Investigation of ring plasmatron for thermal purifacation of the dismantled pipes of an oil assortment from asphalt-resin-paraffin sediments

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Abstract. This paper proposes a method of the thermal purification and removal paraffin, without using of mechanical purification of the oil wells and the oil pipeline.

1. Introduction

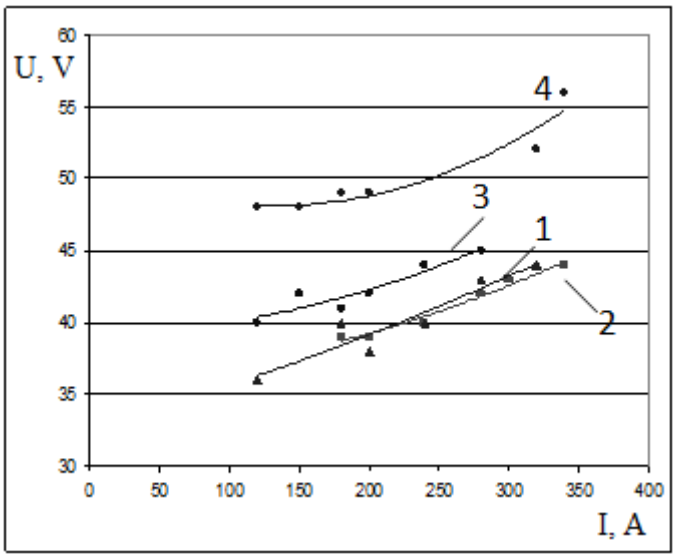
It's a new question about cost-effective and concurrently a reasonable the raw materials extraction in Russian conditions, there is a necessity of oil transportation from places of extraction to places of consumption. In these conditions the most effective way is the fluid-transmission system. In the operation process of the oil pipeline on the internal surface of the pipes there is an accumulation of asphalt-resin-paraffin sediments , which essentially influence the effectiveness and reliability of their work (reduction of bandwidth, increasing the pressure, absence of reliable diagnostic data). To prevent the catastrophic consequences of pipeline blockage (discontinuities or cracks) should be timely carry out repair and maintenance work. Before carrying out the complex repair works, need to purify the internal surface of the pipes from sediments, which formed on it during in the operation. The task of combating asphalt-resin-paraffin sediments of the pipes remains one of the most important for the industry.

The technology for the thermal purification of the dismantled pipes of an oil assortment from asphalt-resin-paraffin sediments consists by using concentrated annular plasma, which allows uniformly heat the pipe from with sides at high speed. The ring plasmatron, moving by means of clamping wheels and mini gear motor with frequency converter, heats the cleaned pipe with asphalt-resin-paraffin sediments from the outside, thereby melting the asphalt-resin-paraffin sediments due to high thermal conductivity of the tube material. The pipe with asphalt-resin-paraffin sediments is set on the operating position at an angle of 20ºC to the horizontal surface. The bulk of asphalt-resin-paraffin sediments are not melted in the center of the heated area of the cleaned pipe, due to low thermal conductivity of asphalt-resin-paraffin sediments. The gradual heating of the cleaning tube, starting from the bottom, causes a progressive melting of the wall layer of asphalt-resin-paraffin sediments along the cleaned pipes, which is provided free of exit gases and the melting products of asphalt-resin-paraffin sediments, without causing explosions during gas formation and thermal expansion of the wall layer of asphalt-resin-paraffin sediments in a closed space. The melted wall layer of asphalt-resin-paraffin sediments capable act as a lubricant at the exit from the cleaning pipe melted solid mass by force of gravity.

