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FOAM-SUPPRESSING DETERGENT COMPOSITION FOR BEVERAGE CONTAINERS

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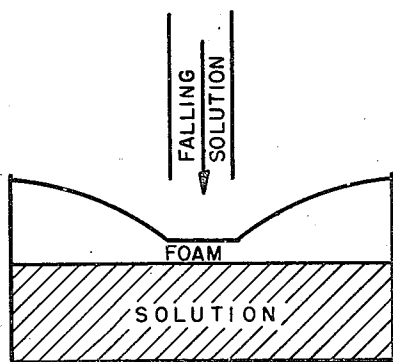


FIG. 2

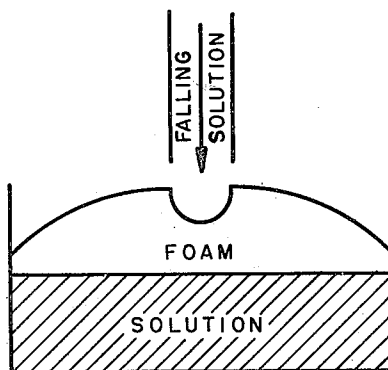


FIG. 1

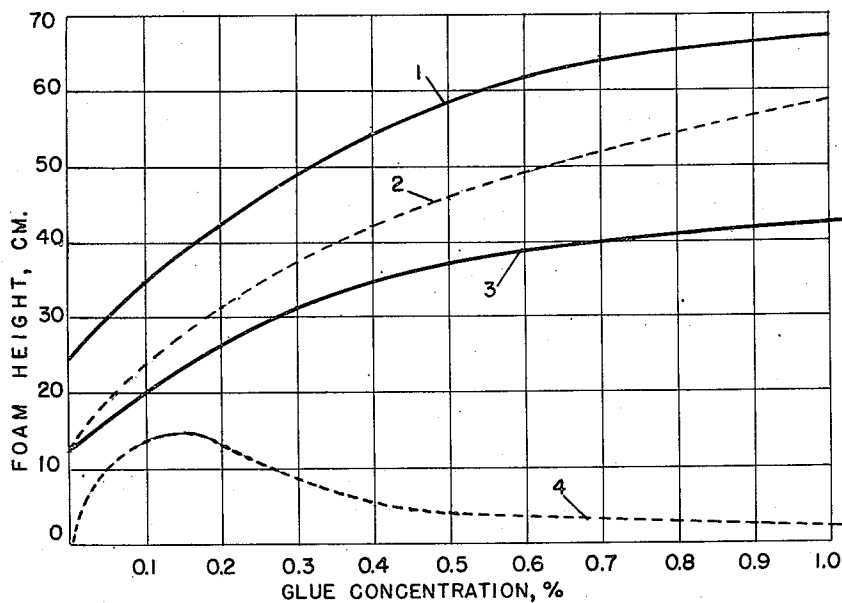


FIG. 3

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FOAM-SUPPRESSING DETERGENT COMPOSITION FOR BEVERAGE CONTAINERS

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The present invention has to do with the problem of controlling the foaming or foam generation in detergent washing solutions which are employed in the hydraulic type of beverage container washing machines. The opportunity for agitation and air entrainment is very pronounced in the operation of washing machines of this type. Heretofore, the foam generated in the solution-receiving tank has often been so great as to build up and flow over the edge of the tank, thus causing a substantial loss in the detergent. To maintain adequate operation of the washing machine, it has been found necessary to replace this foam over-flow loss from time to time, thus increasing the expense for the material and labor required, aside from further losses resulting from the diminished efficiency of the washing operation.

It is a general object and nature of my present invention to provide means for preventing such a foam generation loss. This I accomplish by introducing a foam control reagent to the washing solution, which so changes the characteristics and properties of the generated foam that it becomes unstable and rapidly dissipates, thus preventing the body of the foam from building up to an excessive height and over-flowing the edge of the washing solution-receiving tank.

Solutions employed in the washing of beverage containers such as milk, beer, soft drink bottles and the like, consist primarily of a water solution of an alkali metal hydroxide such as sodium or potassium hydroxide. Sodium hydroxide, of course, is the most common of the two and is employed in this country almost to the exclusion of potassium hydroxide. I have discovered that the addition of relatively small quantities of alkali metal oxide-silica compounds and of the sulphate salts of such alkali metals has the effect of promptly rendering unstable the generated foam.

