DEFOAMER BAR FOR SUCTION SCRUBBER

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This application is a continuation-in-part of an application, Serial No. 821,537, filed June 19, 1959, now abandoned.

The present invention relates to a solid defoamer bar or cake of general application but of particular utility in a wet air stream carrying a liquid having foaming tendencies or in which foam has already formed. The cake is of such nature that when contacted by the wet air stream or by a stream of water it will be eroded away to release an active defoaming agent to inhibit incipient foaming or to suppress foam already formed.

Instead of contact arrangement, the defoamer bar is selected to have an excess capacity of defoaming. The excess capacity is not utilized by the proper selection of the defoamant mixture and nothing is wasted. The destruction of foam by a defoamant is a surface activity phenomenon. If suds have already formed and the defoamant comes into contact with the bubbles, the surface tension is changed and the bubbles break. If bubbles are only incipient, the presence of the defoamant will not prevent their formation but will break them as soon as they are formed and prevent their accumulation.

Due to the surface activity phenomenon in the desuding action of a defoamant, a defoamant is more rapid in action if it is emulsified because of its greater surface covering ability when in emulsified form. From the foregoing, it is evident that in practicing the invention the defoamant should be emulsifiable in water. By definition, an emulsion is a suspension or dispersion of one liquid in another which precludes the emulsification of an insoluble solid. Viscous pastes and greases, however, are not solids but are liquids having a high viscosity and are emulsifiable. As a matter of fact the silicone actually used is almost a grease, being a liquid of high viscosity. Hereinafter, where the term "liquid defoamant" or "liquid defoaming agent" is used, it is intended that those terms shall include such pastes and greases.

This, according to the invention, it is not necessary that the normally solid water soluble material in which the defoamant particles are encased contain an emulsifier. If no emulsifier is present in the defoamant encasing material, the detergent present in the suds will aid in emulsifying the defoamant.

According to the invention, the defoamant encasing material or matrix may be: (1) a waxlike water soluble substance having no emulsifying properties whatsoever; (2) it may be a mixture of two or more such substances; (3) it may be a mixture of (1) and a waxlike water soluble substance which is an emulsifier for the defoamant; (4) it may be a waxlike water soluble substance which is an emulsifier for the defoamant; (5) it may be a mixture of two or more of the (4) type substances; or (6) it may be a mixture of any one of the (1) to (5) type substances with an erosion retarding agent which may be water insoluble but emulsifiable.

Another feature of the present invention is that the rate of erosion of the defoamant cake may be further controlled by (1) replacing the defoaming agent with a mixture of defoaming agents; (2) by replacing the emulsifying agent with a mixture of emulsifying agents; or (3) by replacing the single solid soluble carrier with a mixture of such carriers having different degrees of solubility or any combination of them.

The United States Patent to Chappell, Jr., 2,797,198 discloses two active defoaming agents dispersed in a normally solid water soluble carrier but the defoamant cake or bar of the present invention is different in kind from that of Chappell rather than merely different in composition.

In Chappell the final solid block is formed of a dispersion of 60% by weight of a higher aliphatic alcohol and 15% of a higher aliphatic acid in 25% of a solid water soluble soap.

Both the alcohol and the acid are defoaming agents, are solid at normal temperatures and are insoluble in water. It is true that soap is an emulsifying agent but there is no liquid material present in the Chappell composition to be emulsified by the soap and the emulsification of the defoamating agents is impossible.

According to the Chappell disclosure, it is necessary that a block of the mixture there disclosed be mixed with hot soft water to melt the defoaming agents and dissolve the soap to thus form a water emulsion of the defoaming
agents. That emulsion is then added to the liquid to be defoamed.

Thus it is clear that Chappell discloses a defoamant cake which must of necessity be used differently and acts differently than the defoamant cake of the present invention.

According to a preferred form of the present invention, the defoamant cake or bar is a dispersion of a liquid defoamant agent surrounded by an emulsifier in a slowly soluble or erodible solid body of material. As the body is eroded away by contact with water, the water contacts the emulsifier and defoamant agent, thus exposed, which immediately emulsifies the defoamant agent with the water thus contacted.

Other objects and advantages of the present invention will become apparent as the description proceeds when taken in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of one shape of the defoamant cake made according to the present invention and FIG. 2 is a sectional view showing the probable internal construction of the defoamant cake made according to the present invention.

