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FIRE EXTINGUISHER

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This invention relates to fire extinguishers and to the charge therefor. It is the principal object of the invention to provide a fire extinguisher having superior effectiveness in the extinguishing of fires by means of the application of a fire-extinguishing foam which covers the fire rapidly and results in a long-lasting and highly effective blanket adapted to extinguish the fire and to prevent reignition by exclusion therefrom of oxygen or air.

It is a further object to provide a charge for a fire extinguisher of the foam-generating type which in operation will produce quickly and uniformly a large quantity of highly effective fire-extinguishing foam, resulting in extinguishing of the fire in a rapid and superior manner.

It is a further object to provide for use in a foam-type fire extinguisher a novel foam stabilizing material which is made effective under predetermined controlled conditions and which provides for economically securing a highly effective long-lasting fire-extinguishing foam.

It is a further object to provide an extinguisher of the foam-type in which the foam as generated upon the operation of the extinguisher is maintained under controlled conditions, resulting in uniformity of operation and superior quality of generated foam for fire-extinguishing purposes.

It is a still further object to provide a foam charge including a stabilizer material and a material for maintaining predetermined controlled conditions, which charge is effective in its operation, definite and uniform in its composition, and which is practically free from decomposition and not subject to mold or bacterial growth or the like, over extended periods of time in the extinguisher.

Other objects and advantages will be apparent from the description and the appended claims.

This application is a continuation in part of copending application Serial No. 159,121, filed August 14, 1937, and assigned to the same assignee as this application.

In the fire extinguishing art certain types of extinguishers have been developed for particular effectiveness in the extinguishing of fires of different characteristics, not all methods of extinguishing fires being of the same effectiveness when applied to fires involving different materials. For example, the application of water to fires involving wood, paper, textiles and the like is highly effective, but it is of lesser value in extinguishing fires involving oils, greases and volatile solvents. The foam-type extinguisher produces in operation a blanket of flame-smothering and air-excluding foam, which floats on the surface of burning fluid such as oils, greases and the like, excluding air and oxygen from the seat of the fire and resulting in effectively smothering such a fire.

The present invention relates to such foam-type extinguishers and provides a foam-generating charge which is of superior effectiveness in the extinguishing of fires. In operation, the extinguisher of this invention develops a foam which has superior flowing power such that it flows more readily over the surface of burning fluids, such, for example, as oils, greases and the like, quickly forming an effective flame-smothering blanket and extinguishing the fire. This is highly important in securing the maximum of fire-extinguishing effect from an extinguisher of any predetermined size and is of special importance in connection with the extinguishing of fires involving flammable and volatile liquids. In this latter case the rapidity of flow of the fire-extinguishing foam over the burning surface of the fluid and its great effectiveness in quickly bringing the flame under control makes it possible for the operator to approach the seat of fire more quickly than in the ordinary case, so that he is enabled to approach closely to the fire where the fire-fighting equipment may be used to the best advantage. Thus the extinguisher of the present invention is effective upon fires in open vessels of turpentine, lacquer solvents, paint solvents and like materials which are extremely difficult to extinguish with the media heretofore available.

Foam-generating type extinguishers consist generally of a vessel provided with a discharge opening and constructed to withstand internal pressure and adapted to contain an aqueous solution of one of the foam-generating ingredients. Positioned within or adjacent this vessel is another vessel adapted to contain an aqueous solution of the remaining portion of the foam-generating ingredients, the positioning of the two vessels being such that these solutions are normally kept separate when the device is in the inoperative position. The several ingredients of these two solutions are selected so that upon operation of the device to cause mixing of these solutions a chemical reaction occurs. Thus if one of these solutions is an aqueous solution of aluminum sulfate, for instance, and the other solution is an aqueous solution of sodium bicarbonate, a chemical reaction will occur which will result in the formation of sodium sulfate, carbon dioxide and alu-

minum hydroxide, the carbon dioxide being in the gaseous state, and developing pressure to expel the contents of the device through the discharge opening. Aluminum hydroxide, which is practically insoluble in aqueous solutions of this character, remains in suspension in the solution in a finely divided state and is expelled with the solution through the discharge fitting of the device.

