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DEVICE FOR STABILIZING AND HOMOGENIZING LIQUID MIXTURES

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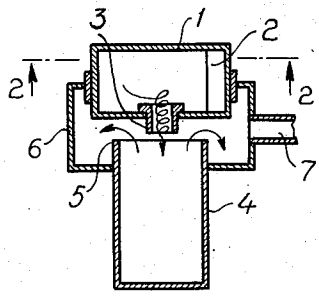


Fig. 1

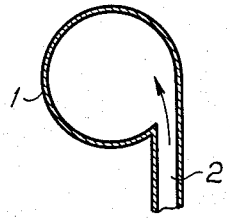


Fig. 2

INVENTOR.

Stig Holger Bjarne Zachariassen

BY Davis, Hoxie, Faithfull

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DEVICE FOR STABILIZING AND HOMOGENIZING LIQUID MIXTURES

Stig H. Bjarne Zachariassen, Stockholm, Sweden, assignor to Aktiebolaget Separator, Stockholm, Sweden, a corporation of Sweden

Original application May 12, 1949, Serial No. 92,774, now Patent No. 2,595,376, dated May 6, 1952. Divided and this application October 30, 1951, Serial No. 253,809. In Sweden May 14, 1948

2 Claims. (Cl. 259—4)

1

This invention relates to apparatus for stabilizing and homogenizing liquid mixtures, such as milk.

The most efficient type of homogenizer known in the art is the so-called high-pressure homogenizer, in which the liquid under treatment is forced through very narrow slots under a pressure ranging from 50 to 600 atmospheres. The basic principle in this type of machine is to subject the particles to be atomized (for example, fat and water) to such considerable deforming, when they are passing through the narrow slot, that they are divided into a number of smaller particles. As the energy necessary for generating the requisite high pressure cannot be recovered, homogenizing machines of this type entail very high operating costs.

Accordingly, a great number of other constructions, so-called low-pressure homogenizers, have been devised. The latter work upon very different principles, the homogenizing being effected by means of pressures between 1 and 10 atmospheres. The power consumption of these machines is, of course, correspondingly smaller, but their homogenizing effect largely corresponds to the operating pressure, so that they can generally be used only for comparatively simple problems. When high requirements must be met in the homogenizing, these machines therefore cannot be used.

The homogenization of milk and cream presents a difficult problem, because in this case an atomization of the fat globules to maximum 2μ, and preferably only 1μ or less, is required. Heretofore, it has been possible to solve this problem only by means of high-pressure homogenizers operated by pressures of at least 50 to 100 atmospheres. Homogenizing of milk therefore has not found the practical and extensive use which could have been expected.

I have found that it is possible to treat liquids to be homogenized (for example, milk and cream) by means of considerably lower pressures and yet obtain the same final quality of the product. This is accomplished by abandoning the principle on which the high-pressure homogenizers work and, instead, utilizing the available pressure for homogenizing in a device constructed according to the present invention. This device comprises a cyclone having its outlet end arranged to discharge into a whirl chamber, in which the liquid velocity is converted as much as possible into internal liquid friction. In such a whirl chamber, the liquid velocity, in other words, is converted into a heating of the liquid.

2

By means of the cyclone, the liquid is forced into the whirl chamber not only with a velocity along the axis of this chamber but also with a rotative motion about the axis of the whirl chamber. The liquid is preferably discharged from the cyclone into the whirl chamber by way of an axial nozzle, the cyclone action causing the liquid to be more or less sprayed through the nozzle so that the particles penetrate into the liquid in the whirl chamber.

Tests have shown that by the use of the new stabilizing and homogenizing device, average diameters of the fat globules ranging from 1.1 to 1.3μ can be obtained, when working with pressures of only 12 to 25 atmospheres in the homogenizer. On the other hand, with the best high-pressure homogenizers of known types, a pressure of 50 to 100 atmospheres would be required for the same purpose. By reason of this fact alone, the device of the present invention is of great importance in practical operation because of the saving of power consumption which it enables; but in addition, simple pumps, such as screw pumps, toothed-wheel pumps, and possibly multi-stage centrifugal pumps, may be used as a source of pressure for the feeding means. Since these pumps have a considerably higher efficiency than the piston pumps which have to be used in the case of pressures of 100 atmospheres and more, a saving of power consumption of 60 to 80 per cent is achieved. Furthermore, it is possible to dispense with the inlet and outlet valves which complicate the use of high pressure homogenizers, so that, taking everything into account, a construction is obtained which, while having the same efficiency, requires only a fraction of the consumption of material and power of piston pumps and which, moreover, is considerably simpler and can be kept clean and hygienic with less work.

As previously mentioned, the source of pressure for supplying the liquid to the cyclone may generally be a screw pump or possibly a toothed-wheel or centrifugal pump. When particularly high requirements are put on the homogenized liquid and when, for some reason, the liquid must also be separated, the source of pressure may be the rotating bowl of a centrifugal separator, as disclosed in my copending application Serial No. 92,774, filed May 12, 1949, now Patent No. 2,595,376, dated May 6, 1952, of which this application is a division.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which:

Fig. 1 is a horizontal sectional view of a preferred form of the device, showing the whirl chamber and the cyclone; and

Fig. 2 is a vertical sectional view on the line 2—2 in Fig. 1.