The defoamant cake, according to the preferred form of the present invention, was designed especially to be placed in the wet air stream of a scrubbing machine of the type disclosed in a co-pending application for United States Letters Patent by Don C. Krammes, Serial No. 821,454, filed June 19, 1959, now Patent No. 2,993,223 dated July 25, 1961, which will hereafter be referred to as the Krammes machine.

The Krammes machine is a combined floor scrubber and drier, by which a clean detergent solution may be dispensed from a detergent tank onto the floor, by which the floor may then be scrubbed and then by which the dirty detergent solution may be sucked up from the floor by a suction air stream and deposited into a dirty detergent tank. During the floor drying operation the Krammes machine normally handles 18 cubic feet of air per minute and sucks up, along with the air, from 165 to 195 cc. of dirty solution per minute.

In using the Krammes machine with certain types of detergents on certain waxed floors, the detergent tends to form an emulsion of the wax and large volumes of suds or foam are or may be formed which seriously interfere with the operation of the machine.

Thus the problem facing the present applicants was to develop a slowly erodible defoamant cake which could be placed in the wet air space of a Krammes type machine and be contacted and eroded by the liquid in the air stream at a suitable rate to prevent or suppress any foaming of the dirty detergent solution likely to take place while at the same time preserving the life of the defoamant cake for a reasonable length of time so that the defoamant cake would not have to be replaced too frequently.

The object was to devise a defoamant cake which would last as long as possible and yet do a good defoamant job. The job was complicated because of space restrictions in the wet air flow path of the Krammes machine. In other words the defoamant cake had to be relatively small so that the air flow path of the machine would not be restricted and yet have sufficient defoamant capacity to last a reasonable length of time.

A single cake of the preferred composition of the defoamant cake according to the invention has been tested for continuous operation for 70 (1300 cc.) tankfuls of dirty detergent one after the other. Thus the single cake properly defoamed 91 liters of dirty detergent solution.

There are many defoamant agents known to the art but those known which faced the present applicants was to develop a defoamer which would be suspended in a wet air stream, which would be eroded slowly by contact with the liquid in the air stream and which would quickly release the active defoaming agent into the wet air stream at the proper rate to present or suppress foaming and without using an excess amount of the defoaming agent.

A solid defoaming agent seemed to be one answer but the prior art was silent on the subject except for the patent to Chappell previously referred to.

Samples of the Chappell defoamant blocks were obtained and tried out without success. It was found to be impossible to release the active defoaming agents into the wet air stream of the Krammes machine in sufficiently effective amounts.

Many experiments were made using different formulations, during which it was discovered that much better results could be obtained if the defoaming agent was emulsified as it is released and that if the emulsifying agent was separate and distinct from the defoaming material a better control of the erosion of the defoamant cake could be had. It was also discovered that better control could be had if the water soluble caking agent was not itself an emulsifier and that a water soluble waxlike substance was a good caking agent when suitable proportions were used.

It was also found that by the use of a retardant or stabilizing agent, further control could be had of the erodibility of the defoamant cake and also of the rate at which the defoaming agent is released and emulsified.

The use of the water soluble wax like substance as a caking agent instead of soap as in Chappell has a number of advantages. It contributes materially to the ease of molding and formulating the defoamant cakes since it is much easier worked than is soap and is soluble in hard water. It also results in a defoamant cake which is much more stable at above normal temperatures and humidities and one which is more stable structurally.

Thus, according to a preferred form of the present invention, a solid defoamant cake is formed containing an active defoaming agent in liquid form, a water soluble emulsifier for the defoaming agent and a solid water soluble caking agent, preferably in the form of a water soluble waxlike substance, with or without a retarding or stabilizing agent to control the action of the caking agent and of the emulsifier and defoamant agent.

The defoaming agent selected according to the preferred formulation was a pure liquid silicone, the emulsifying agent a polyethylene glycol disteareate, the caking agent a polyethylene glycol and the retarding or stabilizing agent a polyethylene waxlike substance.

As an optional additive to the defoamant cake of the present invention is a bactericide to prevent decay and odors from developing in the scrubbing machine and may be added to the mixture two parts to every thousand parts.

According to the invention, the emulsifying agent, the carrier, the retardant and the bactericides are all solid stable at above normal temperatures while the defoaming agent is a viscous liquid.