Due to the fact that carbon dioxide, especially under pressure, is appreciably soluble in aqueous solutions, a substantial percentage of the total quantity of carbon dioxide generated as a result of the chemical reaction is dissolved in the fluid portion of the reaction mixture and is discharged from the device in the discharge stream. And since the interior of the device is under a pressure, the dissolved gas in the discharge stream increases in volume as it is discharged from the outlet into the atmosphere. Thus fluid from within the container is not discharged as a solid stream of fluid, but as an admixture of fluid and gas, with the gas expanding upon discharge. As a result of this condition a large number of very small bubbles are formed, each bubble consisting of a central portion of carbon dioxide gas and an outer envelope or skin of fluid or liquid material from the device. Due to the insoluble aluminum hydroxide formed as a result of the chemical reaction and carried in suspension in the discharge stream, the outer envelope or skin enclosing the center of each bubble is sufficiently tough and elastic to maintain its form for an appreciable length of time with the result that the stream discharged by such a device consists of a froth or foam. However such foam unless properly controlled is comparatively unstable due to the tendency of adjacent bubbles to coalesce and permit the escape of entrapped gas with the result that the volume occupied by the foam decreases more rapidly than desired for effective fire extinguishing purposes.

In accordance with the present invention a foam charge is provided, such charge embodying suitably reactive solutions such as an "A" solution, acid in reaction, and containing an aqueous solution of a salt such as aluminum sulfate, and a "B" solution, alkaline in reaction, and containing an aqueous solution of a salt such as sodium bicarbonate. Upon intermixture of these solutions in the operation of the extinguisher a generation of gaseous pressure takes place providing for the expelling of the fire-extinguishing liquid out of the extinguisher substantially as described above.

With such charge are incorporated materials providing for maintaining control of the body of generated foam so that the tendency for the formed bubbles to coalesce is controlled and reduced and for this purpose there is included a predetermined small quantity of a material capable of developing stabilizing effect upon the generated foam. Such stabilizer material is of definite and predetermined composition such that its effect may be controlled accurately. A material of definite composition is utilized, preferably a synthetic stabilizer material, with uniformity of composition and operating characteristics, avoiding the use of natural products as practiced in the past which are objectionable from lack of uniformity, variation with different sources of supply, seasons of the year, etc. Likewise the stabilizer material of this invention is substantially inert and not subject to deterioration nor adapted to support the growth of bacteria or other micro-organisms. Serious objection has in the past attended upon the use of natural products, such as extracts of licorice and other extracts of barks, leaves, roots and the like, as a result of the growth of mold or other micro-organisms in that portion of the charge containing such material. With the stabilizer material in accordance herewith there is substantially no change in the charge even over extended periods of time, the extinguisher thus remaining in condition suitable for immediate operation without frequent inspections or recharging.

As pointed out above the function of a stabilizer is to toughen the envelope surrounding a small bubble of gas and prevent coalescence of adjacent bubbles which result in the escape of gas and collapse of the body of foam. It is believed that stabilizing materials function by reason of the molecules of such materials orienting themselves or arranging themselves on the surface of the envelope surrounding a bubble in such a manner that coalescence of adjacent bubbles is retarded. Thus, for instance, if a stabilizing material is selected of such a molecular construction that one end of the molecule of such material is adsorbed by the aqueous envelope and the other end is not adsorbed, the outer surface of such a bubble will present a surface consisting of the ends of like molecules. When adsorption of one portion of the molecule occurs, the remaining portion of the molecule becomes negatively charged with the result that when a bubble, the outer surface of which consists of molecules having like ends negatively charged approaches closely a similar bubble, coalescence will be inhibited due to the mutual repulsive forces acting between such surfaces. Thus, coalescence of adjacent bubbles is materially reduced with the result that foam consisting of such bubbles is produced in greater volume and is longer-lasting than foams in which this coalescence occurs rapidly.

The stabilizer materials of the present invention are synthetic materials of hydrocarbon nature selected to have predetermined molecular sizes and molecular structures such that these materials will properly orient themselves with relation to the envelope of individual bubbles so that a foam of superior characteristics is obtained. As a result of this condition such material when present, even in small proportions, exhibits its effectiveness on the exterior surface of a drop of liquid, or a bubble of foam, exerting a protective action upon the bubble, tending to prevent rupture of the bubble and breaking of the foam upon contact with other bubbles. Both the closed chain, or aromatic, and the open chain, or aliphatic, compounds have been used successfully.

