Determination of RDM wear by photometric method

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Abstract. The paper provides an overview of the design features of low-volume RDM rotary-disk mixers, as well as methods for evaluating the quality of mixer operation. It is shown that the most qualitative method is the photometric method. The described method is simple to carry out, quite accurate, allows you to determine many parameters such as the average particle size of the diperse phase, build a graph of the distribution of the number of particles by size, and much more. The dependence of the gap between the rotating and stationary disks on the size of the dispersed phase of the emulsion is determined. It is noted that an increase in the distance between the disks by 0.003 m will lead to an increase in the average particle size of the dispersed phase by approximately 3 times. It is obvious that an increase in the speed of rotation of the rotor, to maintain the quality of the mixture, with an increase in the gap between the disks, leads to an increase in the specific power consumption. In this regard, determining the degree of wear of the apparatus allows you to accurately and timely control the technological mode of processing the emulsion, minimizing operating and energy costs.

1 Introduction

The mixing process is one of the most common processes in chemistry and petrochemistry. Science knows a large number of different designs of mixing equipment. Each device has its own advantages and disadvantages, and can be used in specific technological conditions. Small volume rotary disc mixers have many advantages such as: high efficiency, mixture quality, small overall dimensions, versatility, maintainability and reliability. These qualities make it one of the most promising devices for mixing and emulsion [1,2].
There are many types of RDS with different types of construction (Table 1).

Table 1. Classification of rotary mixers with axial and radial movement of the processed medium.

Classification sign	Machine type
According to the position of the working bodies in space	- submersible; - flow type; - embedded.

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By type of input of components of the mixture	- with giving in one branch pipe; - with giving in different branch pipes.
By the position of the rotor in space	- with a vertical shaft; - with a horizontal shaft.
By the number of cameras in the working area	- with one camera; - with multiple cameras.
According to the way the cameras are positioned	- with serial connection; - with parallel connection; - mixed type of inclusion.
By the number of steps of the apparatus	- with one step; - with several steps.
By type and presence of additional working bodies	- there are no additional working bodies; - there are additional working bodies.
According to the mobility of additional parts	- no movement - axial movement of additional organs; - oscillatory movement of working bodies.

In industry, RDS with smooth disks, which have additional working bodies fixed on their surfaces, have earned wide distribution. They are characterized by high productivity, high emulsion quality and low electrical energy consumption per unit of mixture. Since the resulting emulsion has a relatively soapy size of dispersed particles and, as a result, a large interfacial surface area, RDM can be used as an ideal mixing reactor when processing various media in different states of aggregation. [3].

As the mixer is used for a long time, the wear of the working bodies leads to an increase in the gaps between the working bodies, which negatively affects the quality of the mixture and the energy parameters of the process. Therefore, quality control is an important procedure.

The deterioration of the quality of mixing can occur for several reasons: a change in the processing modes of the mixture, a significant decrease in the speed of rotation of the rotor, wear of the working disks, which led to a change in the gaps between the disks in a larger direction. Deviation from the technological regime can be corrected at the time of operation of the mixer. The wear of the working bodies can be eliminated only after disassembly and revision of the damaged parts, which leads to a stop in the process.

Therefore, disks and additional organs are subject to strong erosive wear, wear increases many times in the presence of abrasive solid inclusions in the medium. It has been experimentally established that the elements located above the surfaces of the disks are subject to the most severe wear.

2 Methodology and materials

At the moment, there are several methods of emulsion analysis, the most suitable are the photometric method and the sedimentation method. The sedimentation method consists in finding the particle size and composition of the mixture from the separation time. It is carried out simply, but it has such disadvantages as low accuracy, long analysis time, limited use in mixtures with high viscosity. The calculation method can be used to determine the composition and size of dispersed particles by specifying some design and measured parameters. However, this method is laborious and has a high level of error, and also takes into account only known physical phenomena and properties. The photometric method is relatively simple and accurate compared to previous methods. Based on the study of the composition of the emulsion on an enlarged image (photo) [4]:

1. taking a sample of the emulsion;
2. we keep the sample of the emulsion in the test tube for about 3 minutes;

3. a few drops of emulsion say goodbye to the microscope glass;
4. examination of the emulsion under a microscope (Figure 1).

In the case when the dispersed phase is difficult to distinguish, then a dye is introduced into the mixer, which dissolves only in the dispersed or main phase.

