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USE OF THE TWO-LEVEL CONTACT AND DISTRIBUTIVE DEVICES IN REACTORS OF TRIAL INSTALLATION PRODUCTIONS OF METHYL AIR OF FAT ACIDS

Justified by the value of dispersion and uniform distribution of flow in the apparatus for a liquid-liquid interactions. Showing the relevance of phase dispersion and distribution of flows in the column reactor plants for fatty acid methyl esters. The design and principle of operation of the contact and switchgear for the esterification reactor, neutralization and washing of the plant. Based on the experience of the plant confirmed efficiency and effectiveness of the device, as well as recommendations for its wider use.

Introduction. In the chemical industry, in allied industries a number of thermal and chemical processes is carried out in diphasic systems liquid – liquid, liquid – gas (steam). Ensuring intensive and effective course of these processes needs uniform distribution of the disperse environment in liquid.

In particular, stable quality of the end-product [1–3] is reached in liquid reactors of continuous action of flowing type at provision with even distribution of the weighed particles in emulsion, representing a reactionary mix. In the long term period of interaction an evenness of emulsion structure can be broken under the influence of gravitational and inertial forces due to occurrence of stagnant zones, merger and, thus, increase of drops and act. Therefore, the processes in such devices should be carried out under the influences providing stability of disperse structure of a reactionary mix and evenness of its distribution on section.

As a result of a complex of the researches carried out in scientific research institute of physical and chemical problems of the Belarus state university (SRIFCP BSU) the way of process production of methyl ethers of fat acids (MEFA) has been developed [4]. MEFA are a component of biodiesel fuel. They are received by interaction of vegetable oils, in particular, rapeseed oil, with methanol. Manufacturing unit of MEFA from rapeseed oil has also been developed for realization of the above-stated method [5]. The installation block – diagram is presented on Fig. 1.

The manufacturing unit is provided with four reactors of continuous action: etherification *2* and *4*, neutralizations *7* and washings *9*. In all reactors heterogeneous interactions occur during technological process. Reactionary mixes are represented as emulsions. There are cooperate rapeseed oil with the catalyst – an alkali solution in methanol in the reactor of the first etherification *2*. Interaction of the fresh dose of the catalyst to the oil-ether phase allocated from products of reaction of the first etherification is going in the reactor of the second etherification *4*. The basic part of methanol, being a part of catalyst, reacts with fat acids in reactors *2* and *4*, forming MEFA.

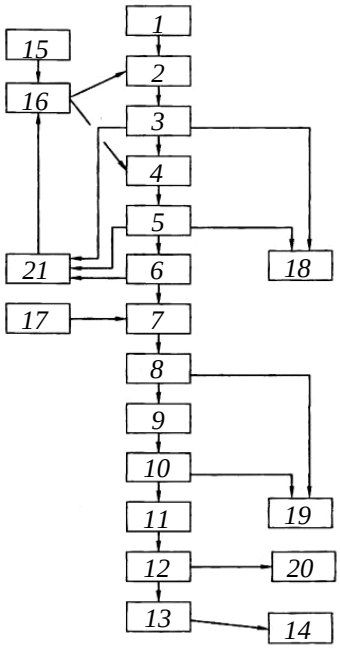

Fig. 1. The block-diagram of MEFA manufacturing: *1* – vessel for oil; *2* – reactor of the first etherification; *3*, *5*, *8*, *10* – sedimentations; *4* – reactor of the second etherification; *6* – the device for distillation of methanol; *7* – neutralization reactor; *9* – washing reactor; *11* – the device for drainage of MEFA; *12* – centrifuge; *13*, *14* – storage tanks for MEFA; *15* – vessel for methanol; *16* – reactor of preparation of the catalyst; *17* – vessel for a neutralized solution; *18* – storage tank of a glyceric phase; *19* – storage tank of washing water; *20* – sediment storage tank; *21* – storage tank of recycled methanol

Reaction products from the reactor *4* after the separation of a glyceric phase and stripping of methanol are directed to the neutralization reactor *7*. The remains of alkali interact with acid in the neutralization reactor *7*. Salts from a ether phase received in the reactor *7* are washed in the washing

reactor *9*. Further from MEFA the remains of water and the weighed particles are separate. Received product is directed to collections *13* and *14*.