In order that a molecule may orient itself in such a manner that it functions efficiently as a stabilizer it must contain certain definite groupings of elements, termed polar groups, or molecular structures which act as polar groups. The term "polar groups" is used herein to designate those groupings of chemical elements in which the electrostatic forces are such that adsorption to aqueous surfaces is caused to readily occur while the term "non-polar" is used to designate those groupings of chemical elements in which the electrostatic forces are such that adsorption does not readily occur at aqueous surfaces. As examples of highly polar groups may be mentioned the hydroxyl (—OH), carboxyl (—COOH), mercaptan (—SH), the halogens (—Cl, —Br, —F, —I), sulphonic (—SO_2OH),

amino (—NH_2), nitro (—NO_2), aldehyde (—CHO), ketone (—CO), nitrile (—CN), and others of similar characteristics. It is further found that the points of unsaturation in the hydrocarbon chain, such as a double or triple bond, act like polar groups, and by the predetermined selection of carbon compounds having points of unsaturation in predetermined arrangements a compound equivalent in its functioning in the present invention to one containing a polar group is provided. In general carbon and hydrogen when grouped together form a non-polar group.

It is important that the molecule have substantial size, as measured in terms of the number of carbon atoms in the chain, so as to bring about adequate protective action upon the surface of the bubbles. Thus, it is usually found that the chain should contain four or more carbon atoms. On the other hand the compound should not be excessively large as its orientation then becomes difficult to control and for that reason it is ordinarily found that for best results the compound should not contain in excess of approximately 18 to 20 carbon atoms between adjacent polar groups or structures which act as polar groups. To provide points of attachment for the molecule to the liquid body of the envelope of the bubble the compound should contain one or more polar groups. In the case where the compound is relatively small, that is, contains a small number of carbon atoms, a single polar group may suffice; where an extended carbon chain is employed it is preferable that the compound have incorporated more than a single polar group and, preferably, that such plurality of polar groups be distributed over the body of the compound.

In the case of aromatic compounds having a simple ring structure a single polar group may suffice, but it is usually desired to utilize two or three polar groups, symmetrically positioned about the molecule; and in the case of more complex molecules, improved results are obtained through the use of compounds having a plurality of polar groups attached thereto.

As examples of compounds which have been found to give satisfactory results in operation, an aliphatic chain compound of the general formula C_nH_{2n+2} ranging from approximately 4 carbon atoms to 18 carbon atoms, and having substituted for an end hydrogen a polar group, such, for example, as an OH group, forming an alcohol, or an SO_3H sulphonic acid group, may be utilized. Preferably, where a sulphonic acid group is utilized, the sodium or potassium salt of the sulphonic acid should be used in preference to the sulphonic acid itself. Compounds of this nature are generally colorless, neutral, non-toxic and soluble in both the "A" solution and the "B" solution ordinarily used in foam-type extinguishers.

The following are examples of aromatic compounds which have been determined to produce highly satisfactory results: sodium phenol-sulfonate, sodium aminobenzenesulfonate, benzoyl chloride, sodium anthranilate and sodium naphthylaminosulfonate, the foregoing being examples of aryl compounds. These materials when utilized in small proportions, for example, in the order of about 1.5 to 5% based on the weight of the charge of salt with which they are used, are found to produce extraordinary results in foam formation as above described.

Not all of the polar groups, examples of which are given above, have the same effectiveness for the purposes of the present invention, some of these groupings being more readily adsorbed than are others. For instance, the sulphonic group, (—SO_2OH) is more readily adsorbed or has a greater effectiveness than does the hydroxyl group, (—OH). When, therefore, an hydroxyl group is used as the polar group it should be associated with a lesser number of carbon atoms than when a sulphonic group is used as the polar group. Thus a hydrocarbon chain consisting of 4 to 6 carbon atoms is sufficient for one hydroxyl group, whereas a carbon chain of 14 to 18 carbon atoms is desired for a sulphonic group. Similarly a six-membered carbon ring is generally sufficient for a single hydroxyl group, whereas a ten-membered ring such as a naphthylene nucleus, is desired when a sulphonic group is used as the polar group. When highly polar groups are used in six-membered ring structures additional hydrocarbon groups should be added to such a structure, such, for instance, as methyl, ethyl or propyl groups the number and length of such chains depending upon the polarity of the polar group or groups used.

