Compressed Air Foam Systems in Structural Firefighting

Prepared for

Dr. Carl Brucker
Technical Writing Instructor
Arkansas Tech University

By
Mike Richards

November 27, 2003

Rt. 1 Box 502
Roland, OK 74954

November 27, 2003

Dr. Carl Brucker
Department of English
Arkansas Tech University
Russellville, AR 72801

Dear Dr. Brucker:

The following research report was written to comply with the requirements for the Technical Writing course. I have chosen the subject of compressed air foam systems in structural firefighting as my subject. As Training Officer for the Fort Smith Fire Department one of my responsibilities is to research new technologies in the fire service. In the past 18 months I have participated in the research of these new systems. This is an exciting new innovation that our department is moving toward. With the information available, I actually found it difficult to format this research paper within the size limits required. The font associated with each Table and Figure was reduced to allow for a better layout for each page.

I am presenting basic information on the principles and use of compressed air foam systems in structural firefighting. This subject can be very complicated and present a lot of technical information. I have tried to highlight the major factors of these systems and present them in layman's terms. Although I have researched these systems for the last several months, the additional research for this paper was very beneficial in my quest to learn as much as I can about compressed air foam systems.

Sincerely,

Mike Richards

Table of Contents

Table of Figures and Tables

Abstract

Compressed Air Foam Systems (CAFS) uses a combination of a Class A foam concentrate combined with water and compressed air to form an extremely effective fire extinguishing agent. The combination of these agents reduces the surface tension of water allowing the solution to penetrate burning fuels much faster and more efficiently than plain water. This solution has a very high heat absorption quality that will suppress a fire in a fraction of the time as conventional firefighting tactics. The result includes increased firefighter safety, improved rescue operations, reduced property damage, and lower overall operational costs.

INTRODUCTION

Description and History of Compressed Air Foam Systems

Compressed Air Foam Systems (CAFS) have been documented to be extremely effective in direct fire attack procedures, exposure protection, overhaul, and vegetation pretreatment. There are many types of firefighting foams specifically designed to help extinguish a variety of different types of fires. This report will concentrate on structural firefighting foams, otherwise known as Class A foam, and the CAFS that are revolutionizing the fire service. Class A foam is a liquid chemical additive in concentrated form that is mixed with water to produce a foam solution that is much more effective than just water in suppressing structure fires. CAFS increases this efficiency even greater by introducing compressed air to the foam solution and water mix to produce a homogenized mixture of foam bubbles that are dense and tightly packed (Colletti 1998, p.199). CAFS have actually been around for decades. The original concept began in wildland firefighting in a effort to fight range and forest fires with limited water supplies. With the increasing expansion of wildland and urban interfacing, it was soon discovered how effective CAFS was in structural firefighting.

Purpose

The intent of this report is to present information on CAFS in structural firefighting. A general overview of how and why Class A foams, when used in conjunction with a CAFS, are superior to traditional firefighting procedures.

Target Audience

The primary audience for this report is Dr. Carl Brucker. The secondary audience may include firefighters or others interested in the advancement of firefighting techniques.

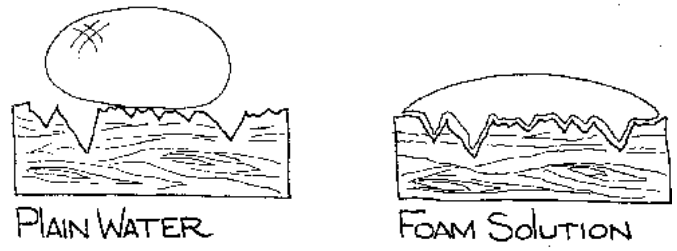
CLASS A FOAM

Definition and Properties

Class A foam is a surfactant added to water to break down and reduce the surface tension of water. Reducing the surface tension of water allows for better penetration into the types of fuels found in a structure fire. These fuels include wood, cloth, paper, rubber, and some plastics that can burn at or below the surface. This is the property that distinguishes Class A from other types of foams that only form a blanket and smother a petroleum or polar base fuel. Class A foams are categorized as a mechanical foam, meaning they require a type of mechanical agitation to produce an effective foam solution.

How Class A Foams Work

Class A foams work by reducing the surface tension of water [,] which in layman's terms, makes the water wetter. Plain water has the tendency to form droplets and bond together due to its surface tension. This in effect reduces water's ability to cover and penetrate a burning fuel. Reducing the surface tension of water allows it to spread out and penetrate burning fuels. It also allows for better heat absorption by increasing the surface area of water. The surfactants found in Class A foams also allow the foam solution to penetrate organic fuels which water can not.