Furthermore, I have discovered that the presence of certain organic materials in the beverage container washing machine solutions have heretofore had the resultant effect of increasing foam generation and stability. These organic materials find their way into the washing machine solutions as residual matter from the beverage containers. Thus, alkali metal salts of short chain fatty acids, such as predominate in milk, will increase the foam-generating properties of the washing solution. Likewise proteinaceous material, such as glue and casein, and carbohydrates, such as starch and dextrin, usu-

ally derived from the label glue or adhesive of the containers, increase the foam-generating ability of the washing solution. I, therefore, characterize these alkali metal salts of short chain fatty acids, proteins and carbohydrates as "foaming agents," as distinguished from the anti-foaming reagent of my present invention.

In general, an increase in foam generation and stability results from increased amounts of such "foaming agent" material present in the washing solution. The product of my present invention, however, possesses the quite unexpected property of producing just the opposite result, namely, a decrease in the foam stability with increasing amounts of such foaming agent content in the solution. This latter result is of particular advantage in that it permits the operator of the washing machine to derive the full benefit and value of the detergent properties of the solution, and without the necessity of discarding a given batch of solution whenever such organic "foaming agent" content therein becomes too high, which heretofore has occurred before the alkaline content of the solution has become spent. My invention thus renders it possible to derive the entire benefit of the alkaline properties of the detergent material.

Another object and advantage of my invention is that it is applicable to washing solutions subjected to a wide range of temperature conditions. Anti-foaming agents which have previously been known and used, have been found subject to the disadvantage that they are operable only in certain prescribed temperature ranges. Inasmuch as my invention overcomes this latter disadvantage, it renders possible a flexibility of use throughout varying temperatures, which has been highly desired by those working in the art. Additional objects and advantages of the invention shall become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, said invention then consists of the steps hereinafter fully described and particularly pointed out in the claims.

The annexed drawing and the following description set forth in detail one approved method of carrying out the invention, such disclosed method, however, constituting but one of various ways in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is more or less a diagrammatic representation showing the characteristics of the

foam generated in a washing solution to which the principle of my invention has been applied; Fig. 2 is a view similar to Fig. 1, but showing the characteristics of the foam heretofore generated in washing solutions and without utilizing the foam control of my invention; and Fig. 3 is a chart showing the typical relationship of the glue or protein content to foam generation of prior art alkaline detergent solutions and of a detergent solution containing the addition reagent of my instant invention.

The hydraulic type of beverage container or bottle washing machine has been rather extensively adopted. This type of bottle washing machine consists essentially of a washing solution-receiving tank from which the solution is circulated by means of a hydraulic pressure pump and expelled under considerable pressure through a jet into and about the bottles, and a conveying mechanism or traveling rack for bringing the bottles intermittently into position with respect to such jets. The washing solution is then allowed to fall by gravity back into the solution-receiving tank. The forcible spraying of the solution, its impacting action upon the bottles, its falling back through space into the tank, and the possibility of leaks in the pump circulatory system, all contribute to the extreme amount of agitation which is imposed upon the solution, as well as affording ample opportunity for entrainment of air. Thus, the foam generating conditions in such a machine are indeed excellent, and as this foam is deposited upon the surface of the solution in the solution-receiving tank, it has an opportunity of building up to a substantial height so that it ultimately over-flows the top of the tank and becomes lost in the drainage system of the machine.

The cause of foam formation is not definitely known. Pure liquids do not foam; whereas, solutions or suspensions of lyophilic colloids, such as glues, dextrans and many soaps possess this property in marked degree. This much is known, however, that any substance present in a solution which will cause a change in the surface tension thereof, whether such change be an increase or a decrease, will facilitate the formation and stabilization of a foam. See Glasstone: "Textbook of Physical Chemistry" (1940—pp. 1226-27); Perry: "Chemical Engineers' Handbook" (1934—p. 940). Foam control has heretofore been attempted by the addition of oils and various organic compounds such as fatty acids and esters. But all such addition agents have been found to be unsatisfactory, primarily because they failed either to maintain foam-control for a sufficient period of time or because they proved ineffective within the temperature ranges encountered in the operation of bottle washing machines.

