Nov. 19, 1957 L. J. REVALLIER 2,813,833

METHOD OF AND APPARATUS FOR BREAKING DOWN OF FROTH

Filed June 17, 1953

2 Sheets-Sheet 1

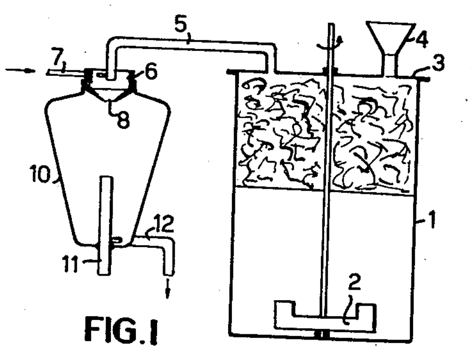

FIG.1

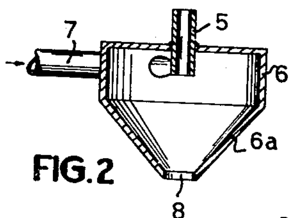

FIG.2

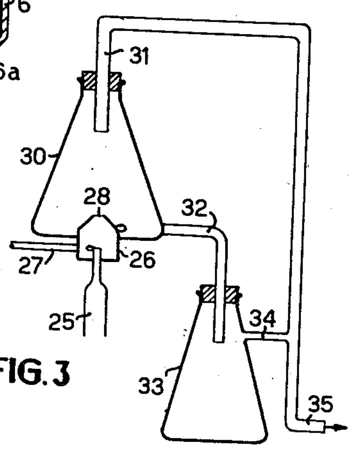

FIG.3

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FIG.4

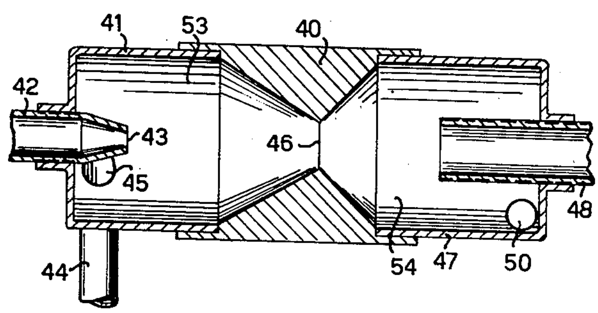
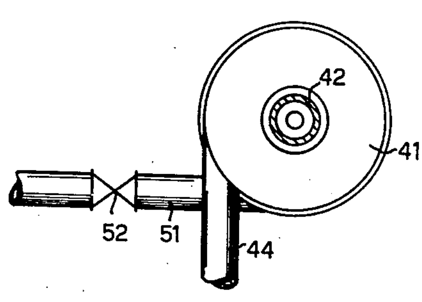


FIG.5



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METHOD OF AND APPARATUS FOR BREAKING DOWN OF FROTH

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7 Claims. (Cl. 252—321)

My invention concerns a method of and apparatus for the breaking down of froth. It is a well-known fact that froth repression is often a difficult problem, especially if the froth is stable and the difficulty is further increased if the froth has a corrosive action.

As an example of a froth which is difficult to break I may mention the froth obtained in the decomposition of phosphate rock by means of a strong acid such as H_2SO_4 or HNO_3. The gas evolution during this decomposition is chiefly due to the presence of rather large amounts of calcium carbonate; the stability of the froth is highly increased by the presence of colloidal clay in the raw rock.

In many instances where froth formation is encountered, chemical froth inhibitors cannot be used, either because the said inhibitors are rapidly decomposed by the frothing liquids or because the addition of foreign substances, even in small amounts, is undesirable. The latter objection chiefly applies to the pharmaceutical, foodstuff and luxury product industries.

The use of mechanical froth breakers comprising moving parts which act on the froth is not desirable if the froth has a corrosive action.

It is the main object of my invention to provide a method of breaking down froth in which a very stable froth may be broken down in a simple and efficient manner. Another object of my invention is to provide a method of breaking down froth in which no use is made of moving mechanical parts.

A further object of my invention is to provide a method of breaking down froth without the use of chemical froth inhibitors in such instances where said use is customarily desirable but hardly admissible. A still further object of my invention is to provide a method of breaking down froths with an unusual high liquid content.

Another object of my invention is to provide simple and efficient apparatus for carrying out my new process.

Further objects will appear hereinafter and in the claims hereof.