As shown in this exagerated cross-section sketch of water and foam solution droplets, reducing the surface tension of water by adding Class A foam concentrate allows a greater surface area of contact at the foam solution/fuel interface.

Figure 1. Surface tension of plain water verses Class A foam solution.

Source: Colletti, D. (1998). Class A foam – Best practice for Structure Firefighters. Royersford: Lyon's Publishing.

COMPRESSED AIR FOAM SYSTEM (CAFS)

Components of a CAFS

Although a CAFS can be modified into different configurations and unit designs, all must have five basic components. The components essential to CAFS operation are:

- A water source through the pump
- A water pump
- A foam solution proportioning system
- An air compressor
- Ancillary pressure controls

The difference between a CAFS and all other foam systems is a high capacity air compressor that injects air into the foam solution within the fire pump discharge piping.

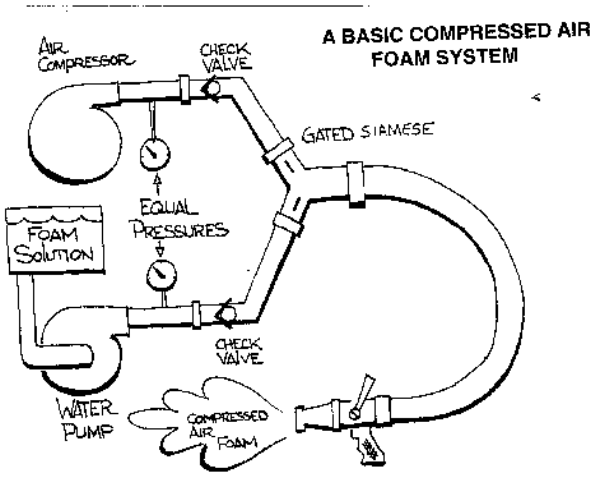


Figure 2. Components of a Compressed Air Foam System.
Source: Colletti, D. (1998). Class A foam – Best practice for Structure Firefighters. Royersford: Lyon's Publishing.

Advantages of a CAFS

CAFS have proven to provide many advantages to the fire service. Research of test data indicates the CAFS is superior to either plain water or Class A foam solutions for interior or exterior structural fire attacks. Some or the advantages are:

- Firefighter safety
- Much faster fire suppression
- Improved rescue operations
- Reducing the amount of property damage by water
- Preserving evidence of fire cause
- Increased exposure protection
- Reducing the amount of time on the fire scene by fire personnel and equipment

CAFS systems have been documented to be extremely effective in direct fire attack procedures, exposure protection, overhaul, and vegetation pretreatment.

Field Test

Live burn tests were conducted by the Los Angles County Fire Department (LACFD) using identical single family dwellings with the results published in *Fire Chief* magazine. Results of the burn tests conducted by the LACFD proved a Class A foam/water solution will knock down a fire in about half the time as just water. The CAFS **knockdown time** shown in Table 1 was about half that of Class A foam/water making CAFS approximately 4 times more effective than water alone in **knockdown time** (Cavette 2001, p. 3).

Table 1 also illustrates the amount of **water** used in conjunction with CAFS is substantially less than just plain water or Class A foam/water solution. Using the same data from

the LACFD test, the amount of Class A foam/water was about _ **(44 gal)** that of just water **(75gal)** while CAFS used only about _ **(16 gal)** the amount of **water** for complete **knockdown**.

Table 1: LACFD Foam Test Results

	Water	**Class A Solution**	**CAFS**
Foam setting %	N/A	0.5	0.2
Water flow (gpm)	90	90	90
Air flow (cfm)	N/A	N/A	30
Knockdown (sec)	**50**	**25**	**11**
Knockdown water (gal)	**75**	**44**	**16**
Temperature drop to 200^{o} F (min:sec)	6:03	1:45	1:28

Source: Cavette, C. Bubbles Beat Water. Fire Chief. Retrieved November 10, 2003 from the World Wide Web: http://firechief.com/ar/firefighting_bubbles_beat_water/index.htm

The use of CAFS significantly reduces the amount of water used in firefighting. This is based on three primary theories:

- Air injected into the foam/water solution greatly expanding the extinguishing agent
- Large volumes of steam generated by CAFS
- The properties of the foam/water solution in relation to the reduced surface tension and its ability to penetrate burning materials

As Table 2 shows, the heat absorption properties of foam are much greater than water. In the LACFD test ran on an interior burn where the average temperature had reached 600^{0} F, an interior attack with water took 6:03 minutes to drop the room temperature to 200^{0} F. Class A foam/water solution dropped the same temperature in 1:45 minutes and CAFS dropped the same temperature in just 1:28 minutes. Again, CAFS was approximately four (4) times faster and more effective than just water (Cavette 2001, p. 4).