I have examined a large number of substances and made many formulations of chemical compounds. As a result, I have discovered that the presence of the alkali metal silicates and the sulphate, along with the caustic alkali, produces the desired results of decreasing the stability and building power of the foam generated in the washing solution, as well as rapidly dissipating such foam as is generated. Such alkali metal silicates have the general formula (in the case of sodium, as the alkali metal) of $XNa_2O.YSiO_2$ where X represents a value of 1 and Y represents any value above and including 1. Particular examples of such compounds are: sodium orthosilicate, sodium metasilicate, sodium sesquisilicate and waterglass. The silicates and the sul-

phate salts are present in the detergent mixture in a minor amount with respect to the caustic present. Caustic alkali in my detergent mixture is present in the amount of 85% or greater, the alkali metal silicates from 3 to 11% and the sulphate present in the amount of approximately 2-6%. Thus, I have found suitable formulas for the detergent composition to be as follows:

Formula 1

	Percent by weight
Caustic soda (NaOH).....	88
Sodium orthosilicate (Na_4SiO_4).....	8
Salt cake (technical grade Na_2SO_4).....	4

Formula 2

	Percent by weight
Sodium hydroxide.....	90.7
Anhydrous sodium metasilicate (Na_2SiO_3).....	5.3
Sodium sulfate.....	4.0

Formula 3

	Percent by weight
Sodium hydroxide.....	85.1
Sodium sesquisilicate ($3Na_2O.2SiO_2.11H_2O$).....	10.9
Sodium sulfate.....	4.0

Formula 4

	Percent by weight
Sodium hydroxide.....	92.6
Anhydrous waterglass ($1Na_2O.3.22SiO_2$).....	3.4
Sodium sulfate.....	4.0

Formula 5

	Percent by weight
Sodium hydroxide.....	93.4
SiO_2	2.6
Sodium sulfate.....	4.0

Formulas 1, 2, 3, and 4 can be made by mixing together the separate components. Formulas 1, 2, 3, 4, and 5 can be made by fusing together the separate components, viz., sodium hydroxide, silica or sodium silicate and sodium sulfate, and finishing the material in any of a variety of physical forms, such as flaking or granulating. In Formula 5, of course, on heating or fusion, the silica component reacts with a portion of the sodium hydroxide to form a sodium silicate. Formulas 1, 2, 3, and 4 can be used by adding the separate components in the given ratios to water to make a solution of the desired strength. Formulas 1, 2, 3, and 4 can be used by adding sodium sulfate and the respective alkali metal silicates listed to a caustic solution in such amounts as to give the same sodium hydroxide, SiO_2 and sulfate ratios as given in Formulas 1, 2, 3, and 4, respectively. Each of the above composition formulas are dissolved in water to make solutions in the concentration range of .25% to 10% by weight of the composition.

As such a solution is heated, subjected to hydraulic pressure, forcibly expelled through the bottle washing jets and then permitted to fall by gravity into the solution tank, it will form a body of foam in the latter substantially of the characteristics as shown in Fig. 1. Thus, in Fig. 1, it will be noted that the foam has built up rather rapidly in the central portion, or in that zone where the falling solution comes in contact with the main body of the solution. However, the height of the foam is lowest at its outermost edges, showing that the initially generated foam is quite unstable and that there is a rapid dissipation.

The foam contour and characteristics of Fig. 1

is to be compared with those represented in Fig. 2 which shows the type of foam that is formed by an ordinary alkaline washing solution, viz., one in which the dissolved detergent consists of about 90% caustic soda and 10% sodium carbonate.

In Fig. 2, it will be seen that the initial foam formation at the central portion is relatively slow, but, on the other hand, is of a stable character and hence, builds up to the maximum height at the outer edges of the body of the solution or of the solution-receiving tank.

The foam-dissipating detergent composition of my invention has also been found to be effective over the relatively wide range of temperatures encountered in commercial bottle washing machines. Such temperatures vary from 115° F. to 175° F. I have ascertained that the generation of foam in detergent bottle washing solutions in which the foam-dissipating composition of my invention is not present varies directly in proportion to the temperature. Various organic foam-retarding reagents, which have heretofore been known, such as kerosene oil, tributyl phosphate, citrate and sulphonated castor oil and the like, are effective only for a limited period of time and below a given temperature. Thus, after one day of operation, it has been found that such previously used organic foam-retarding agents completely lost their retarding action and the foam generation in the washing solution returned to its original characteristics, just as if no reagent had been added.

