PROCESS AND APPARATUS FOR DEFOAMING LIQUIDS
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As is well known foam is a problem in many situations such as in the art of paper coating. In this art coating compositions commonly are used consisting essentially of water, pigment and adhesive. The adhesives customarily used e.g. casein and starch set in protective colloids or foam stabilizers so that it is practically impossible to make a paper coating composition of this type which is entirely free of foam or entrapped air or gas bubbles.

Foam increases the apparent viscosity of liquids and affects their flow characteristics so that they do not pump or spread as well as foam-free liquids. The foam or bubbles present in the drying layer of coating composition on paper causes foam pits, cratering and holes and seriously affects the quality of the coated paper product.

So-called foam killers or anti-foam agents are almost universally used in paper coating compositions and are necessary to prevent these defects in the coated paper such as so-called oil-spots or fish-eyes.

An object of the present invention is to provide relatively simple and inexpensive means for de-airing or de-foaming liquids of the type of said paper coating compositions i.e. any liquid which is sufficiently fluid to be pumpable.

A further object of the invention is to provide apparatus which is sufficiently effective that the use of de-foaming agents may be obviated, or the amount thereof required may be reduced or the results obtained with their use may be improved.

It has been found in the practice of the invention that paper coating compositions of the type referred to, are rendered substantially bubble-free so that they flow smoothly and spread well. The resulting dried coatings are free of pits or holes and it even appears that the coated paper product has better folding properties than similar coated paper made in the usual way without the use of the de-foaming apparatus of the present invention.

The invention will be described below with reference to the accompanying drawings which show an illustrative embodiment of the invention.

In the accompanying drawings:

Fig. 1 is a vertical section with parts appearing in elevation of a vertical cylindrical tank of suitable size or capacity e.g. 1 to 1.5 feet diameter and of suitable height e.g. 4 to 6 feet. The height generally should be several times the diameter e.g. 3 to 6 or more but operative limits of the ratio of height to diameter have not been determined and are not thought to be critical.

The tank 1 is provided with a flat cover 2 providing a gas-tight closure and secured to the tank in any suitable way such as by means of the flanges 3 and 5 and bolts (not shown). The cover 2 is provided with an opening for the valved pipe 4 through which liquid to be defoamed is introduced into the tank 1, a second opening for the pipe 5 through which air is exhausted from the tank 1 and a third opening through which the rotatable shaft 6 extends. A stuffing box and bearings (not shown) are mounted on the cover 2 for rotatably supporting the upper end of the shaft 6 and the shaft is provided with means which is conventionally illustrated by the pulley 7 and belt 8 for rotating it.

The pipe 4 discharges against the splash plate 9. This is not essential but is useful for breaking up the stream of liquid and gives improved and improved operation.

The bottom of tank 1 is closed by a funnel-shaped bottom 10 which is secured to the tank in any suitable way as by means of the flanges 11 and 12 and bolts (not shown). The funnel 10 consists of the upper conical portion 12 and the lower cylindrical portion 13 which is closed at its lower end by the plug 14 which also serves to provide the bearing for the lower end of the shaft 6. The lower end of the cylindrical portion 13 of the funnel 10 is connected to the discharge pipe 15 for the de-aerated and defoamed liquid, the movement of which is assisted by the pump 16. Pipe 5 is connected to the gas pump 17 for creating vacuum in the tank 1.

The wall of the tank 1 carries inwardly extending, spaced apart stationary blades 18, secured at their outer ends in any suitable way to the tank wall.

Blades 18 may be positioned in a variety of arrangements around the wall of the tank. i.e. they may be scattered at random or arranged in a curved row extending lengthwise and around the wall of the tank or in any other pattern so long as they permit the introduction and withdrawal of the shaft 6 with its blade 19 and the rotation of said shaft and blades and provide a scissoring action between themselves and the rotating blades. Each blade 18 presents a vertically disposed flat surface and is positioned vertically as to provide a clearance preferably of 0.10 to 0.5 inch for medium to low viscosity liquids and up to about 0.75 inch for high viscosity liquids between its edges and the edges of the rotatable blades 19.

It is noted however that a blade clearance of 0.20 to 0.25 inch is capable of handling liquids within the viscosity range from that of water up to the highest viscosity that the pumps will handle. More power is of course required for the more viscous liquids. As illustrated the blades 18 are mounted in two opposite vertical rows. Each blade suitably has widths (vertical dimension) of about 1 to 1.5 inches, is of suitable thickness for strength and rigidity and its inner end is spaced a suitable distance from the shaft 6, say 0.5 inch. The blades 19 are similar to the blades 18 and extend outwardly from the shaft 6 to a suitable clearance from the wall of the tank 1, say 0.5 inch. Blades 19 also may be distributed around the shaft 6 in a variety of arrangements similar to the blades 18. As illustrated they are arranged in two opposite vertical rows. In order to avoid sudden peaks of hydraulic resistance as the rotating blades 19 pass the stationary blades 18 one or the other or both are positioned at an angle to the plane through the axis of the tank so that they will pass each other with a scissoring action. As illustrated the blades 19 extend outwardly in parallel planes tangent to the shaft so that their outer ends trail behind their inner ends as the blades rotate counterclockwise as viewed in Fig. 2 and the blades
extend inwardly from the wall of the tank in parallel planes tangent to the shaft. Thus the inner ends of the rotor blades will precede the outer ends thereof in passing the stator blades. Either the blades may extend radially from the wall of the tank toward the axis thereof or the blades may extend radially from the distant end 10 toward the tank wall provided that the other set of blades is arranged non-radially to give the described scissoring action.

