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A METHOD FOR OPTIMIZING THE DOSING OF DEMULSIFIER AT A COMPLEX OIL PROCESSING UNIT

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ABSTRACT

The process of dosing demulsifier is considered by changing its consumption depending on the consumption of oil emulsin at the installation inlet. The oil emulsion flow ratio and the rate of change of the demulsifier level, which leads to a change in the consumption of the demulsifier, is determined. The proposed process allows to reduce the cost of oil refining by increasing the accuracy of dosing. The whole complex oil processing unit (COPU) is a single block module. The delivery set includes a technological unit, a control unit, furnaces and heat exchangers, automatic furnishing and maintenance units. COPU should be equipped with valves and flow sensors as well as, other means of monitoring, control and regulation, as well as, instruments for testing and emergency protection systems. Operation of COPU control is carried out using an automated system, both remotely and locally. In the process of oil preparation, monitoring and measurement must be carried out the regulation of technological parameters, if necessary. Various comprehensive training facilities correspond to various indicators of economic efficiency, in particular: indicator of energy consumption, complexity of technology; costs of installation, operation, maintenance of installations (including the cost of servicing personnel); the complexity of the oil preparation process.

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The process of oil emulsion demulsification (OE), including the dosage of the chemical reagent (demulsifier), are the subject of several research papers [6, 9]. In particular, in [1], in order to reduce the cost of commercial oil, the demulsifier dosage (D) is carried out according to the modal radius (r_m) of emulsified water droplets (EWD).

$$\begin{aligned} & r_m = \alpha r_T \frac{1}{\nu}\sqrt{\frac{\sigma_m}{\rho r_T}} \\ & \delta_m = \delta_m^0 - RTA\ln\left(\frac{Q_D}{Q_D \cdot Q_{OE}} + 1\right) \\ & \nu = Q / \pi r_T^2 \end{aligned} \qquad (1)$$

r_T is the radius of the pipeline OE, v is the flow rate of OE, α is coefficient determined experimentally, ρ is the density of the reservoir fluid, R is a gas constant, T is OE temperature, A is limiting adsorption of the demulsifier on the armor covering of EWD; Q_D, Q_{OE} is respectively the consumption of D and OE; δ_m^0, δ_m is respectively the interfacial tension of water and oil in normal and working conditions.

Consumption D also varies depending on the value of the resistance coefficient, shown to the movement of OE in the area from the reservoir of oil producing wells to the oil refining installation [2].

$$\lambda = \frac{4r\Delta P}{\rho_{OE}\nu_{OE}^2}$$
$$\rho_{OE} = W\rho_w + (1-W)\rho_o \qquad (2)$$
$$\nu_{OE} = Q_{OE} / \pi r_T$$

where $\Delta\rho$ is the pressure drop in the flow of OE between two points along the length of the pipeline, W is the concentration of water in OE, ρ_w and ρ_o is the density of water and oil.

In [3], the dosage D is carried out depending on the content of asphaltenes, resins and refractory paraffin hydrocarbons. With the increase in the content of asphaltenes in the oil, at a temperature above the hardening of paraffin, increase the specific consumption of D or vice versa.

There is a similar method for automatically controlling the process of dosing demulsifier at an oil refining installation [4], where the flow rate D is also determined by the change in level D in the measuring device.

As it is known, one of the determining factors of the thermo chemical oil dehydration process is the intermediate emulsion layer (IEL), which exists in any settling apparatus. And the effectiveness of this layer, as a hydraulic filter, mainly depends on the dosage of the reagent that affects the aggregative and kinetic stability. In this aspect, the work [5] dedicated to the mathematical modeling of IEL in settling apparatus of the thermo chemical oil refining installation (TCORI), is of particular interest in the direction of solving the assigned task.

In work [6], the process of minimizing consumption D was investigated. In order to determine the optimal consumption D, a method was proposed, where, along with other technological parameters, the effect of D on the cost of commercial oil was taken into account.

It is also worth noting the work of the authors [7], where the importance of the D activity indicator is noted during the intensification of TCORI processes. It is shown that the process temperature and flow rate D have a synergistic result on the depth of oil dehydration. With increasing temperature, the flow rate D is reduced or vice versa. This method is used in the injection of water into the reservoir, as well as in the dehydration and desalting of oil in complex oil refining installations (CORI).

It should be noted that the known methods for controlling the process of dosing demulsifier by controlling the flow ratio of the oil emulsion (OE) and the demulsifier (chemical agent) at the installation inlet depending on the ratio of the hydrostatic pressure drops of OE, measured in two zones of the settling apparatus, with a direct measurement of demulsifier flow rate have low accuracy [1, 2].

In order to reduce the cost of oil refining by increasing the accuracy of dosing the demulsifier, a process of dosing the demulsifier is proposed by changing its consumption depending on the consumption of OE at the installation inlet. In addition, the rate of change of the demulsifier level in the measuring device is measured, OE flow ratio and the rate of change of the demulsifier level is determined and, depending on the specified value, the consumption of the demulsifier is changed.

The figure 1. shows the diagram consisting of the measuring device 1, the demulsifier pipeline 2 and after the measuring device 3, respectively, pump 4, the pipeline supplying demulsifier at the inlet of demulsifier CORI 5, the OE pipeline 6, bypass 7, level detector 8, secondary device 9, differentiator 10, the control unit 11, the ratio controller 12, shutdown relay 13, the actuator 17.