The components actually used according to the invention are as follows:

The defoaming agent is Silicone Antifoam A available from Dow Corning Corporation, Midland, Michigan. It is viscous liquid having a specific gravity of 0.98 gram per cc. It will hereinafter be referred to as "Dow A."

The water soluble emulsifying agent is Polyethylene Glycol 1540 Distearate available from Kessler Chemical Company, Philadelphia, Pennsylvania. This material comes in solid cake form and should be broken into small chunks before melting. The 1540 represents the average molecular weight of the polyethylene glycol portion of the complete molecule. It will hereinafter be referred to as "1540."

The caking agent is Polyethylene Glycol E-20,000 available from Dow Chemical Company, Freeport, Texas. The material is a water soluble waxlike material, comes in flake form and may be mixed with the other ingredients of the mixture without modification. The 20,000 represents the average molecular weight of the material. It will be referred to hereinafter as "E-20,000."

The retarding or stabilizing agent is not necessary with
all formulations. It is Emulsifiable Polyethylene Wax, Epolene E, available from Eastman Chemical Products, Kingsport, Tennessee. It comes in pellet form and may be mixed with other ingredients without modification.

One method of preparing a defoamant cake according to the foregoing formulation is as follows:

The emulsifying agent "1540" is melted at 250° F.±5°.

The retardant "Epolene E" is slowly added with constant stirring while the temperature is maintained constant at 250° F.±5°, whereby it is melted and mixed with the "1540".

The water soluble wax "E-20,000" is then slowly added with constant stirring while the temperature is kept constant at 250° F.±5° whereby the wax is melted and mixed with the mixture of "1540" and "Epolene E."

The heat is then removed and the bacteria killer "G-11" is added. As the mixture cools the liquid deforming agent "Dow A" is slowly poured into the mixture with constant stirring and becomes completely dispersed in the mixture with minute globules of the silicone, which is an oily liquid, being surrounded by or encased in the emulsifying agent "1540" which is in continuous phase.

The constant stirring is continued until the temperature of the mixture reaches 145° F.±5° and the mixture is then immediately molded into cakes or bars, preferably by injection molding.

The shape of the molded defoamant cake, according to the invention, may take any shape desired but is preferably of small cross-sectional area and of large surface area in order to fit into the restricted space available and to present a large surface for contact with the wet air stream. The cake shown by FIG. 1 of the drawings shows one form of the defoamant cake or bar may take. The cake there shown is intended to be placed in the nozzle of a Krampmes type machine as shown by FIGS. 2 and 3 of the aforementioned Krampmes application.

Defoamants made in accordance with the foregoing formulation are effective in the theoretical and probable arrangement of the various components of the defoamant cake of the present invention. Minute globules of the liquid silicone are represented by the white space 11 inside the small circles 12 which represent the emulsifying agent "1540." The small black dots 13 and the surrounding white areas represent the waxlike "E-20,000." The retardant "Epolene E" is not shown but will be evenly mixed with the "E-20,000." While the emulsifier is shown by the small circles 12 it is probable that some of it will be distributed throughout the mass of the carrier.

When it is remembered that the various components were dispersed while in a molten state, it is reasonable to suppose that the oily globules of the silicone will take a coating of the emulsifier as in making an oil-in-water emulsion. There the oil globules are coated with the emulsifier and an emulsion is formed instantly when water is added to the mixture.

In use, when the dirty detergent laden air stream comes into contact with the defoamant cake of the present invention, the water soluble waxlike "E-20,000" and "1540" are slowly dissolved which will progressively expose globules of the liquid silicone "Dow A" in the presence of the emulsifier "1540" and the silicone will immediately form an emulsion with the water present and inhibit any foaming tendency or suppress any foam present.

If the retardant "Epolene E" is also present, it will slow down the rate at which the "E-20,000" is dissolved because less of the soluble carrier will be exposed to the liquid flowing over the cake. It will also slow down the emulsification and release of the liquid silicone because less of the silicone in the presence of the emulsifier will be exposed to liquid for each increment of the carrier which is dissolved.

Thus the retardant or stabilizing agent acts in two ways to increase the life of the defoamant cake.

The rate at which the defoamant agent is released and the rate at which it is emulsified may be controlled according to the invention by varying the proportions of the various components which make up the whole. Thus the percentage of the defoamant agent may be varied within certain limits, the percentage of the emulsifying agent may be varied or the percentage of the water soluble carrier may be varied. Also, according to the invention, the rate of erosion and emulsification may be further controlled by the addition of varying amounts of the retarding or stabilizing agent.

