Class A Foam In Municipal Fire Operations

by Dominic J. Colleffl

Class A foam, originally used in forestry applications, is steadily gaining acceptance for structure firefighting. State-of-the-art equipment incorporated into new and existing municipal apparatus make this technology more user friendly and cost effective than ever before. Because class A foam technology is relatively new to the structural fire service, many questions are being asked. Does it work? Is it the same as wet water? Will it replace the need for a large fire pump and water tank on our apparatus? Should we take a close look at using class A foam?

Each department should carefully weigh the cost of foam agent, equipment, and training required, against the benefits of the technology for their specific fire needs. Most, after looking at the body of technical knowledge known about class A foam, and examining the benefits, decide to implement its usage because predominantly, fires burning “class A” - ordinary combustibles are some of the most typical, hazardous, and resource consuming fire challenges within most fire districts today.

Foam Agent Concepts

While not readily considered until recently for class A - ordinary combustibles, the application of foam agents to manually combat class B - flammable liquids is well accepted within the fire service.

Typically, class B foam concentrates are mixed with water, creating a foam solution, and then aerated to create a finished-foam bubble mass. The finished-foam bubble blanket applied correctly reduces total water supply needed to extinguish most flammable liquid fires, through increasing suppression abilities of gallon per minute water flows. The use of plain water in the extinguishment process is not eliminated, however, the effectiveness of its ability to suppress the fire is enhanced by the addition of the foam chemical. For example, a hand line flow of 95 gpm of plain water will work to remove only the heat side of the fire tetrahedron when applied to a flammable liquid fire. This same 95 gpm flow mixed with a Fluorocarbon Surfactant (class B foam concentrate), and then aerated and applied as a finished-foam blanket will enhance fire killing abilities of the same water flow through vapor sealing the flammable liquid, thus removing the oxygen and fuel sides of the fire tetrahedron. The net effect is the efficient use of the gpm flow and total water supply available to promptly extinguish the fire. The perception that plain water is abandoned for foam chemical is false. Rather, its ability to suppress fire is enhanced by the addition of foam concentrate.

This improved ability of water as finished-foam to suppress flammable liquid fire increases fire operational efficiency and firefighter safety, while reducing property damage.

Water treated with class A foam concentrate, applied to ordinary combustibles including structure fires, shows these same three net effects in municipal fire operations by increasing the ability of water to suppress burning class A type fuels. Class A foam solution has excellent ability to wet and penetrate ordinary combustibles, resulting in reduced fuel core temperatures, aiding in flame knockdown, extinguishment, and fuel securing capabilities.

Plain Water

Plain water has the capability to absorb a large volume of heat if it can be held in contact with burning ordinary combustible fuels. One inherent problem preventing it from utilizing its full potential is surface tension or simply stated, the tendency of water to form into droplets, or bead. This is caused by water molecules bonding together, affecting its ability to spread over the surface of fuels. Plain waters high surface tension reduces the surface area in contact with the combustible, limiting its ability to absorb heat. Gravity causes the water droplets to roll off, the majority ending on the floor. A study in 1974 showed that a conventional solid fire stream is only five to ten percent effective at actual extinguishment. Approximately ninety percent of the heat absorbing potential is wasted because of the effects of surface tension and gravity when water is applied to three-dimensional structural fuels. Not only is the water wasted, it may also contribute to structural collapse and exceptional insurance claims for water damage far exceeding the actual structural damage from fire.

Class A Foam

Class A foam concentrate, a synthetic detergent hydrocarbon surfactant, mixed at concentrations from 0.1% to 1.0% with water, turns water into a very effective wetting/penetrating and cooling agent. By reducing high surface tension, and allowing more surface area of water applied to contact the ordinary combustible, fuel-cooling abilities increase. Not only will the foam solution spread over the fuel surface, it will seek to bond with carbons, enhancing waters penetrating abilities resulting in “wet” class A fuels further aiding fuel cooling and the prevention of rekindles.

Class A foam solution, mechanically agitated with air creating a finished-foam bubble blanket, will enhance this ability by “cheating” gravity through causing foam solution (as finished foam) to adhere to vertical fuels. This has practical advantages upon direct structure attack, because the class A finished-foam applied as a quick draining low expansion foam blanket will;

- Hold water (as foam solution) on three-dimensional class A fuels allowing maximum water utilization to cool fuels.

- Vapor seal fuels momentarily (until the foam solution drains out of the bubble mass evaporating or wetting the material) aiding extinguishment by removing the oxygen and fuel sides of the fire tetrahedron, causing a reduction in flammable vapors/smoke.

- Increase surface area of water droplets through application as a foam bubble structure, maximizing heat absorbing capabilities.

Effectiveness

Class A foam methodology is easily understood after a close look at the dynamics at work. However, claims of increases in effectiveness of water in the suppression of fire remain controversial . Anecdotal/empirical evidence and limited comparative testing has yielded a “three to five times more effective than plain water” standard. An effort undertaken earlier this year by members of private industry and the fire service toward a preliminary step in quantification of class A foam for structure suppression, provides insight into its effects and possible ramifications in municipal fire operations.

A series of controlled room and contents fires were performed at Wallops Island, Virginia and Salem, Connecticut by Hale Fire Pump, the Atlantic Virginia Fire Department, Ansul Fire Protection, the International Society of Fire Service Instructors, Elkhart Brass, the National Aeronautic and Space Administration-Goddard Flight Center Fire Department, the Charlotte North Carolina Fire Department, the Fairfax County Virginia Fire Department and F.I.E.R.O. (Fire Industry Equipment Research Organization) and the Salem Connecticut Fire Department.