On the other hand, the foam control addition reagent of my invention maintains its foam depressing and dissipating action for extended periods of time and in the relatively higher temperature ranges. Thus, in actual operation on a commercial milk bottle washing machine, a 0.5% concentration solution of the above composition Formula 1 was used for a period of 4 weeks and without causing foaming over in the washing solution-receiving tank. In the same machine, and under similar conditions, a detergent composition of 90% sodium hydroxide and 10% sodium carbonate, produced foaming over at the end of two days of operation. In the actual operation of a soft drink bottle washing machine where the protein or glue content becomes relatively high due to the presence of glue from the bottle labels, it was found that the foam control detergent composition of my invention, employed in a 4% concentration solution, could be operated successfully and without foaming over for an indefinite period. In fact, this latter result is attributable to the unusual foam control property of my detergent composition of becoming increasingly effective as the glue or protein content of the solution increases.

This last-mentioned novel property of my foam control composition is clearly illustrated by reference to Fig. 3. In this latter figure, there are shown curves for alkaline detergent bottle washing solutions with and without my foam controlling addition reagent and showing the relationship or glue concentration in the solution to the foam height initially generated, and after a period of five minutes standing. Fig. 3 thus illustrates the novel foam-depressing and foam-dissipating properties of my invention.

The readings for the vertical ordinates in Fig. 3, viz., foam height, have been obtained from a comparatively simple but quite reliable test method. This test method consists in making up a 100 cubic centimeter sample of the washing solution, with one or more of the previously men-

tioned foaming agents present, heating it to the desired temperature and then placing in a 250 cc. shaking graduate. The graduate is then grasped at both ends in each hand and shaken 75 times during a period of about 40 to 60 seconds. The graduate is held at an angle of about 30° from the horizontal during shaking, with the bottom end of the graduate uppermost. Immediately after shaking, a reading is taken of the height of the foam in the graduate. Five minutes later, a second reading of the foam height in the graduate is taken. Thus, a reliable test measurement of the initial foam generating properties, as well as the foam dissipating properties of the solution, are obtained. The results of this test method have been substantiated by actual operation in the field, viz., by operation in commercial hydraulic type bottle washing machines.

In the case of Fig. 3, 4% concentration solutions in distilled water, of the respective detergent composition, heated to a temperature of 150° F. and with the varying percentages of glue content, were subjected to the above-outlined test method. The solid curves 1 and 3 represent the results obtained with an alkaline detergent in which no foam-depressing or foam-dissipating reagent was present. The dotted line curves 2 and 4 represent the results of a detergent composition of 88% sodium hydroxide, 8% sodium orthosilicate and 4% sodium sulphate. The foam readings for curves 1 and 2 were taken immediately after shaking in the 250 cc. graduate and the readings for curves 3 and 4 were taken five minutes after such shaking. It will thus be seen that curve 2, representing the foam control detergent of my invention, is at all times below curve 1, thus illustrating the initial foam retarding action. Curve 4 is also below curve 3 and as the glue content rises above .15%, the curve changes in slope and direction, thus illustrating the increased foam-dissipating property of my foam control composition with increased glue or protein content. By comparing curves 2 and 4, it will immediately be appreciated that the foam-dissipating properties of the addition agent of my invention are just the opposite of those of a solution in which such agent is not present.

As hereinbefore indicated, the cause of foam generation is quite obscure and not definitely known, hence, I am unable to ascribe any scientific theory or principle upon which my invention is founded. It is possible that the silicates and sulphate salts of the alkali metal form a chemical compound which has an effect upon the surface tension of the solution tending to impart to it the non-foaming properties of a pure liquid, thus accounting for the instability of the foam that is produced.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

For the purpose of conciseness the letters X and Y in the claims will be understood to denote the same values as enunciated in the specification proper.

I, therefore, particularly point out and distinctly claim as my invention:

1. The method of washing beverage containers and the like in which residual material from the group consisting of alkali metal salts of short

chain fatty acids, proteins and carbohydrates are present as foaming agents comprising the steps of adding a detergent in an amount forming 0.25 to 10% of the weight of the solution to a quantity of water, said detergent comprising at least 85% by weight of sodium hydroxide, 3 to 11% by weight of a water-soluble sodium silicate compound as represented by the formula



and 2 to 6% by weight of sodium sulfate, heating the resultant solution, withdrawing a portion of said solution under hydraulic pressure, forcibly ejecting it into contact with said containers and returning it by gravity fall to the main body of the solution, whereby foam is generated in the latter but rapidly dissipated before reaching an excessive height and then repeating such withdrawal and return of a portion of said solution.

