A first portion of water under pressure is mixed with a foam liquid concentrate and a gas such as air in a pump to form a primary foam upon discharge from the pump and a second portion of water under pressure is mixed with the primary foam thereby enabling the generation of a given volume of foam by the use of a smaller pump than would be required by the prior practice of passing both portions of water through the pump.

16 Claims, 2 Drawing Figures
MECHANICAL FOAM GENERATING METHOD AND SYSTEM

This is a continuation of application Ser. No. 170,786 filed Aug. 11, 1971 and now abandoned.

This invention relates generally to a mechanical foam generating method and a system incorporating that method. It relates particularly to a method of operating an in-line foam pump system in which a foam liquid concentrate and a diluent such as water are mixed with a gaseous medium such as air in a rotary positive displacement type pump, to form a foam upon discharge therefrom and additional water is mixed with the foam at a point in the system beyond the discharge port of the pump.

It is another object of this invention to provide a method and system for proportioning the amounts of foam liquid concentrate and water to be mixed in the pump.

That these and other objects are fulfilled by this invention will be evident from the following description.

It has been found that a mechanical foam having a lower expansion ratio than previously possible from conventional mechanical foam systems comprising a rotary sliding vane pump operating at maximum capacity may be generated by a system wherein only a portion of the water required to make the desired foam is passed through a foam pump along with the foam liquid concentrate and a gas such as air, the remainder being by-passed around the pump to mix with the foam formed upon discharge of the concentrate-rich mixture from the pump.

The mechanical foam generating system of this invention comprises a pump having a gas inlet port, a liquid inlet port and a foam outlet port, a liquid inlet conduit connected to the liquid inlet port, a main water conduit adapted for connection to a source of water under pressure, a pump water conduit between the main water conduit and the liquid inlet conduit, a foam liquid concentrate conduit adapted for connection to a concentrate reservoir and connected to the liquid inlet conduit, a foam conduit connected to the foam outlet port and a by-pass water conduit between the main water conduit and the foam conduit whereby a portion of the water by-passes the foam pump.

The method of this invention comprises the steps of dividing a stream of water under pressure into first and second portions, mixing the first portion of the water with a foam liquid concentrate and a gas in a rotary positive displacement pump to make a concentrate-rich mixture, discharging said mixture from the pump to make a primary foam, and mixing the second portion of water with the primary foam to make a dilute foam. The diluted foam is a mechanical foam having an expansion ratio between about 15:1 and about 2:1 or less. For most applications the ratio will be between about 4:1 and about 12:1.

The steam of water may be obtained from any suitable source as long as the water is under pressure at the point where it enters the system. The source may be a municipal water supply or a separate water reservoir. In the latter case the pressure may be created by raising the reservoir to a suitable height above the system or by pumping the water to the system by means of a centrifugal pump or the like.

The relative sizes of the first and second portions into which the stream of water is divided will be determined by the capacity of the rotary positive displacement pump (i.e., the foam pump) in the foam generating system, the amount of cooling required for the pump, the concentration of the foam liquid concentrate and the expansion ratio desired. Usually the second portion will constitute the major portion but in cases where the capacity of the foam pump is only slightly less than that
required to deliver a given volume of foam having a given expansion ratio the first portion may be the major one. It follows that the two portions of water may be of equal volume. Most often the second portion will be from about 60 to about 90 percent, preferably from about 70 to 80 percent of the total volume of water. The water, and foam liquid concentrate, however, act as a coolant for the pump so the pump will operate at or near isothermal conditions. To effect the necessary cooling, the mixture of water and concentrate passing through the pump is usually at least about 40 percent of the liquid capacity of the pump. The foam liquid concentrate may be any one of the known products commonly used for the generation of mechanical foam. These include the protein and synthetic types. The fluorinated surfactants and the detergents are examples of the latter type.

The gas used in mechanical foam generation is commonly air since it is the most available one. Other non-flammable gases such as nitrogen may also be used, however.