My invention is applicable in the breaking down of froths encountered in many different technological fields, e. g. the breaking of froth formed in fermentation processes, in the processing of milk, potato starch water and solutions of capillary active substances, and in the breaking of the very corrosive froth encountered when decomposing rock phosphates with a strong acid.

According to my invention the froth is broken down by subjecting it to the forces obtaining in a gas vortex, generated in an auxiliary gas.

The expression "gas vortex" as used herein, and in the claims hereof, designates a body of gas in rotational movement with a current moving spirally inwards towards the axis of rotation so that the angular velocity increases from the periphery towards the core of the body.

If a gas vortex is established in a rotation chamber of suitable form by feeding the gas into the chamber at a

suitable velocity, then given an adequate discharge rate from the chamber, if a froth is introduced into the core of the vortex through an axial feed aperture, the froth is broken, presumably by the centrifugal forces and shearing stresses prevailing in the vortex and the liquid material from the froth is flung to the wall of the rotation chamber and is carried along the said wall towards the discharge aperture of the chamber from where it is blown out of the chamber in the form of large drops by the discharging gas.

The term "rotation chamber" as used herein and in the claims hereof, designates a radially symmetrical chamber with one axially located discharge aperture in one end thereof and one or more feed passages disposed so that a gas fed into the chamber therethrough at a suitable velocity, commences to rotate in the chamber in a path of greater radius than the radius of the discharge aperture and forms in the chamber a vortex from which gas continuously discharges through the discharge aperture.

For the purpose of my present invention, the rotation chamber is preferably of that type having a discharge end portion which tapers towards the discharge aperture and in which material moving along the tapering wall will pass directly out of the discharge aperture in continuing its said movement.

Accordingly, the method according to my invention of breaking down froth, comprises introducing the froth into the core of a gas vortex which is established in a rotation chamber of the kind defined by feeding gas continuously into such a chamber, the velocity of the said feed and the area of the rotation chamber discharge aperture being such that the froth after entering the chamber is broken down and the liquid from the froth is precipitated on the chamber wall, flows along the said wall and passes through the discharge aperture of the chamber in unfrothed condition, e. g. in the shape of big drops.

I prefer to use a rotation chamber with one or more feed passages in substantially tangential relation to the chamber, but a chamber may be used in which the feed takes place axially, e. g., through an annular slot which is provided with guiding members which impart the rotary motion to the gas.

For feeding the froth into the core of the vortex, the rotation chamber may have an axially located feed aperture formed by or connected with a feed pipe. For example, the feed aperture may be located in the end of the chamber opposite the discharge end or the feed pipe may intrude axially into the chamber.

If desired the froth may be introduced into the chamber under the aspirating effect of a depression in the core of the vortex, which depression occurs if the dimensions of the rotation chamber are adequately selected. Otherwise, the froth may be supplied under an only slight overpressure. In order to aspirate the froth into the chamber it is essential for the diameter of the froth feed aperture to be smaller than the diameter of the discharge aperture.

The dimensions of the rotation chamber may be chosen with regard to the nature of the froth and the quantity to be broken down in a given time. It is impotrant to remember, however, that the pressure drop necessary to create a gas vortex giving the desired result is greater the larger the rotation chamber. On account of this fact it may be advantageous in order to attain the desired capacity to use a plurality of small rotation chambers connected to operate in parallel, instead of a single large rotation chamber.

The pressure drop necessary for causing the gas to flow through the rotation chamber at the required velocity can be produced either by supplying the gas under pressure or by connecting the discharge aperture of the rotation chamber to a suction line. As with a small rotation chamber, the difference between the pressure at the entrance and at the discharge required for breaking the froth need not be great, the latter method is very useful in practice.

The actual pressure drop to be employed in a given rotation chamber, to give the desired result, is determined empirically. If the gas velocity is too high the liquid on the wall of the chamber, instead of flowing to the discharge aperture, becomes dispersed in the gas. It is found that the froth breaking action is attained at relatively low velocities, so that it is easy to avoid causing this dispersal of the liquid. The area of the discharge aperture in relation to the feed aperture area is also a factor which influences the result, since this will affect, in addition to the maximum angular velocities obtaining in the chamber, the rate of discharge and hence the period of time during which the precipitated liquid remains in the chamber and in contact with the rotating gas. To give an adequate rate of discharge and to avoid unduly high angular velocities the area of the discharge aperture is preferably larger than the area of the feed aperture or the aggregate feed aperture area in the event that there is more than one feed aperture.