Laboratory researches have shown that from 15 to 30 min are required for qualitative carrying out of each of the stages proceeding in reactors *2*, *4*, *7* and *9*. Laboratory modeling of the specified stages was carried out in devices with mixers.

In accordance with the complex state scientific and technical project "to develop the technology of cultivation of rape kind with the high maintenance of unsaturated fat acids and its complex processing with reception of various kinds of diesel fuel and accompanying products" designing, manufacturing and installation of trial MEFA manufacturing unit have been implemented on the basis of the scientific and technical decisions presented in patents [4, 5]. Mass-overall installation characteristics have been limited by the design objective. The possibility of mobile moving of the equipment from one industrial platform to another was stipulated in it. At stages of outline designing and technical design performance the decision about application as reactors of the first and the second etherification, neutralization and washing of columned reactors of flowing kind was made.

Thus each of reactors consists of four consistently connected modules. In all reactors installation of internal devices for maintenance of reactionary mixes in an look, and also for uniform distribution of streams on section of devices was required.

Main part. It was offered to use static contact-distributive centers for ensuring of emulsification of reactionary mixes and even distribution of streams on section of reactors of manufacture installation of MEFA. They are easier on a design, more cheaply, demand smaller expenditures of labor and qualification of the personnel at operation service and repair. The elementary device of such type is perforated sheet [6].

However, it does not provide with quite uniform distribution of a dysphasic flow in device section. The two-level distributor presented in Fig. 2 is considered to be more perfect.

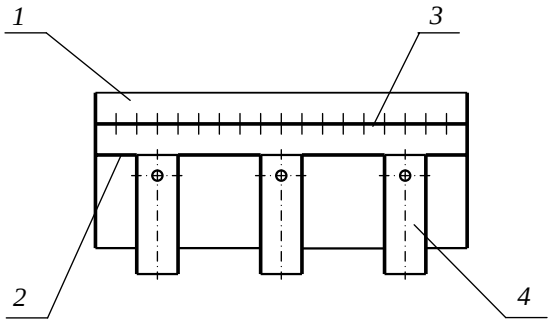

Fig. 2. Two-level distributor:
1 – barrel; *2* – bottom plate;
3 – top plate; *4* – air-lift branch

Researches of the specified distributor [7] have shown that it provides with much more uniform distribution of an easy phase on device section (Fig. 3). The design of the two-level distributor has been modified in accordance with the facts that distribution of a liquid phase is carried out in reactors, and it requires to be maintained in an emulsified condition. Thus, it was called "a contact-distributive center" [8]. The contact-distributive center scheme is represented on Fig. 4.

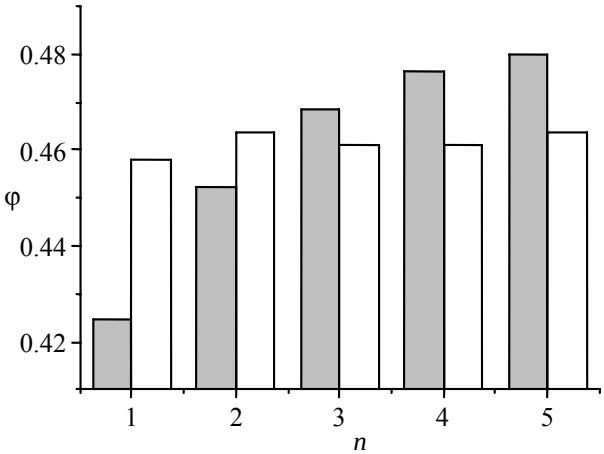

Fig. 3. Histograms of gas content of φ
for a perforated leaf (a dark background)
and two-level distributor (a light background):
n – number of a measuring cell

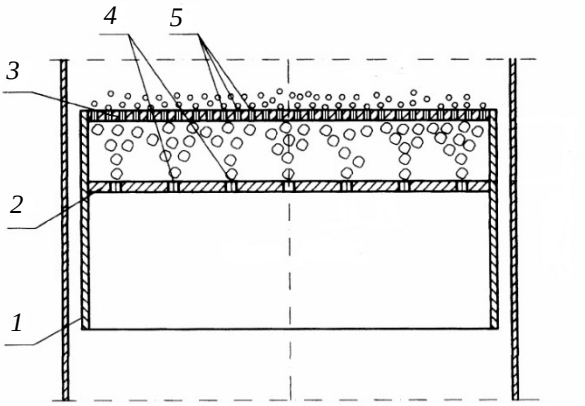

Fig. 4. Contact switching center [8]:
1 – barrel (shell); *2* – bottom plate; *3* – top plate;
4, *5* – openings (apertures)