By varying the proportions properly, the final properties of the defoamant cake according to the invention may be closely controlled. Also by varying the percentages of the various components, the structural stability of the cake may be controlled. Obviously a cake which falls apart upon handling and one which is extremely brittle would be unsuitable. The cake must also be stable at any temperature and humidity conditions likely to be encountered in use or storage.

It has been found that the amount of the various components by weight may be varied as follows:

(1) Defoamant agent "Dow A"—20 to 40%.
(2) Emulsifying agent "1540"—10 to 30%.
(3) Water soluble carrier "E-20,000"—5 to 70%.
(4) Retarding agent "Epolene E"—0 to 20%.

The formulation found to be the most effective in the Krampmes machine has the following percentages by weight:

(1) Defoamant agent "Dow A"—30%.
(2) Emulsifying agent "1540"—55%.
(3) Water soluble carrier "E-20,000"—10%.
(4) Retarding agent "Epolene E"—5%.
(5) 2 parts per 1,000 of bacteria killer "G-11."

In actual use with a Krampmes type machine, a defoamant cake having the foregoing formulation was used continuously for picking up 91 liters (70 tanksfuls) of dirty detergent solution varying in temperature from 113° F. to 78° F. before the defoamant cake became ineffective.

In a simulative test, in which conditions of actual use were simulated, three tanksfuls (3.9 liters) were picked up, one after the other, the apparatus unused for 3 days and similarly used the fifth day and so on until the defoamant cake became ineffective; 115 tanksfuls (149.5 liters) were picked up.

The marked longevity of the defoamant cake in the simulated test was because the cake was permitted to dry out between each use.

Another formulation, quite similar in longevity to the preferred one given above, in which the characteristics of the finished defoamant cake may be more closely controlled is one in which the emulsifying agent is a mixture of two different emulsifiers. Part or all of the emulsifier "1540" is replaced by Wyandotte Phuronic F-68 available from Wyandotte Chemicals Corporation of Wyandotte, Michigan. Also the percentage of the emulsifier present may be as high as 55% by weight of the total and the two emulsifiers "1540" and "F-68" mixed in any proportion.

A formulation, which gives good results, in which no emulsifier is present, is 30% "Dow A" dispersed in a continuous phase water soluble body of polyethylene.
Glycol 6000 known as "Carbowax" available from Union Carbide and Chemical Company of New York City.

A satisfactory formulation in which the encasing body was formed of a single emulsifying substance is 30% "Dow A" and Polyethylene Glycol Glycol 6000 monostearate. Many variations of the percentages of the four main ingredients, defoamer, emulsifier, carrier, and retardant, have been formulated. Those formulations would be useful for many purposes, although not as effective in the Krammes machine as the preferred formulation given above. The following chart lists a number of formulations which have been found to be effective in the Krammes machine. Giving the preferred formulation a defoaming effectiveness rating of 1, the last column of the chart will give the relative effectiveness of the other formulations in decimals. The other columns of the chart show the percentages by weight of the various components:

<table>
<thead>
<tr>
<th>Defoaming Agent</th>
<th>Emulsifying Agent</th>
<th>Causing Agent</th>
<th>Retarding Agent</th>
<th>Effectiveness</th>
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<tr>
<td>&quot;Dow A&quot; 1500&quot;</td>
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Another method by which the above formulations may be made is to weigh the four components into a heated mixing vessel maintained at 230° F. ± 10°. The mixture is heated and homogenized thoroughly by means of a high-speed mixer for from 30 to 60 minutes. When the mixture has reached a creamy homogeneous consistency it is poured directly into flexible molds and allowed to cool for 30 minutes after which the molds may be removed by flexing.

It is to be understood that other liquid and emulsifiable defoaming agents may be used according to the invention. Other emulsifying agents and other water soluble carriers may be used so long as they are compatible with each other and with the defoaming agent. It is, of course, necessary that the carrier be in solid form and water soluble. It is also preferable that the emulsifying agent be a solid or form a solid with the carrier. Other retarding agents may be used but should be solid under conditions of use to be effective.