Using CAFS also allows significant features that Class A foam/water solution alone will not allow. By mixing the air/water ratio, a solution can be made wet or dry and used as an exceptional blanket for exposure protection. In the demonstrations that I have observed,

continuous intense flame impingement directly on exterior walls had virtually no damage to the area coated with a dry foam solution.

Increased Safety

CAFS will also allow for a greater standoff distance when needed. The range of the CAFS stream is approximately 33% farther than foam/water solution or just water alone (Colletti 1998, p. 202). This would allow for a safer firefighting distance in certain circumstances when conditions are too dangerous to move in closer. And in some demonstrations, complete knockdown occurred on structures that were heavily involved as the firefighters were advancing from the outside before they even could get up to the building.

The weight of attack lines are considerably less than lines filled with water or Class A foam/water solutions. CAFS lines weigh about half that of conventional attack lines therefore reducing firefighter fatigue, increasing mobility, and reducing the risk of injuries from sprains and strains (Klein 2003, p. 44).

Cost Benefits

The reduced knockdown time of a CAFS also means less time spent on the fire scene. This is extremely cost beneficial to fire departments and the communities in which they serve. Less time on the fire scene results in reduced engine time therefore reducing the wear and tear on fire apparatus, reduced risk to firefighters by reducing time on scene, and allowing fire companies to get back in service much quicker. This would provide our citizens better response times and coverage. CAFS may actually be recognized by Insurance Service Organization (ISO) in the future for credit to those departments utilizing the system. The state of Texas has successfully lobbied ISO to give additional credit to fire departments with apparatus that have CAFS (Riecher 2002, p. 9). This credit could help reduce a community's insurance premiums.

Disadvantages

There are some disadvantages to a CAFS. Although today's Class A foam solutions are completely biodegradable and safe, exposure to large concentrated quantities on a continued basis can cause dry and chapping skin to some personnel. Lack of training may also cause confusion at first until personnel become thoroughly familiar with CAFS applications. The initial cost has also been listed to be a disadvantage to those who could not afford a CAFS. Also, it must be noted that CAFS is not a miracle solution to fire fighting. Sound firefighting principles must be adhered to at all fire scenes, with or without the use of CAFS.

THE FUTURE OF CAFS

Many fire departments believe CAFS will be the standard firefighting tool for the future as fire departments become more educated to its advantages. Some fire departments may look at the initial additional $30,000.00 to $40,000.00 cost of CAFS to fire apparatus and feel those cost are not justified for their department. Other fire departments believe this additional initial cost is minor to the overall advantages CAFS can provide. Tradition is another factor that has hindered the widespread acceptance of CAFS. Fire departments throughout the country notoriously resist change because "that's the way we always done it." However, the Houston, Los Angeles County, and Phoenix Fire Departments use CAFS and require that CAFS be purchased with any new fire trucks. Phoenix Fire Chief Alan Brunacini is on record as saying that any new pumper purchased without CAFS is already obsolete (Riecher 2002, p. 9).

CONCLUSION

There are many deaths and injuries each year as the result of structure fires. These fires also account for hundreds of millions of dollars in property damage. CAFS can help the fire

service better protect the public and reduce property damage. The advantages of CAFS have proven to outweigh any concerns regarding its cost and effectiveness.

As CAFS technology and understanding become more widespread, the fire service's ability to bring structure fires under control will vastly improve. The future will soon find that CAFS in firefighting will be the normal firefighting procedure, rather than the exception.

References

Cavette, C. (2001). Bubbles Beat Water. [27 paragraphs]. Fire Chief. [On-line serial], Retrieved November 10, 2003 from the World Wide Web: http://firechief.com/ar/firefighting_bubbles_beat_water/index.htm

Colletti, D. (1998). Class A Foam – Best Practice for Structure Firefighters. Royersford: Lyon's Publishing.

Klein, R. (2003, October). Foams & Foam Proportioning. Fire & Rescue, 37-44.

Riecher, A. (2002, November/December). CAFS: The New Generation. Industrial Fire World, 5-9.