The proportions of the concentrate and the first portion of water are such that the primary foam will contain all of the concentrate which will be present in the diluted foam. The conventional concentrates are designated as 3 percent and 6 percent concentrates which means that they are used in proportions of 3 percent and 6 percent by volume.

The rotary positive displacement type pump used as the foam pump in this method is usually of the rotary sliding vane type as described in U.S. Pat. Nos. 3,353,550; 3,234,962, and 2,827,858, which are hereby incorporated by reference into this disclosure. Other rotary positive displacement type pumps may also be used.

The primary or concentrate-rich foam is formed as the concentrate-rich mixture is discharged from the pump into a conduit attached to the pump. This conduit serves as a mixing chamber when the second portion of water is introduced into the conduit at a point downstream from the point of discharge from the pump.

The foam resulting from the mixture of the second portion of water with the primary foam is a diluted foam and has an expansion ratio less than that of the primary foam. The reduction in the expansion ratio is determined by the amount of water added to the primary foam. For example, in 6,000 gallons of foam having an expansion ratio of 6 the total volume of liquid is 1,000 gallons, of which 60 gallons will be 6 percent foam liquid concentrate. To make 6,000 g.p.m of foam, the 940 g.p.m. of water is divided into a first portion of 188 g.p.m. (20 percent) and a second portion of 752 g.p.m. (80 percent). The primary foam is formed by mixing the first portion of water with 60 g.p.m. of foam liquid concentrate and 5,000 g.p.m. of air will have an expansion ratio of 5248/248 or about 21:1. A primary foam generated from 464 g.p.m. of water, 36 g.p.m. of 6 percent concentrate and 5,500 g.p.m. of air will have an expansion ratio of 12. Adding 100 g.p.m. to the primary foam will give a foam having an expansion ratio of about 10:1:1.

The mixing of the second portion of water with the primary foam may take place in an open, unobstructed conduit or, at least partially, in a foam refiner comprising a screen or series of screens or a bundle of parallel tubes inserted in the conduit. The axes of the tubes are parallel to the axis of the conduit. A laminar flow is more conducive to the formation of substantially uniform bubbles and in applications where a substantially homogeneous foam is desired the mixing of the diluted foam may include a refining step. In order to avoid too great a pressure drop during the refining step the cross-sectional flow area of the foam refiner should be at least equal to that of the conduit carrying the foam.

The system incorporating the method of this invention will be better understood from the following descriptions with reference to the drawings.

FIG. 1 illustrates a fire truck equipped with a foam generating system of this invention.

FIG. 2 is a semi-diagrammatic view showing an embodiment of this invention suitable for a stationary installation.

In FIG. 1 truck chassis 10 supports foam liquid concentrate reservoir 11 upon which is mounted pump 12 driven by a power take-off from the truck engine, a separate diesel engine, or the like. Pump 12 has air inlet port 13 and liquid inlet port 14 which is connected to liquid inlet conduit 15 which is connected to foam liquid concentrate conduit 16, in which valve 17 is interposed, and to pump water conduit 18, in which valve 19 is interposed. Conduit 18 is connected to main water conduit 20 at a point upstream from valve 21 which controls the flow of water from main conduit 20 to by-pass conduit 22. Main conduit 20 is adapted for connection to a city water hydrant or other source of water under pressure. Flow rate indicator 23 is interposed between main conduit 20 and by-pass conduit 22.

Foam conduit 24 is connected to outlet port 25 of pump 12 and to by-pass conduit 22 and foam refiner 26. Distribution conduit 27 is connected to foam refiner 26 and is adapted to be connected to a discharge turret, as shown, or to some other discharge apparatus. Distribution conduit 27 may also be extended at its lower end and adapted for sub-surface application of the foam and for various other modes of application.

