Study of the petroleum schedules thermal cleaning process from asphalt, ressin and paraffin deposits using low-temperature plasma

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Abstract: Petroleum industry uses large amount of pumping and compression pipes. Carrying out the whole range of repair works requires cleaning of the pipe inner surface from deposits which appeared in it during operation [1]. The task of asphalt, resin and paraffin deposits control remains one of the most essential for the branch. The article deals with thermal method and device for asphalt, resin and paraffin deposits removal from pumping and compression pipes inner surface, describes and provides the device application scope for cleaning the pumping and compression pipes inner surface. To deal with borehole equipment and pipe systems waxing problem various deposit prevention and removal methods are used, including mechanical, thermal, chemical, combined and nonconventional methods.

1. Introduction
Thermal method of asphalt, resin and paraffin deposits removal from pumping and compression pipes is based on side-wall melting. This is achieved by warming of the cleaned pipe inner surface by heating with plasma torch from outer surface and high-thermal conductivity of cleaned pipe material. When cleaned pipe inner surface reaches the temperature which exceeds melting temperature of asphalt, resin and paraffin deposits, it leads to softening and melting of the asphalt, resin and paraffin deposits thin side-wall layer adjunct to heated area of the cleaned pipe [2].

2. Device operation
Device for removing the asphalt, resin and paraffin deposits from pumping and compression pipes operates the following way. Circular plasmatron is aligned with cleaned pipe with asphalt, resin and paraffin deposits. The pipe with asphalt, resin and paraffin deposits is mounted to working position at an angle $\alpha$ to the level surface. Angle $\alpha$ to the level surface is adjusted depending on pipe clog level and the length of the cleaned pipe with asphalt, resin and paraffin deposits. Circular plasmatron is activated [3].

Gradual heating of the cleaned pipe starting from the bottom part leads to continuous melting of the side-wall layer of asphalt, resin and paraffin deposits along the cleaned pipe resulting in free vent of gases and melting outputs of asphalt, resin and paraffin deposits without resulting in explosion due to gas development and temperature expansion of side-wall layer of asphalt, resin and paraffin deposits in closed space.
Bulk of asphalt, resin and paraffin deposits in the center of heated area of cleaned pipe does not melt due to low-thermal conductivity of asphalt, resin and paraffin deposits. Circular plasmatron operation rate is adjusted depending on the outside pipe diameter and pipe wall thickness. Calculated data shows that cleaning rate of pipes from asphalt, resin and paraffin deposits for pipe with diameter 70 mm and wall thickness 4 mm is 0.42 m/min i.e. device will clean 6 m pipe within 14 min. It will consume 1.3 kW for the cleaning process. Melted side-wall layer of asphalt, resin and paraffin deposits can function as lubricant at outflow of the melted solid mass of asphalt, resin and paraffin deposits from cleaned pipe under gravity [4].

After outflow of melted solid mass of asphalt, resin and paraffin deposits from the cleaned pipe the heating of the cleaned pipe by several circular plasmatron actuations is continued until all the melted asphalt, resin and paraffin deposits residue flow down to receiving container.

3. Computer modeling
For more complete study of temperature distribution pattern and melting of asphalt, resin and paraffin deposits computer modeling of heating process of pumping and compression pipes with asphalt, resin and paraffin deposits was carried out using Star CCM+ software package [5]. Calculation results are shown in Figure 1 and 2.

Figure 1 shows scalar temperature field of the cleaned pipe in cross section after 140 seconds.

Figure 1. Scalar temperature field in cross section of pipe with asphalt, resin and paraffin deposits.

Figure 2 shows scalar temperature field of the cleaned pipe in longitudinal section with 1 m length after 140 seconds.
Figure 2. Scalar temperature field in longitudinal section of pipe with asphalt, resin and paraffin deposits.

4. Conclusion
Given thermal cleaning method allows to effectively clean the pumping and compression pipes from asphalt, resin and paraffin deposits. Besides this method is more energy-efficient due to application of low powered plasmatron and low-cost equipment.

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