Using of Photometric Method of Emulsion Investigation to Determine of Wearing Degree of Rotor-Disc Mixer

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Abstract. There is presented in this article a brief of low-capacity rotor-disc mixers and methods of estimation of theirs operation quality. It is determined that a photometric method of investigation is the most perspective. This method is simple, has an enough accuracy and allows to determine a distribution of dispersed particles by sizes. There is presented a dependence of dispersed particles average size of emulsion on value of gap between disks of the rotor-disc mixer, specified by a wear of working tools of the last. It is determined that an increasing of a gap between disks by 3 mm is result to increasing of averaged size of dispersed particles in ~3 times. There is shown that at increasing of rotor rotation rate with purpose to save a quality of mixture as working tools wear out is result in increasing of energy consumption. An opportunely determination of the rest recourse of the apparatus allows to correct right and opportunely a mode of processing of the product minimizing consumptions at production process.

1. Introduction
One of the main process, using at production process are mixing processes. There are use a mixer apparatus of various types and constructions to these processes. One of them is a low-capacity rotor-disc mixer (RDM). These mixers have such advantages as a low-capacity dimensions, high quality of mixture, a low energy consumption, a high resource [1,2].

2. Classification and methods of research
There are known a lot of types of RDM which have different construction (Table 1).

The RDM with smooth discs, which have a rigid fixed additional working tools are the most popular. They are different by a good productivity, more high mixture quality, and a relatively low energy consumption. Besides it thank to creation of fine-dispersated mixtures, they are well approach as reactors for different chemical reactions carrying out in liquid-liquid, liquid-gas systems [3-5].

A reducing of mixing efficiency is result to increasing of average size of drop of dispersed phase and to reducing of contact area, consequently it there will a reducing of quality of an initial product. Therefore a control of processed mixture quality has a big mean

There are some reasons of mixing efficiency reducing: a changing of technological regime (increasing of consumption), reducing of shaft rotation revolutions, wearing of working tools. As a rule in difference the wearing out of working tools the first two reasons are eliminated without any stopping of process.
Table 1. classification of low-capacity rotor-disc mixers.

| Type of classification | Type of apparatus |
|-------------------------|-------------------|
| By the arrangement of working tools in a body | - dipping; - flowing; - integrated. |
| By components supply method | - with supply to general branch pipe; - with separately supply. |
| By the arrangement of power shaft | - with vertical shaft; - with horizontal shaft; |
| By the number of chambers | - a single chamber; - multichamber. |
| By the method of chambers connecting | - consecutive; - parallel; - mixed. |
| By the number of steps | - one-step; - multi-step. |
| By an available of additional working tools | - without additional working tools; - with an additional working tools. |
| By the displacement of additional working tools | - without any additional displacement; - with an axial displacement; - with oscillatory move. |
| By the condition of working tool surface | - a smooth surface; - a corrugated surface |

An additional working elements (teeth) welded to discs surfaces, are create a highly-turbulent flows of liquids in a working area of the apparatus. Consequently there is in these apparatus is take place an erosion wearing, which is intensified, if there is a rigid inclusions (abrasives) in a processed agent [6].

A sedimentation, photometric and accounting methods are the most using among of many methods of investigation of dispersed content of emulsion. A sedimentation method it is a determination of dimensions of dispersed phase droplets by lagging time. This method has such drawbacks as a long time of lagging, a relatively non-highly accuracy, a big influence of external factors (a temperature of environment, a vibration and etc.). An accounting method it is a determination of averaged dimension of dispersed particles on base of power, expended for mixing by means of the received formulas. This method is a labor-consuming and there is take a place a high inaccuracy. A photometric method is a relatively fast and allows to determine a distribution of dispersed particles by sizes [7,8].

An investigation by the photometric method is carrying out by follows:
1. An intake of emulsion in exit of the mixer
2. The probe is holding in a vial for 1-3 min. (it is necessary for stopping of eddy flows in the emulsion).
3. Put a drop of the emulsion on a slide glass of microscope by a pipet and then overlap by a cover glass.
4. Investigate the emulsion under the microscope and make series of photos if it is necessary.

If the main and dispersed phases are undistinguishable, then at the point, where enter components to the apparatus, need to enter a colorant additionally, which is dissolve only in the main or dispersed phase[9-12].
For an experimental researches there was used a water as an etalon component of processing mixture ($\rho=998 \text{ kg/m}^3$, dynamical ductility $1004 \text{ mPa} \cdot \text{s}$, kinematic ductility $1,006 \cdot 10^{-6} \text{ m}^2/\text{s}$, surface tension $0,07 \text{ H}/\text{m}$ (at 293K)) and diesel fuel ($\rho=860 \text{ kg/m}^3$, dynamical ductility $560 \text{ mPa} \cdot \text{s}$, kinematic ductility $0,62 \cdot 10^{-6} \text{ m}^2/\text{s}$, (at 293K)) with a volumetric relation $d.f./\text{water} = 1/5$ and volumetric consumption $Q=0,2 \text{ m}^3/\text{h}$. A capacity of working area of the RDM - 0,8 l [13,14].

There is seen from the dependence (Fig.2) that at increasing of the gap between discs an averaged size of dispersed particles is increased too. It is associated with reducing of influence of teeth to processed agent in the working area of the apparatus [5]. An initial height of the tooth is equal to the thickness of the disc and doesn’t exceed 5 mm, consequently if a gap is 5 mm it is mean an availability of worn out working element. It is should to increase a rate of shaft revolution, to compensate a wearing with an aim to save an enough small dispersed particles, but it is result to additional energy consumptions [6].
It is seen from the graphic (Fig.3), that at increasing of the rotor rotation speed of the RDM, a consumption power for mixture processing is increase too. And it is result to rise in price of the unit of the product. [15].

3. Conclusion
So carrying out a periodical analysis of emulsion, it can be talk about a condition and grade of wearing of the RDM's working tools. As it mentioned above, a photometric method allows to determine with an enough accuracy a quality of the emulsion without any stopping of the process. According to the researches of the emulsion it can be made a decision about changing of the processing mode or about repair of the RDM.

4. References
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