Development of Multizone Radiator and their Application at Flowing through Viscous Liquids

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The abstract – The article is devoted to the problems of development multizone ultrasonic radiators and their application for decrease of power inputs in transition of viscous fluids, in particular of oil and petroleum derivatives. Features of oil disperse systems and influence of ultrasonic oscillations of high-intensity on them are observed.

I. INTRODUCTION

Exploitation of old and developing new oil field in our country and abroad requires solving complex scientific, technical and economic problems. It is known that throughput capacity and cost-effectiveness of pipeline system depend on characteristics of transferred liquids. Viscosity of liquids is the main obstacle for realization of necessary transfer speed. Petroleum rapidly cools down and has jelly-like structure. Differential pressure (created by transferring pump) is spent for static deformation of frozen petroleum. Standard transfer procedure cannot be used in such conditions. Pumps cannot transfer frozen petroleum because viscous losses increase at movement jelly-like liquid inside tube [1].

II. PROBLEM STATEMENT

Viscous liquids are previously processed for an increasing of transfer process efficiency. It is known that many methods of liquids (mainly for a petroleum and petroleum products) processing for a decreasing of its viscosity exit. All this methods is well known and have wide application in industry. One of the most perspective methods of preliminary processing of liquids (for a decreasing viscosity) is combination of a high-intensity ultrasonic and thermal influence.

There are some limits on a leading-out of acoustical energy from a radiating surface of the working tool. In paper [2] ways of these limits elimination by means of multizone ultrasonic radiators were observed.

In view of absence of practical designs of such radiators there was a necessity to design, develop and create multizone ultrasonic radiators, suitable for the solution of observed technical problem.

III. THEORETICAL PART

It is known, that oil forms a disperse system as a result of crystallization or concretions of a part of its components. The long, randomly placed molecules of paraffin and resins form flexible lattice in which clusters there are particles of a dispersed medium in which the solution is allocated. This lattice restricts traffic of particles and provides its aggregate stability. Therefore the system shows significant resistance to shift forces. Besides that interaction of disperse medium particles greatly influences on viscosity of disperse systems. Separate sections of a surface of such particles do not have the adsorptive or developed solvate layers; owing to intermolecular interaction on these sections there is their adhesion.

High-intensity ultrasonic oscillations tear a continuous chain; destroy connection between separate clusters of particles at influence on such medium. Also C-C bond is destroyed in paraffin molecules. As a result liquid changes physical and chemical characteristics [3, 4]. Main reason of these effects is interface of compression and stretching zones that create ultrasonic oscillations in liquid.

It is necessary to note that a working tool and a processing liquid are heated during work. Main reason of this heating is viscous friction in liquid and a radiator heat-transfer. This heating also decreases viscosity.

IV. PRACTICAL REALIZATION

The scheme of a device that realizes present method is shown in Fig. 1. Piezoelectric transducer (position 1) is figure of revolution with piezoelectric elements displaced relatively an acoustical axis of a transducer. Acoustical axes of piezoelectric elements are converged on plane of joining a piezoelectric transducer and a booster (position 2).
Booster is intended for providing of needed amplification coefficient. Also a mounting flange with case is fixed on booster section with null oscillations.

An ultrasonic processing is carried out in the following way. Radiator (position 4) is immersed and moved into a processing liquid (position 7). Radiator (position 4) is rod. It consists of successive placed cylindrical sections of different diameters. Length of each section with big diameter is correspond to 1/15 part of wavelength. A total length of successive placed section of big and small diameter is corresponding to half wavelength of ultrasonic oscillations into material of a rod (at frequency 22 kHz).

Ultrasonic oscillations are fulfilled from the surface of radiator in a crossing between sections of different diameters. Oscillations amplitude should be sufficient for creation of cavitation into a processing liquid. Radiator has central channel (position 5) and radial channels (position 6). Radial channels are placed on section of small diameter symmetrically to sections of big diameter and perpendicularly to a central channel. Sum profiles of all radial channels are equal to profile of central channel. Processed liquid is continuously output through aperture. A speed of liquid transfer is selected on the base of liquid viscosity, dimensions of a radiator and intensity of ultrasonic oscillations.

An intensity of ultrasonic oscillation is selected sufficient for creation a cavitation on the radiator surface. A viscosity of petroleum and other liquids of processing medium decreases under influence of ultrasonic oscillations. Paraffin contained in petroleum and petroleum products as admixture is emulsified into petroleum under influence of ultrasonic oscillations. This decreases its settling on walls of a pipe line and reservoirs, so efficiency of transfer increases. Working tool and a processing liquid are heated during work. Main reason of this heating is viscous friction in liquid and a heat-transfer from a radiator. This heating also decreases viscosity. As a result an area with a decreased viscosity around working tool is created. This liquid is easy to transfer by standard pump stations.

The technical result is a decreasing of power consumption and transfer costs of viscous liquids (by means of decreasing it viscosity). And it is also possible to pump and transfer petroleum at low temperatures [1].

Practical constructions are designed on base of devices “Bulava-3” (Fig. 2), “Bulava-6” (Fig. 3) and “Bulava-8” (Fig. 4).
REFERENCES


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V. CONCLUSION

The offered method has been realized in the prototype in Acoustic processes and devices laboratory of Biysk Technological Institute. Experiments have been carried out to check an efficiency of device. Petroleum, vegetative and technical oils have been processed. Exploitation of model sample of device has confirmed efficiency of offered method and provided productivity of petroleum transfer up to 1000 liter per hour at power consumption 3000 VA.