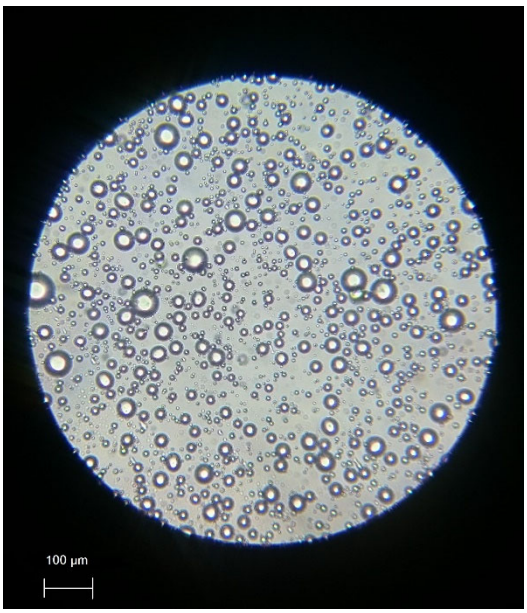

Fig. 1. Emulsion photography.

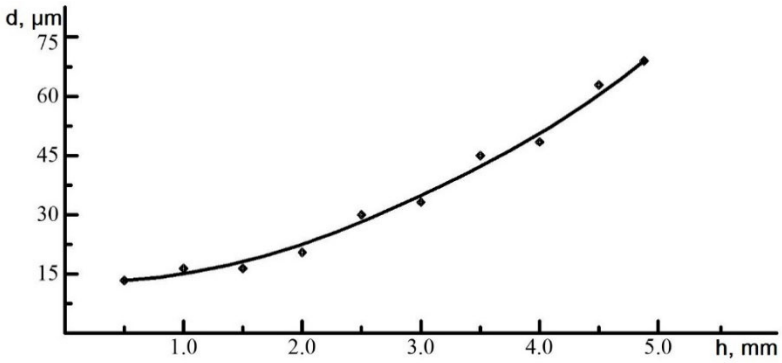

Fig. 2. Graph of the dependence of the average size of the dispersed phase on the gap between the rotating and stationary disk.

Water and diesel fuel with the following parameters were used as test media. Water (kinematic viscosity 1.006•10-6 m2/s, density ρ=998 kg/m3, dynamic viscosity 1004 µPa•s, surface tension 0.07 N/m (at 293K); diesel fuel (kinematic viscosity 0.62•10-6 m2/s (at 293K), dynamic viscosity 560 µPa•s, ρ=860 kg/m3, diesel fuel/water volume ratio = 1/5, volume flow Q=0.25 m3/h RDS working zone volume - 0.85 l.

As can be seen from the graphs (Figure 2), there is a direct relationship between the average size of dispersed particles and the gap between the movable and fixed disks, with other processing modes unchanged. However, reducing the gap requires a finer adjustment

of the gaps, since when a slight runout of the shaft appears, for example, due to wear of the bearings, the discs may engage and the working bodies may be destroyed (jamming). On the contrary, at large gaps, turbulence sharply weakens and, as a result, the dissipated power decreases. An increase in the gaps between the rotating and fixed disks can occur spontaneously when the working bodies or additional elements mounted on them are worn out. Wear occurs especially quickly in the presence of abrasive particles in the treated medium or when working with a heterogeneous liquid-solid particle medium.

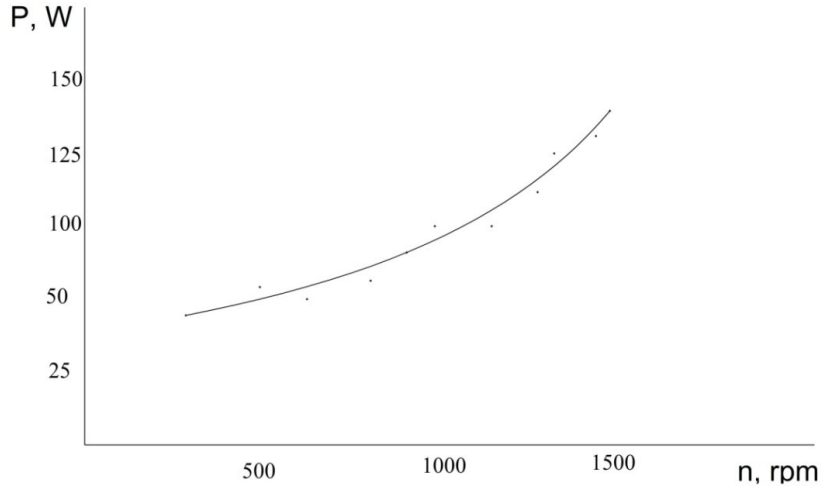

Fig. 3. Graph of the effect of power on the speed of rotation of the rotor at a flow rate of the medium Q=0.2 m3/h, the ratio of diesel fuel/water 1/5.

3 Conclusions and discussion

The conducted studies have shown that an increase in the gap requires an increase in the rotor speed (to maintain the quality of the emulsion) and, as a result, the energy consumption of the process increases [5]. Therefore, to save energy and reduce wear, it is recommended to periodically analyze the emulsion. The photometric method is an express method that has a number of advantages; it allows not only to determine the parameters of the emulsion, but also to determine the degree of wear of the apparatus by indirect signs.

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