It has been further found that, generally, a better quality of foam results when the stabilizer is a mixture of closely related compounds than when a single pure compound is used. For instance, if an alkyl chain consisting of 14 carbon atoms is used with a single polar group, it will be found advantageous to include a substantial percentage of similar alkyl compounds having 12 and 16 carbon atoms. If desired, mixtures may be utilized of compounds having even a greater range in the number of their carbon atoms such as from 4 to 20 carbon atoms.

Furthermore, more complex compounds, such as the arakyls and alkarals, containing both an aliphatic chain and an aromatic ring may have attached thereto suitable polar groups to form compounds which produce satisfactory results in accordance with the present invention.

If the formed bubbles of foam break in too short a period of time as a result of the dissipation or substantial change of electrical charge on the outer surface of the bubble envelope, the resistance of the bubbles to coalescing is diminished and the body of foam is no longer maintained as an effective flame-smothering blanket. It is desired to maintain the foam for as long a time as possible and to this end it is desired to avoid such change in the charge condition of the bubbles as would lead to rapid coalescence. Such change may result from a substantial change in hydrogen-ion concentration or pH value of the foam and it has been found that if the pH value of the foam departs substantially from a neutral condition the quality of the foam is adversely affected.

In the operation of the usual extinguisher where a quantity of "A" solution is discharged into a body of "B" solution, or vice-versa, only chemically equivalent portions of these solutions can react and the product of reaction is substantially neutral. But this reaction product may have physically present therewith a small quantity of "A" solution or "B" solution, depending upon which solution is in excess, with the result that this reaction product including the foam bubbles themselves, while having a hydrogen-ion concentration substantially neutral when formed may have a non-neutral hydrogen-ion concentration as actually discharged.

In accordance with this invention it has been discovered that certain materials, such as the monobasic and dibasic phosphates of sodium and potassium, the acetates of sodium and potassium, and the borates of sodium and potassium, when present in small quantities, materially affect the performance of the stabilizer under these conditions. These materials are especially desirable for incorporation in the B portion of the charge. It is important that the buffer materials be and remain substantially inert in the portion of the charge with which they are incorporated prior to operation of the extinguisher to avoid premature reaction thereof. As an example of buffer materials suitable for use with the A portion of the charge, aluminum phosphate or acetate may be utilized. It is believed that these compounds partially dissociate and resist the change in hydrogen-ion concentration caused by the mechanically admixed portions of unreacted solution carried by the generated foam. That is, it is believed, when the hydrogen-ion concentration of the generated foam is changed from a substantially neutral condition that these compounds partially dissociate and release or absorb hydrogen-ions restoring the generated foam to substantially a neutral state with the result that the negative charges carried by adsorbed stabilizer molecules become effective and thereby prevent a rapid collapse of the foam with resultant improvement in its quality and effectiveness. While these materials are not the only materials suitable for this purpose, such materials are available generally commercially, and economically, so that they form preferred materials for use as what will be termed herein "buffers," effective to develop a buffering and in conjunction with the stabilizer a protective action upon the generated foam. The quantity utilized may be rather small, such, as in the examples given below, as of the order of about 1 to 1.5% based on the weight of the salt portion of the charge with which they are used.

Such buffer material may be satisfactorily added either to the "A" solution or to the "B" solution, and either in the presence or absence of the stabilizer material. It is desired, however, particularly where both stabilizer and buffer material are present together in one portion of the charge, that the materials be compatible with each other, and not subject to mutual reaction prior to the actual operation of the extinguisher.

As a specific example of a charge for a fire extinguisher formed in accordance with the present invention, an "A" solution is made up containing:

	Per cent
Aluminum sulfate (14 H_2O)	46.5
Water	53.5
	100.0

and a "B" solution containing:

	Per cent
Sodium bicarbonate	10.00
Sodium alkyl sulfate	.17
Sodium tetraborate (10 H_2O)	.15
Water	89.68
	100.00

where the alkyl radical is substantially octyl and contains 8 carbon atoms. Throughout these examples the two solutions are to be mixed in the general proportion of 14 parts of the A solution to 66 parts of the B solution.

As another example a "B" solution may contain:

	Per cent
Sodium bicarbonate	10.00
Sodium alkyl sulfate	.15
Sodium tetraborate (10 H_2O)	.15
Water	89.70
	100.00

where the alkyl radical is substantially dodecyl or lauryl, containing 12 carbon atoms.

