffins, asphaltenes and resins in the oils of the fields of Ukraine, from which the samples of the deposits were withdrawn, it is revealed that the more is the ratio of the concentration of asphaltenes (asphaltenes and resins) to the concentration of paraffins, the deposits are more proof. This is confirmed by the laboratory research.
4) The results of the laboratory research testify that the ARPD washing off percentage increases when using the alkaline solution of reagent Tween 80.

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