The process may be carried on with the rotation chamber orientated in any desired manner. For example the chamber may be placed with its discharge aperture uppermost or lowermost.

In order to collect the liquid flung out of the discharge aperture of the rotation chamber, a collecting chamber is preferably suitably positioned in receiving relation to the discharge aperture of the rotation chamber, the said collecting chamber being provided with a gas outlet and a liquid outlet. Such outlets may be combined if desired, but in this case, due care should be taken to ensure that the gas velocity in the combined outlet is not so high that an intensive mixing, and hence possibly a new froth formation occurs.

It is preferred to use a collecting chamber of a radially symmetrical form located coaxially with respect to the rotation chamber. This arrangement makes it possible for the rotary motion of the gas discharging from the rotation chamber to continue within the collecting chamber, so that the thorough separation of the precipitated liquid from the gas is promoted by the continuing centrifugal accelerations. In this form of apparatus it is preferred to provide a discharge conduit for the gas which extends axially into the collecting chamber, and to provide a peripheral discharge outlet for the liquid which flows down the wall of the said chamber. This liquid outlet may take the form of a conduit provided in such tangential relation to the collecting chamber that the liquid which spirals downwards along the wall of the collecting chamber, flows into the discharge conduit as it continues its spiral movement. The liquid may be removed from this collecting chamber continuously or discontinuously.

My invention may be used for dealing with froths of widely differing compositions and properties. Froth with a high liquid content can be broken down without difficulty. If desired a separation may be effected beforehand between a liquid and a froth.

If a froth to be broken down is so stiff that it is very difficult or even impossible to convey it along a froth feed conduit to the axial feed aperture by application of pressure, it may be fed into the core of the vortex by means of a screw conveyor. Thus a rotation chamber for this purpose, may have a comparatively wide froth feed conduit and associated axial feed aperture, and a screw conveyor may be arranged within the said feed conduit. It may be necessary for dealing with such froths, to make the vortex current of suitably greater power than is normally required, but subject to this requirement a rapid and complete breakage of the froth can be attained.

The use of an auxiliary gas for breaking the froth may be open to objection in some cases, e. g., when a dilution of the gas phase occurring in the froth is undesirable. In that case a gas of the same composition as the gas phase in the froth may be used as the auxiliary gas to form the vortex. If necessary this gas may be recycled after separation therefrom of the liquid precipitated from the froth.

My invention will be further described with the help of the accompanying drawings which diagrammatically illustrate, by way of example only, various forms of apparatus suitable for carrying out my new method.

Referring to these drawings:

Figure 1 shows apparatus, comprising a vessel in which e. g., phosphate rock may be decomposed, and associated apparatus for breaking down the froth which is formed during the decomposition.

Figure 2 shows a preferred form of the rotation chamber to be used in greater detail.

Figure 3 shows another assembly in which apparatus according to my invention is incorporated.

Figures 4 and 5 illustrate a very compact construction of rotation chamber and a conjoined collecting vessel. Figure 4 shows a longitudinal cross section of the apparatus and Figure 5 an end view of the same.

In Figure 1, the decomposition vessel **1**, has a stirring element **2** and is closed by a cover plate **3**. The filling opening of the vessel **1** is provided with a charging hopper **4**.

Through said hopper ground phosphate rock and strong nitric acid can be introduced into the vessel. As a result a very tenacious and corrosive froth is formed which very soon fills up the entire free space.

In order to break this froth it is allowed to pass through a pipe **5** the other end of which intrudes axially into a rotation chamber **6** provided with a tangentially directed feed conduit **7** for air and an axial discharge aperture **8**.

The rotation chamber is mounted in the mouth of a radially symmetrical collecting chamber **10** which is provided with an axially arranged gas discharge pipe **11** and a tangentially disposed liquid outlet pipe **12**. If air is passed into the rotation chamber at a suitable velocity through the pipe **7**, for instance from a low pressure air line, an air vortex is set up in the rotation chamber and the depression at the core of the vortex aspirates the froth out of the vessel **1**.