The liquid to be treated is fed to a cyclone 1 by way of its inlet 2. The cyclone has at one end a central, axial outlet 3 which is preferably in the form of a nozzle. The nozzle 3 discharges the liquid into a cylindrical whirl chamber formed by a member 4, where the liquid velocity is converted as far as possible into internal liquid friction. The liquid enters the whirl chamber 4 along its axis, and the homogenized liquid is discharged from the whirl chamber over the outlet edge 5 thereof at the entrance end of this chamber. In order to permit adjustment of the distance of the whirl chamber 4 from the outlet 3 of the cyclone, I prefer to arrange the latter so that it is movable axially relative to the whirl chamber, as by means of the sliding connection provided by a sleeve 6 connected to the whirl chamber and surrounding and slidably engaging the cyclone. The sleeve 6 forms an outlet 7 for the treated liquid.

It will be understood that the cyclone 1 imparts a rapid rotation to the liquid discharging through nozzle 3 into the whirl chamber 4, thus increasing the velocity gradient in chamber 4. (This rotational velocity is an addition to the axial velocity of the liquid passing through the nozzle.) In the device as illustrated, the liquid leaves the whirl chamber 4 in a direction parallel but opposite to the inlet direction, which has the effect of producing a high relative velocity between the incoming and the discharging liquid in the whirl chamber.

By way of further explanation, it is to be noted that a high homogenizing effect requires a high velocity gradient. A high velocity gradient, that is, a high velocity difference between two adjacent liquid layers, causes the emulgated droplets of the liquid mixture to be torn into smaller particles. In the whirl chamber 4, the velocity gradient of the whirls produced is proportional to the velocity of the inflowing liquid, and this velocity in turn is proportional to the square root of the available pressure. In the cyclone 1, a great velocity gradient is obtained in the center (the velocity multiplied by the radius is constant), and this velocity gradient is directly proportional to the available pressure. Consequently, the cyclone 1 is well adapted for homogenization at the relatively high pressure at which the liquid is forced through inlet 2. The whirl chamber 4, on the other hand, works well with a small pressure energy. The liquid is discharged from the center of cyclone 1 through the axial aperture 3, and in order to obtain a high velocity gradient it is advantageous that the aperture 3 be not too large, thereby providing sufficient pressure to discharge the liquid through the outlet of the cyclone 1 with a substantial axial velocity. The whirl chamber 4 has a good homogenizing effect at a low velocity of the liquid, and this chamber is arranged beyond the cyclone 1 in order to utilize the velocity of the liquid discharging from the cyclone. The combination of the cyclone 1 and the whirl chamber 4 thus provides a very good homogenizing effect, because the cyclone utilizes the relatively large pressure drop and the whirl chamber the relatively small pressure drop.

The dimensions of the cyclone 1 and of the whirl chamber 4 should be adapted to the liquid mixture to be treated and to the desired throughput rate. The dimensions of the cyclone may be easily calculated, since the flow of liquid and the pressure drop in the cyclone follow known laws. With regard to the whirl chamber, it is a general rule that the higher the pressure for the desired effect, the longer the whirl chamber must be, reckoned in the axial direction of the liquid jet issuing from the cyclone. The volume and the distance of the whirl chamber from the outlet of the cyclone is also determined by the viscosity of the liquid to be treated. As an example, the following data apply to a device for homogenizing milk so that no cream plugs are formed within 48 hours: pressure of 15–30 kgs./cm.^{2} in the whirl chamber 4, diameter of whirl chamber 6–12 mms., length of whirl chamber 50–70 mms., distance between outlet edge 5 of whirl chamber and outlet of nozzle 3 greater than 4 mms. If, for example, 12 percent cream is homogenized by means of a higher pressure, the aforesaid distance should be greater, possibly as much as 20 mm.

I claim:

1. A device for stabilizing and homogenizing liquid mixtures, which comprises a cyclone having an inlet for the mixture, the cyclone also having a central outlet for the mixture, and a member forming a whirl chamber positioned to receive the mixture discharged through said outlet and in which the velocity of the mixture is converted at least largely into internal liquid friction, the whirl chamber having an open end adjacent said central outlet and being closed at the opposite end, said central outlet being positioned to discharge the mixture into the central part of said open end and toward the closed end, the edge of the whirl chamber at its open end forming an outlet for discharging the treated mixture from the whirl chamber.

2. A device for stabilizing and homogenizing liquid mixtures, which comprises a cyclone having an inlet for the mixture, the cyclone also having a central outlet for the mixture, a member forming a whirl chamber positioned to receive the mixture discharged through said outlet and in which the velocity of the mixture is converted at least largely into internal liquid friction, and a sliding connection between the cyclone and said member forming the whirl chamber, whereby the distance of the whirl chamber from said central outlet may be varied.

STIG H. BJARNE ZACHARIASSEN.

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