From the foregoing, it is evident that the defoaming cake of the present invention, in its broadest aspects, is in the form of a dispersion of an emulsifiable liquid defoaming agent encased in a normally solid water soluble body in continuous phase preferably, a solid emulsifying agent, and a normally solid water soluble carrier or caustic agent.

It can also be seen that the present invention provides a solid defoaming cake which is slowly erodable when contacted by a wet air stream to release the active defoaming agent for emulsification at the proper rate for any given set of conditions, in which the rate of erosion and defoaming agent release is readily controllable to vary the rate to suit conditions. Also the defoaming cake of the present invention is stable structurally as well as under normal temperature and humidity conditions.

The defoaming cake of the present invention may be readily molded into any desired shape, form or size to suit various types of apparatus in which space may be limited and is easily made according to the methods disclosed herein.

While we have disclosed only some of the formulations of our invention, it is to be understood that those formulations are to be taken as illustrative only and not in a limiting sense. We do not wish to be limited to the particular formulations described but wish to include all equivalent variations thereof except as limited by the scope of the claims.

We claim:

1. A solid water erodable defoaming cake for use in an air stream carrying a liquid having a tendency to foam comprising, a liquid defoaming agent, a solid emulsifier for said defoaming agent, a solid water soluble wax-like carrier and a solid non-soluble retardant, said defoaming agent and said emulsifier being dispersed throughout said carrier with the latter in continuous phase and the former in discontinuous phase, said defoaming agent comprising from 20 to 40% by weight of said cake, said emulsifier comprising a polyethylene glycol distearate and constituting from 10 to 65% by weight of said cake, said carrier comprising a polyethylene glycol and constituting from 5 to 70% of said cake and said retarder agent comprising a non-soluble polyethylene wax and constituting from 0 to 20% by weight of said cake in which said defoamant is a liquid silicone, in which the molecular weight of the emulsifier is 1540, and in which the average molecular weight of the carrier is 20,000.

2. A solid water erodable defoaming mixture including a liquid silicone defoaming agent, a solid polyethylene glycol distearate emulsifying agent, a solid water soluble polyethylene glycol wax-like solid as a carrier and a non-soluble polyethylene wax-like solid as a retarding agent in which said defoaming agent comprises in the proportions 20 to 40% by weight, in which the emulsifying agent is present in the proportions 10 to 65% by weight, in which said carrier is present in the proportions 5 to 70% by weight and in which said retarding agent is present in the proportions 0 to 20% by weight.

3. A solid water erodable defoaming cake for use in an air stream carrying a liquid detergent solution having a tendency to foam comprising, a liquid silicone defoaming agent, an emulsifying agent for said defoaming agent and a solid water soluble carrier for said defoaming agent and emulsifying agent, said defoaming and emulsifying agent being dispersed throughout said carrier with the latter in continuous phase and the former in discontinuous phase, said emulsifying agent comprising a wax-like polyethylene glycol distearate mixture having an average molecular weight of 1540 and comprising 55% by weight of said cake, said carrier comprising a wax-like polyethylene glycol mixture having an average molecular weight of 20,000 and comprising 10% by weight of said cake.

4. A defoaming cake as in claim 3 including a non-soluble retardant for said carrier in the form of a wax-like solid polyethylene and comprising 5% by weight of said cake.

5. A solid water erodable defoaming cake for use in an air stream carrying a liquid detergent solution having a tendency to foam comprising, a liquid silicone defoaming agent, a solid silicone, a solid water soluble carrier for said silicone and emulsifier and a solid non-soluble retardant, said silicone and said emulsifier being dispersed throughout said carrier with the latter in continuous phase and the former in discontinuous phase, said emulsifier being a wax-like solid water soluble polyethylene glycol distearate having a molecular weight of 1540 and comprising from 10 to 65% by weight of said cake, said carrier being a wax-like solid water soluble polyethylene glycol having a molecular weight of 20,000 and comprising from 5 to 70% by weight of said cake, said retardant being a wax-like solid non-soluble polyethylene and comprising from 0 to 20% by weight of said cake and said silicone comprising from 20 to 40% by weight of said cake.

6. A solid water erodable defoaming cake comprising, a liquid silicone and a carrier for said silicone, said silicone being dispersed throughout said carrier with the latter in continuous phase and the former in discontinuous phase, said carrier being a wax-like water soluble solid polyethylene glycol having a molecular weight of 6000 and comprising 70% by weight...
of said cake and said silicone comprising 30% by weight
of said cake.

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