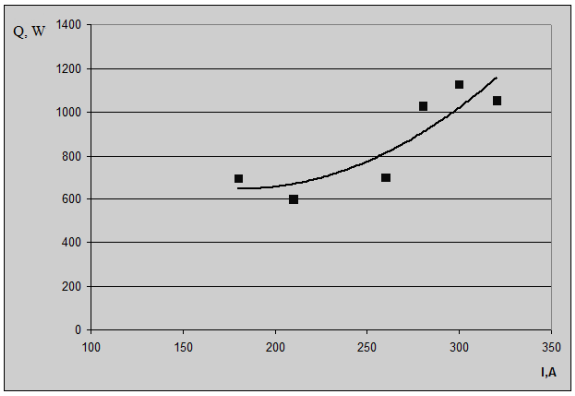
2. Experimental studies

The plasmatron of a special design was designed and developed for creation of ring plasma [1]. The plasmatron comprises ring electrodes, a frame, chamber of the working gas and a device for controlling the interelectrode gap. The electric arc under the influence of electromagnetic forces runs through the electrodes with great speed, at the same time heating the mixture of working [2-3].

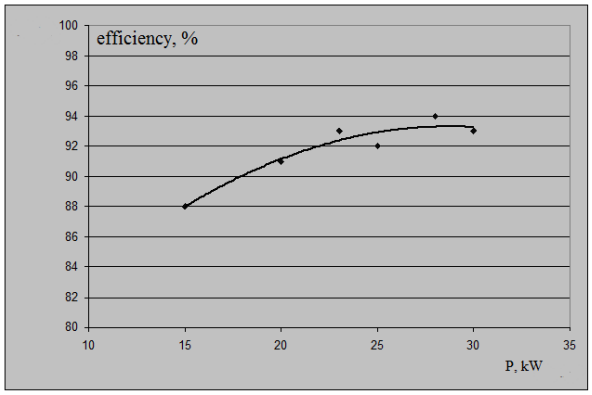
In the course of experimental studies on the ring plasmatron were obtained following the energy and thermal characteristics (Figure1):



a)



b)



c)

Figure 1. Energy and thermal characteristics: a) current-voltage characteristics of the plasmatron for different diameters of electrodes: 1– d_E=4mm, 2– d_E=6mm, 3– d_E=12mm, 4– d_E=14mm (d_E - diameter electrodes), b) the dependence of the heat losses in the electrodes and the coolant on the current strength, c) the dependence of the efficiency on power.

For current of 150-300A and voltages of 100-150V current-voltage characteristic increasing [4]. This is the result of compression the arc of magnetic fields and limitations the arc of electrodes. The arc burns in the smallest interval to increase the arc length necessary to increase the voltage, but it is limited by the power supply voltage, which cannot be increased. In the course the experiments high-

speed photography showed that a moving electrical charge is drawn into the interelectrode space and the length of the arc is the magnitude of the interelectrode gap.

The diagram (Figure 1 b) shows that with increasing current, the losses increase. This is connected with increase of the current density in the reference arc spots on the electrodes.

The diagram of relationship the efficiency of the injected power (Figure 1c) shows that the curve has a distinct maximum efficiency, which corresponds to the optimal operating mode of plasmatron of these electrical and geometrical parameters. The ring plasmastron developed by with inter-electrode gap of 5 mm, with power of about 28 kW has an efficiency of 94%.

The plasmatron produces a large volume of plasma in the form of a ring, which eliminates the need to rotate a part because the part immediately processes the uniformly on all sides.

The design of the plasmatron is envisaged the regulation of the interelectrode gap, which changes the power, pumped into the electric arc, and thereby regulates the temperature of the plasma. The essential brightness of the plasma temperature for heating the pipe obtains by regulating of the plasma gas flow [5-7].

3. The conclusion

The results of the experimental researches show the stability of the characteristics of the plasma technological complex so that get a steady the plasma flow [8-14] and carry out purification of the pipe from asphalt-resin-paraffin sediments.

An analysis of the characteristics shows that the optimum values of control limits of electrical parameters to ensure the effectiveness of plasma technological complex are: a current intensity 150...300 A, the voltage of 100...150 V, the total plasma gas flow of 1...1.5 g/s, the interelectrode gap 3...5 mm.

The result of this work is the increase of the performance heat pipes by replacing a linear plasmatron on the ring, and also the reduction of energy consumption by stabilizing the specified energy characteristics of plasma technological complex and as a consequence quality purification of pipes from asphalt-resin-paraffin sediments.

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