2. The method of washing beverage containers and the like in which residual material from the group consisting of alkali metal salts of short chain fatty acids, proteins and carbohydrates are present as foaming agents, comprising the steps of adding a detergent in an amount forming 0.25 to 10% of the weight of the solution to a quantity of water, said detergent comprising at least 85% by weight sodium hydroxide, 3 to 11% by weight of a water-soluble sodium silicate compound as represented by the formula $\text{XNa}_2\text{O} \cdot \text{Y} \cdot \text{SiO}_2$ and 2 to 6% by weight of sodium sulfate, heating the resultant solution, withdrawing a portion of said solution under hydraulic pressure, forcibly ejecting it into contact with said containers and returning it by gravity fall to the main body of said solution, whereby foam is generated in the latter but rapidly dissipated before reaching an excessive height, then repeating such withdrawal and return of a portion of said solution, and permitting the contents of said residual material in said solution to increase to an amount substantially greater than that originally present therein.

3. The method of washing beverage containers and the like in which residual material from the group consisting of metal salts of short chain fatty acids, proteins and carbohydrates are present as foaming agents, comprising the steps of contacting the said containers with an aqueous solution of the detergent composition comprising at least 85% alkali metal hydroxide, 3 to 11% water soluble alkali metal silicate, as represented by the formula $\text{XMe}_2\text{O} \cdot \text{YSiO}_2$ (Me representing a member of the group consisting of Na and K) and 2-6% alkali metal sulfate, the total weight of these three last mentioned compounds representing 0.25% to 10% of the weight of the aqueous solution, said solution having incorporated therein entrained gases normally causing generation of foam, which is rapidly dissipated because of this detergent.

4. The method of washing beverage containers and the like in which residual material from the group consisting of metal salts of short chain fatty acids, proteins and carbohydrates are present as foaming agents, comprising the steps of contacting said containers with an aqueous solu-

tion of the detergent composition comprising at least 85% by weight sodium hydroxide, 3 to 11% by weight of a water soluble sodium silicate, as represented by the formula $\text{XNa}_2\text{O} \cdot \text{YSiO}_2$ and 2-6% by weight of sodium sulfate, the total weight of these three last mentioned components representing 0.25% to 10% of the weight of the aqueous solution, said solution having incorporated therein entrained gases causing generation of foam which is rapidly dissipated because of this detergent.

5. A foam-suppressing detergent for washing beverage containers and the like comprising an alkali metal hydroxide in the amount of at least 85% by weight, 3 to 11% of water-soluble alkali metal oxide-silica compound of the formula $\text{XMe}_2\text{O} \cdot \text{YSiO}_2$ (Me representing a member of the group consisting of Na and K) and 2 to 6% of an alkali metal sulfate.

6. A foam-suppressing detergent for washing beverage containers and the like comprising sodium hydroxide in the amount of at least 85% by weight, 3 to 11% by weight of a water-soluble alkali metal oxide-silica compound of the formula $\text{XMe}_2\text{O} \cdot \text{YSiO}_2$ (Me representing a member of the group consisting of Na and K) and 2 to 6% of an alkali metal sulfate.

7. A foam-dissipating solution for washing beverage containers and the like containing mostly water, from a mere trace up to 1% proteaceous material, a detergent comprising at least 85% sodium hydroxide, 3-11% of water-soluble alkali metal silicates as represented by the formula $\text{XMe}_2\text{O} \cdot \text{YSiO}_2$ (Me representing a member of the group consisting of Na and K), and 2 to 6% of sodium sulfate, said percentage of NaOH being based on the total weight of the constituents, said detergent comprising 0.25% to 10% of the weight of the solution.

8. A foam-dissipating solution for washing beverage containers and the like containing mostly water, from a mere trace up to 1% proteaceous material, a detergent comprising at least 85% of sodium hydroxide, 3 to 11% of a water-soluble sodium silicate as represented by the formula $\text{XNa}_2\text{O} \cdot \text{YSiO}_2$, and 2 to 6% of sodium sulfate, the percentage of said detergent components being based on their total weight, these three components representing 0.25% to 10% of the weight of the solution.

9. A foam-suppressing detergent for washing beverage containers and the like, comprising by weight approximately 90.7% of sodium hydroxide, approximately 5.3% anhydrous sodium metasilicate and approximately 4% of sodium sulphate.

10. A foam-suppressing detergent for washing beverage containers and the like, comprising by weight approximately 92.6% of sodium hydroxide, approximately 3.4% of anhydrous water-glass and approximately 4% of sodium sulphate.

11. A foam-suppressing detergent for washing beverage containers and the like, comprising by weight approximately 93.4% of sodium hydroxide, approximately 2.6% of silica reacted with said sodium hydroxide and approximately 4% of sodium sulphate.

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