Mounted on the lower end of the shaft within the cylindrical portion of the funnel 10 of the helical auger type blade 20. This blade fits fairly a wide range and cylindrical extension (clearance of about 0.25 inch) and serves to move any heavy material or jumps toward the outlet pipe 15 to pump 16.

Above the helix on the shaft, within the conical portion of the funnel 10 the shaft 6 carries the two blades. These blades are arranged with their lower edges close to the surface of the portion 12 of the funnel 10 and with their end edges close to the cylindrical side wall of the tank so as to prevent any substantial accumulation of solids on these surfaces. These blades are set at an angle to the radius from the axis to the side wall of the tank so that their outer ends lead with respect to their inner ends as they rotate and material scraped from the surface of the conical portion 12 is moved inwardly and downwardly toward the helix.

In operation of the apparatus described above, the liquid level in the tank is maintained preferably at a height below the top rotor blades. The blades are rotated at a suitable rate such as from 120 to 150 revolutions per minute. The vacuum in the tank is maintained at a suitable value say 26 to 28 inches of mercury. The rate of flow of the liquid to be de-aerated through the tank may vary within a wide range and may be very rapid since de-aeration appears to be practically instantaneous. The rate of flow is limited only by the capacity of the pipes and valves to convey the liquid, the ability of the vacuum pump to maintain the vacuum in the tank and the ability of the apparatus to dispose of foam which appears on the surface of the body of liquid in the tank. This foam is beaten down by breaking the walls of the foam bubbles while they are in an expanded condition due to entry into the reduced pressure in tank 1, through the action of the exposed rotating blades. The foam must not be permitted to overflow from the tank into the vacuum pump. The level of the liquid pool in tank 1 is maintained at a height such that the added height of the yet unbroken foam is below the level of the uppermost rotating blades.

The separation of the bubbles from the liquid in the form of a foam is effected very rapidly by flotation, as the bubbles expand upon entry into the evacuated tank. This separation serves to maintain the bubbles in the path of the rotating blades, where they are sheared and ruptured. The pool consists of substantially bubble-free liquid. With the blade arrangements described, the rate of rupture of the bubbles is very rapid, regardless of wide variations in viscosity and tenacity encountered in paper coating compositions, and the rate of treatment of liquid is limited only by the relative volume of foam entrained in a volume of untreated liquid, in that the foam layer must be maintained within the limits described above. With paper coating compositions which vary considerably in viscosity and in the tenacity of their foams, it has been found that the rate of movement of the liquid through a tank having a total capacity of about 30 gallons varies from about 15 gallons to about 35 gallons per minute.

I claim:

1. Apparatus for defoaming liquids comprising a vertically disposed cylindrical tank, means for supplying liquid to said tank, means for withdrawing liquid from said tank, means for maintaining a vacuum in said tank, a set of stationary blades carried by the wall of said tank and extending inwardly, a shaft extending axially of said tank, means for rotating said shaft, a set of blades extending outwardly from said shaft toward the wall of said tank and automatic means for maintaining the level of liquid in said tank at a substantial distance below the uppermost blades carried by said wall and said shaft, at least one of said sets of blades being positioned at an angle to the plane through the axis of said shaft so that they will pass each other with a scissoring action.

2. Apparatus as defined in claim 1 in which the stationary blades are positioned in at least one plane tangent to said shaft.

3. Apparatus as defined in claim 1 in which the blades carried by said shaft extend in at least one plane tangent to said shaft.

4. Apparatus as defined in claim 1 in which said tank has a conical bottom and said shaft carries blades which are positioned to move close to the surface of said conical bottom and extend outwardly from said shaft at an angle such that the outer end of each blade precedes its inner end as the blade rotates.

5. Apparatus as defined in claim 1 in which the tank has a conical bottom with a cylindrical downward extension and the shaft carries blades and a screw which cooperate respectively with said conical bottom and said cylindrical extension to move material out of the tank as the shaft rotates.

6. Process of defoaming a liquid which comprises continuously feeding a liquid containing bubbles of gas into the top of a closed chamber, continuously withdrawing liquid from said chamber adjacent to the bottom thereof, regulating the relative rates of supply and withdrawal of liquid into and out of said chamber so as to maintain a substantially constant level of liquid therein, maintaining a vacuum in said chamber, and continuously subjecting both the body of liquid in said chamber and the layer of foam which collects on the upper surface thereof to a shearing action between relatively moving solid surfaces.

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