The device is installed inside of the vertical cylindrical frame of the device in which the ascending stream of a continuous phase – liquids moves. The device consists of the shell *1* and punched plates installed in its bottom *2* and top *3*. Plates *2* and *3* have apertures *4* and *5* accordingly. Apertures in plates are placed in regular intervals, and the total area of apertures *5* in the top plate is much more than the total area of apertures *4* in the bottom plate. The distance between plates has to be not more than eight diameters of apertures *4*.

The contact-distributive device works as follows. The easy phase arrives inside of shell *1* under the bottom punched plate *2*. Since the degree of perforation of the bottom plate is small, and even having low consumption of an easy phase a considerably high layer of this phase is formed and provides its uniform inflow in apertures *4*. The easy phase in the form of drops (liquid) or bubbles (gas) flows out of apertures *4* between plates. Whereas distance between plates is small, drops (bubbles) of an easy phase have no possibility to migrate considerably in a cross-section direction. Therefore even in the absence of a easy phase layer under the top punched plate this phase evenly expires through its openings. At the jet expiration of an easy phase through openings *4* bottom plates, the subsequent disintegration of streams on drops (bubbles) in space between plates uniformity of the expiration of an easy phase through openings *5* remain because of limited cross-section migration of a phase, as well as at its drop (bubbles) expiration through openings *4*.

Apertures *4* and *5* carry out with the considerable size that provides their small sensitivity to pollution and corrosive attacks.

The heavy phase in the device carries out through an annular gap between the walls of its frame and the shell of contact-distributive center. Creation of a layer of an easy phase under the bottom plate with the subsequent dispersion provides updating of a surface of contact and raises efficiency of interaction.

The described contact-distributive center in comparison with analogues provides:

– increased uniformity of distribution of an easy phase;

– expansion of a range of steady work;

– high safety in operation;

– increased efficiency of phase interaction.

Besides, owing to formation of a considerable layer on height of an easy phase under the bottom plate even at small expenses of this phase, exact horizontal installation of plates isn't required. It considerably simplifies manufacturing and installation contact distributing devices.

The design of each reactors sections of trial installation of MEFA manufacturing unit (Fig. 5) is provided with the cascade from ten contact-distributive centers.

While designing of contact-distributive centers the total area of apertures of the bottom plates has been calculated so that in the easy phase interphase voltage sufficient for effective dispersion was provided. The step of an arrangement of contact-distributive centers has been chosen with a glance of the recommendation about designing pulsating liquid extractors with perforated plates [9]. Designing and manufacturing of reactors have been carried out by firm Wiedemann-Polska. Installation and commissioning of the device was made by OS "Grodno-Nitrogen". During its operation MEFA was received, that had allowed to adjust the manufacture of the biodiesel fuel corresponding to standards in Belarus for the first time.

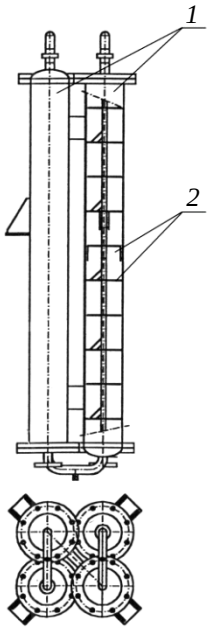

Fig. 5. Reactor scheme:
1 – sections; *2* – the contact-distributive devices

All reactors of pilot-plant installation in which two-level contact distribute devices were used, provided stable technological process carrying out. Operating experience showed that operation of reactors without deterioration of made MEFA is possible in a wide range of loadings. After the small modernization, installation was successfully maintained at the loadings corresponding to productivity of 5,000 t/year (design productivity – 2,000 t/year of MEFA).

Conclusion. Application of the two-level contact-distributive center in trial installation of manufacture of MEFA has proved an efficiency and reliability of its work. On this basis the use of this device can be recommended in reactors for a liquid – liquid and liquid – gas interactions in liquid-phase extractors, absorbers.

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