In operation, foam liquid concentrate and water are drawn from reservoir 11 and main water conduit 20, through conduits 16 and 18, respectively, by pump 12. The proportions of foam liquid concentrate and water are regulated by valves 17 and 19, respectively. Only a portion of the water flowing through conduit 20 passes through pump 12, the amount being regulated by valve 19. The concentrate and water mix in liquid inlet conduit 15 and the mixture enters pump 12 through port 14. Air is drawn through port 13 into pump 12 wherein it is mixed with the concentrate and water. A foam rich in concentrate is formed as the mixture is forced into conduit 24 through port 25. The remainder of the water flowing through conduit 20 by-passes pump 12 via conduit 22 and mixes with the concentrate-rich foam in foam conduit 24 at the junction of conduit 22 and conduit 24. The diluted foam may then pass through foam refiner 26 wherein the bubbles comprising the foam are made uniformly small by passage of the foam through a screen, a series of screens, or a bundle of parallel tubes which comprise refiner 26.

The diluted foam flows into distribution conduit 27 from which it may be discharged through a nozzle or other means for application to the substance to be protected.

In FIG. 2, pump 40, mounted on a suitable support (not shown), and having a suitable drive means (also
In the event pressure within foam conduit 55 exceeds a predetermined value, pressure relief valve 66 opens to permit vent conduit 65 to carry the foam out of the system. The predetermined value is usually no higher than about 50 p.s.i. but may vary according to the stress characteristics of the remainder of the system.

It should be understood that the foregoing description of the invention is illustrative only and the scope of the invention should be determined from the following claims.

I claim:

1. A mechanical foam generating system comprising a pump having a gas inlet port, a liquid inlet port and a foam outlet port, a liquid inlet conduit connected to the liquid inlet port, a main water conduit adapted for connection to a source of water under pressure, a pump water conduit between the main water conduit and the liquid inlet conduit, a foam liquid concentrate conduit adapted for connection to a concentrate reservoir and connected to the liquid inlet conduit, a foam conduit connected to the foam outlet port and a by-pass water conduit between the main water conduit and the foam conduit whereby a portion of the water by-passes the pump.

2. The system of claim 1 characterized further by means for proportioning the amounts of foam liquid concentrate and water flowing into the pump.

3. The system of claim 2 wherein the proportioning means comprise orifice plates in the foam liquid concentrate and pump water conduits.

4. The system of claim 1 characterized further by a means for regulating the flow of water through the by-pass water conduit.

5. The system of claim 4 wherein the regulating means comprises a valve responsive to a pressure differential across a restriction in the by-pass water conduit.

6. The system of claim 1 characterized further by means for relieving pressure in excess of a predetermined value in the foam conduit.

7. The system of claim 1 characterized further by a check valve mounted in the foam conduit and arranged to permit flow of foam away from the pump only.

8. The system of claim 1 characterized further by a check valve mounted in the main water conduit and arranged to permit flow of water to the pump water conduit and bypass water conduit and to check flow of foam from said conduits into the water source.

9. A method for generating mechanical foam comprising the steps of dividing a stream of water under pressure into first and second portions, mixing the first portion of the water with a foam liquid concentrate and a gas in a positive displacement pump to make a concentrate-rich mixture, discharging said mixture from the pump to form a primary foam, and mixing the second portion of water with the primary foam to make a diluted foam.

10. The method of claim 9 wherein the first and second portions of water are of equal volume.

11. The method of claim 9 wherein the second portion is a major portion of the water.

12. The method of claim 9 wherein the second portion constitutes from about 70 to about 80 percent of the stream of water.

13. The method of claim 9 wherein the step of mixing the second portion of water with the primary foam in-
includes refining of the diluted foam to a mass of substantially uniform bubbles.

14. The method of claim 13 wherein the diluted foam is refined by passing it through at least one screen.

15. The method of claim 13 wherein the diluted foam is refined by passing it through a conduit having its crosssection filled with tubes having axes parallel to each other and the conduit.

16. The method of claim 9 wherein the gas is air.

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