As a still further example a "B" solution may contain:

	Per cent
Sodium bicarbonate	10.00
Sodium alkyl sulfate	.12
Sodium tetraborate (10 H_2O)	.15
Water	89.73
	100.00

where the radical may be substantially either hexadecyl containing 16 carbon atoms or octadecyl containing 18 carbon atoms.

Still another example, a "B" solution may contain:

	Per cent
Sodium bicarbonate	10.00
Sodium alkyl sulfate	.10
Sodium tetraborate (10 H_2O)	.15
Water	89.75
	100.00

where the alkyl radical may be an unsaturated carbon chain such as hexadenyl or octadenyl containing 16 or 18 carbon atoms respectively.

Still another example, a "B" solution may contain:

	Per cent
Sodium bicarbonate	10.00
Sodium phenolsulfonate	.50
Sodium tetraborate (10 H_2O)	.15
Water	89.35
	100.00

The following is an example of the buffer being present in the "A" solution:

	Per cent
Aluminum sulfate	46.5
Aluminum phosphate	.6
Water	52.9
	100.0

and "B" solution:

	Per cent
Sodium bicarbonate	10.00
Sodium alkyl sulfate	.12
Water	89.88
	100.00

The examples given above are suitable for the generation of foam when used in extinguishers of standard design of a capacity of 2½ gallons. Suitable change in the proportions given above may be made to secure the most desirable operating results in extinguishers of a capacity other than approximately 2½ gallons or other than of usual design.

While the proportions given above have been found to be most suitable for these particular compounds when used in one kind of extinguisher, it must be pointed out that changes in extinguisher design or size may require proportions

different from those set out above. Further, these examples are of stabilizers having 8, 12, 16 and 18 carbon atoms in the chain, and if the chain length is decreased, it has been found that the quantity of stabilizer used should be increased, not in direct proportion to the decrease in chain length, but in inverse exponential relation thereto. Similarly, if the chain length is increased, the quantity of stabilizer required may be decreased in exponential proportion.

The quantity of buffer material required for generation of maximum foam volume varies with the kind and amount of stabilizer used. If a larger quantity of stabilizer is necessary, the quantity of buffer material used should be increased accordingly; while if a smaller quantity of stabilizer is required, a correspondingly smaller quantity of buffer material may be used.

In the examples given above, the quantity of buffer material specified is such that the maximum foam volume is secured with these particular stabilizers, and if other stabilizers are used, the quantity of buffer material may be increased or decreased in accordance with the relationships set out above for maximum effectiveness.

The extinguisher of this invention comprises a charge which in operation provides for securing extraordinary results in effectiveness in extinguishing fires. The charge includes a stabilizer material of predetermined definite characteristics and in predetermined quantity based upon such known characteristics. Such material is incorporated with either the "A" solution or the "B" solution as determined to be most satisfactory, and is substantially neutral and inert, and may also be colorless, odorless, non-corrosive and non-toxic. The charge also incorporates a buffer material therein which exerts its effectiveness during operation to provide a foam having the desired hydrogen-ion concentration such that the entire body of the foam will have those characteristics best adapting it to the furtherance of its smothering and flame-extinguishing action.

While the process and composition of matter herein described constitutes preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise process and composition of matter, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A foam charge for a fire extinguisher of the foam generating type comprising chemically reactive foam forming materials including aluminum sulfate having an acid reaction and a material having an alkaline reaction adapted to be brought together with said acid material in the presence of water to develop carbon dioxid gas and to form a fire extinguishing foam, a foam stabilizer, and a buffer material present in and compatible with one portion of said charge in an amount of the order of 1% to 1½% of the salt portion of the charge with which it is present, said material being selected from the group consisting of sodium, potassium and aluminum phosphates, acetates and borates.

2. The foam charge as defined in claim 1 in which said foam stabilizer comprises a hydrocarbon material having a polar group attached thereto.

3. The foam charge as defined in claim 1 in which said foam stabilizer comprises an aliphatic hydrocarbon material having from 4 to 20 carbon atoms in the molecule and also having a polar group attached thereto.

4. The foam charge as defined in claim 1 in which said foam stabilizer comprises an aryl compound having a polar group attached thereto.

5. The foam charge as defined in claim 1 in which said foam stabilizer comprises compounds containing an aliphatic chain and an aromatic ring having polar groups attached thereto.

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