Using a thermocouple-strip chart recorder, identical rooms in acquired structures were instrumented, the objective to measure time/temperature reduction relationships with the application of water, class A foam solution, and Compressed Air Foam System (CAPS) aspirated class A foam solution. The goal in using acquired structures was to perform testing in a manner as “real world” as possible, while still giving the utmost attention to variables such as fuel loading, fuel placement, agent application, and room ventilation. The same nobleman was used on each interior attack, duplicating agent application, with streams being applied after flash over occurred. After indirect (ceiling) application for 60 seconds, direct application was made to room contents for an additional 60 seconds. Identical gallon per minute and total water flow rates were established through the use of sensitive flow measuring equipment. In the Connecticut bum series shown in the chart below, room sizes were 1 1' & 10' & 8' high with moderate fuel loading. The fuel was straw and pallets providing a duplicate scenario with similar fuel combustion characteristics.

A 20 Gpm flow of plain water in burn number one provided a flow slightly above the mean critical application rate. Any additional improvement in fire suppression capability would be identified in the time/temperature chart during burns two and three with the application of class A foam solution, and class A foam solution as Compressed Air Foam—all delivered at the same application rates. (*Note: These evolution’s were not NFPA 1403 training burns, but data collecting fires performed by veteran professionals).

Test Results

The ceiling thermocouple time/temperature difference recorded on all three burns was negligible. This was not surprising because agent application was made directly to the ceiling for the first 60 seconds.

The four-foot level thermocouple however, yielded graphic results.

Temperature Drops’ High Level -1000 DEG. F. Down To 212 Deg. F.

	Time (Sec.)	Drop Rate (Deg. Per Sec.)
Water	222.9	3.5
Foam Solution	102.9	7.6
Compressed Air Foam	38.5	20.5

Firefighter/Victim Stress

These four-foot level thermal readings would directly affect stress/survivability of trapped occupants in close proximity to the room of involvement, and also firefighting personnel involved in rescue/suppression operations in an actual fire. These clearly show an increased Btu absorbing ability of the same amount of water applied, thus reducing stress and increasing tenability. In this test, water as CAPS discharge was 480% more effective, and water as foam solution over 110% more effective than just plain water in working to lower room temperature.

From a property water damage viewpoint, the total water supply needed to lower the temperature as indicated was 13 gallons using compressed Air Foam, 34 gallons using foam solution, and 74 gallons using plain water, had the nozzle had thermal been shut at the 212 Deg. F. point. Practical experience with Class A foam and common sense dictates that there would be a reduction in water damage, and smoke/fire damage (however these tests were not run to yield data proving this). In all tests, one specific point commented upon by the attack crew time and time again, was the outstanding visibility with little smoke and steam generated from the application of Compressed Air Foam. The vapor sealing/penetrating ability of CAPS discharge produces only small amounts of steam, maintaining a stable thermal balance, providing superior ventilation and removal of combustion products increasing visibility.

In all tests, a total of nine rooms were instrumented, with agent applied in the same fashion. Results of the Salem tests were typical of all tests. An important factor in the effect of class A foam solution application is the type of aspiration device employed. Note that in the plain water and foam solution applications, an adjustable fog nozzle set on straight stream was the application device. Experience shows that had an air-aspirating nozzle used, higher efficiency would have been gained from the application of the foam solution. The goal in these tests was to duplicate agent application using the same straight fire stream. CAFS application used a ball shut off valve only, providing a straight stream.

Practical Ramifications

The introduction of rapidly burning synthetic furnishings over the last two decades have reduced the ability of hand line water flows to suppress interior fires. Modern day interior attacks using water flows of 90 to 120 Gpm with 1 -3/4' hose line and automatic nozzle have increased application rates from years past. However, limited personnel resources, nozzle reaction force, and larger diameter hose line immobility dictates that there are practical limits to introducing higher gpm application rates to increase flame knockdown and firefighter safety. Adding class A concentrate through a proportioning system on structural pumpers can be one way to increase fire killing ability of water flows. A possible 100% increase could make 120 gpm of foam solution flow have the suppression ability of up to 240 gpm of plain water if applied correctly. This increase justifies the cost (from $750 up to $4000) of a proportioning system, and the minimal education and training required to implement the use and application of the foam. Installing CAFS equipment on new and existing pumpers can cost from $8,000 to $25,000. Initial attack apparatus that rely on tank water may be able to improve that waters suppression ability by 300% to 500% with CAFS when applied correctly. Considering new class “A” pumpers cost in the range of $100,000 to $250,000, adding 10% to the cost for a CAFS that could increase fire stopping ability 3 to 5 fold should be an option well considered because of the cost vs. benefit ratio involved.

Considering scientific and anecdotal evidence available, along with this practical test, there is little doubt that class A foam can increase our ability to manually combat ordinary combustibles including structure type fire. This confirms the need to perform full-scale laboratory controlled scientific comparative testing by third party agencies.

The implementation of a departmental class A foam program requires education and training for proper results. Class A foam concentrate enhances waters ability to suppress fire and is not a replacement for water. Care should be taken not to reduce practical plain water flow rates with its usage. Preferably, use the same application rates of plain water with class A foam concentrate added to those rates. Applied correctly class A foam can increase firefighter safety, improve operational efficiency, and reduce property damage. It should be one tool considered when looking at ways to improve fire operations.

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