In the rotation chamber the froth is broken down. The liquid phase from which the gas has been liberated is flung against the wall of the rotation chamber and this liquid, after flowing to the discharge aperture **8** is flung outwards in the form of fairly big drops, onto the wall of the collecting vessel **10**, by the rapidly rotating air discharging through the said aperture **8**. Subsequently, the liquid spirals down along the wall of the vessel **10** and passes out of the vessel through the outlet pipe **12**. The air leaves the vessel **10** through the centrally located discharge pipe **11**.

Using a rotation chamber as illustrated in Figure 2 having the following dimensions: diameter of the chamber (at wide end) 38 mm., diameter of the axial discharge aperture (8) 11 mm., diameter of the feed pipe (7) 10 mm., diameter of the froth feed pipe (5) 7 mm., angle of the cone (*6a*) 90°, an air feed gauge pressure of 7 cm. Hg is sufficient to break the froth forming in vessel 1 when phosphate and nitric acid are supplied to the said vessel at a rate which is a few times greater than would be admissible if no use were made of the invention.

In Figure 3, **26** is a rotation chamber which is disposed with its discharge aperture **28** uppermost. The rotation chamber is provided with a froth supply pipe **25** which discharges axially into the chamber. The rotation chamber is mounted in the wall of a radially symmetrical collecting vessel **30** so that it is coaxial with the said vessel. The vessel **30** has an outlet **31** for the gas and a tangential outlet **32** for the resultant liquid. The outlet **32** opens into a further vessel **33** provided with a gas discharge conduit 34 which is connected to a gas delivery pipe 35. If pipe 35 is connected to a suction conduit in which a depression of 10 cm. Hg or more is maintained, the suction is sufficient to cause continuous feed of gas into the rotation chamber 26 through the pipe 27, at a velocity such that a vortex is established in the rotation chamber and such that by the action of this vortex froth is aspirated into the rotation chamber through the pipe 25 and is broken down, the separated liquid being forced out of the discharge aperture 28 by the gas discharging from the rotation chamber and being flung against the wall of the vessel 30. The liquid subsequently flows off through the pipe 32 into the vessel 33.

Referring now to Figures 4 and 5, the rotation chamber 53 is formed by the combination of a hollowed-out lock 40 and a connected cylindrical part 41. This part 41 is provided with a tangential gas inlet conduit 44, discharging at 45, and with an axial froth supply conduit 42 the discharge end 43 of which is narrowed.

Connected to the discharge aperture 46 of the rotation chamber 53 is a radially symmetrical collecting chamber 54 formed by the combination with the block 40 of the cylindrical part 47. The cylindrical part 47 is provided with an axially disposed discharge pipe 48 for the gas and a tangential discharge pipe 51 for the liquid obtained from the broken froth.

As the discharge aperture 50 leading into the discharge pipe 51 is located to the lower portion of the chamber 54, the liquid present in the said chamber after the gas supply has been stopped can still flow away.

The discharge pipe 51 is provided with a regulating cock 52 by means of which the gas can be prevented from leaving through the said pipe.

I claim:

1. A method of breaking down froth which comprises the steps of continuously flowing an auxiliary gas tangentially into a radially symmetrical space to generate a gas vortex therein, continuously discharging said auxiliary gas axially from said vortex, and introducing froth into the core of said vortex, the forces prevailing in said vortex being effective to break down said froth and discharge the liquid separated from the froth in liquid form along with said auxiliary gas.

2. A method according to claim 1, wherein the froth is aspirated into said vortex.

3. A method according to claim 1, wherein the auxiliary gas is of the same composition as the gas occluded in the froth to be broken.

4. A method according to claim 1, including the further step of separating the discharged liquid from the auxiliary gas discharge.

5. Apparatus for breaking down froth comprising a radially symmetrical rotation chamber, a circular axial discharge aperture in said chamber, at least one feed conduit for an auxiliary gas discharging tangentially into said chamber on a radius exceeding the radius of said discharge aperture, and a froth feed conduit discharging axially into said chamber opposite said discharge aperture, the outlet diameter of said froth feed conduit being less than the diameter of said discharge aperture, and a radially symmetrical receiving vessel joined coaxially to said rotation chamber and enclosing the discharge aperture thereof, said receiving vessel being provided with a gas discharge conduit projecting axially thereinto opposite the discharge opening of said rotation chamber.

6. Apparatus according to claim 5, wherein said receiving vessel is provided with a peripherally disposed discharge aperture for the liquid.

7. Apparatus according to claim 5, wherein the receiving vessel is provided with a peripherally disposed and tangentially directed discharge conduit for the liquid.

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