The measuring device 1 through pipeline 2 is periodically filled with demulsifier (chemical reagent). At the measuring device outlet, the demulsifier is fed to the inlet of the pump 4 through the pipeline 3 with a constant productivity. At the pump outlet, the demulsifier is divided into two flows. The first flow through pipeline 5 enters the pipeline 6 for mixing with the OE, and the second one through the spare line 7 returns to the outlet of the measuring device (pump inlet 4) for mixing the demulsifier entering the pump 4.

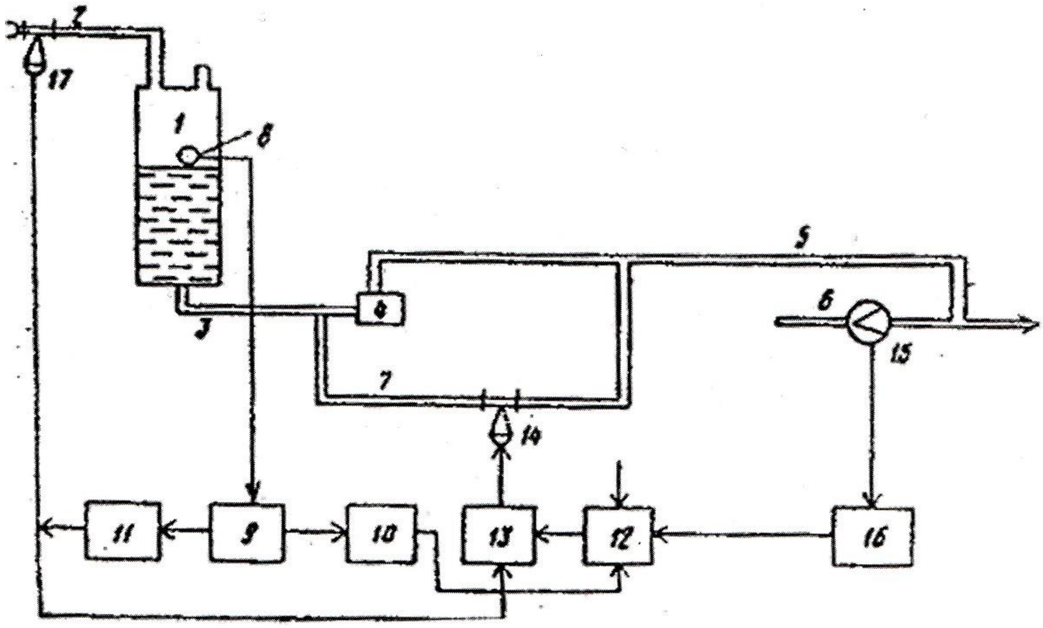

Fig.1. Diagram of the process of dosing the demulsifier

The demulsifier level in the measuring device is measured by the sensor 8 and the secondary device 9. The output signal simultaneously enters the differentiator 10 and the control unit filling the measuring device 11. The output signal of the differentiator 10 being proportional to the speed of reducing the level of the demulsifier in the measuring device, enters the ratio controller 12. The regulator 12 also enters the signal is proportional to the flow of OE, measured by sensor 15 and the secondary device 16. The error signal through the shutdown relay 13 is fed to the actuator 14 mounted on the pipeline 7.

The measuring device is a cylinder with a maximum volume of 60 liters. The device of periodic filling of the measuring device represents one element of the adder and two elements comparing the current value of the demulsifier level in the measuring device with its limit value. The shutdown relay 13 is used to eliminate the movement of the actuator during the filling of the measuring device. The position of the actuator is fixed with the help of a signal that opens a check valve on the line supplying the demulsifier into the measuring device during its filling. During a change, for example, an increase in OE flow rate, measured by the sensor 15 and the secondary device 16, the ratio controller 12 issues a command to cover the actuator 14. At the same time, the flow rate of the circulating demulsifier decreases, therefore, pump 4 takes more demulsifier in the measuring device 1 and the rate of decrease in demulsifier level in the measuring device increases. This means that the consumption of the demulsifier at the inlet of CORI increases.

If the flow rate of demulsifier in pipelines 3, 5 and t is denoted respectively as Q_3, Q_5 and Q_7, then during the time dt the demulsifier in the amount of $(Q_3 - Q_7)dt$ should pass through pipeline 5. During this time, the level in measuring device 1 decreases by the value of dh, then the volume of the demulsifier consumed during dt will be Sdh. Making a material balance, the following is obtained:

$$Sdh = (Q_3 - Q_7)dt \tag{3}$$

Taking into account $(Q_3 - Q_7) = Q_5$, we obtain:

$$Sdh/dt = Q_5 .$$

If we take into account the $dh/dt = v$, then we obtain:

$$v_D = Q_5 / S .$$

v_D is the rate of change of the demulsifier level in measuring device 1, S is the cross-sectional area of the vertical-cylindrical measuring device.

As it is seen from formula (3) the rate of change of the demulsifier level is directly proportional to the flow rate of the demulsifier supplied to the pipeline for mixing with OE. Therefore, instead of flow rate Q_5, the rate of change of level in the measuring device 1 can be used.

Conclusions. Since the measurement of the liquid level is carried out more accurately than the flow measurement, the use of the proposed process reduces the cost of oil refining by increasing the dosing accuracy.

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