FOAM: A PRIMER

By Shawn Oke

The wave has crashed back into the shore when it comes to the use of additives in fighting fires. In the fire service today, we are seeing more and more use of making our water more efficient by adding something to it. The current generation of fire service leaders might think the use of something in our water is a new and a great advance in firefighting. This couldn't be further from the truth, as is evident in the dates the National Fire Protection Association (NFPA) committees dealing with foam and wetting agents were formed. NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, is prepared by the Technical Committee on Foam. The first action noted by NFPA related to NFPA 11 was in 1921. NFPA 18, *Standard on Wetting Agents*, is prepared by the Technical Committee on Water Additives for Fire Control and Vapor Mitigation. The original work done through NFPA as it relates to wetting agents began in 1949.

In addition to NFPA 11 and NFPA 18, three other NFPA standards relate to additives; these standards are fairly new in comparison to NFPA 11 and NFPA 18. They are NFPA 18a, *Standard on Water Additives for Fire Control and Vapor Mitigation*; NFPA 1145, *Guide for the Use of Class A Foams in Fire Fighting*; and NFPA 1150, *Standard on Foam Chemicals for Fires in Class A Fuels*, the oldest of these three standards. The first edition of NFPA 1150 was issued in 1989 as NFPA 298, *Standard on Foam Chemicals for Wildland Fire Control*. NFPA 1150 is prepared by the same technical committee that oversees NFPA 18. NFPA 1150 has evolved over the years with changes in technology and as the use of Class A concentrates has shifted from wildland firefighting to more use in structural firefighting. NFPA 1145 is the next oldest standard that addresses additives. It was developed in 1998 as a means to provide a guidance document to help departments embrace the use of Class A foam for structural and wildland firefighting. It is managed by the Technical Committee on Forest and Rural Fire Protection. The newest, NFPA 18a, was developed in 2007. NFPA 18a is under the guidance of the same technical committee as NFPA 18. As you can see, using something in your water isn't new to the fire service.

BASIC TERMS

If concentrates are going to be used, it is important to become educated about what you are using and how you can expect it to perform. You should know the different types of concentrates available to the fire service and how they perform. You should know how to get the necessary information on each concentrate to ensure you are getting the best possible product for the price you are paying. You should know how to determine the cost per gallon of finished foam to ensure you are being wise with your funds. It is also important to have knowledge of how to deliver the concentrate and ensure the extinguishing method being used is the proper method for the concentrate being used.

You need to have a basic understanding of a few terms when talking about foams. You need to understand that the term "foam" is a loose term in the firehouse that generally encompasses all types of concentrates from wetting agents to water additives, Class A concentrates, and Class B concentrates. To the majority of firefighters, foam means bubbles. The firehouse definition of foam does fit closely with the definition found in Merriam-Webster's Dictionary: "a light frothy mass of fine bubbles formed in or on the surface of a liquid or from a liquid." The use of foam in the firehouse can often mean concentrate or finished foam. It should be noted that to have finished foam, you need to have three components mixed together: water, concentrate, and air. When you mix water and concentrate together, you have a foam solution; once air is introduced, you have finished foam.

Concentrates are the buckets or totes of thick gooey stuff that you have on your apparatus or sitting around the firehouse. The majority of firefighters don't know whether they are making foam with a water additive, wetting agent, Class A concentrate, or Class B concentrate. They just know that they are mixing the gooey stuff with water in the proportion recommended by the manufacturer or department policy and it makes bubbles. This generally doesn't present an issue because someone in the department has done the research to ensure all components of the finished foam, including application, work together as intended. The problems occur when someone doesn't do their research or provide the correct information to those who will be making the bubbles.

NEVER MIX CONCENTRATES

If there is only one thing you take away from the information presented here, it should be that you should NEVER mix concentrates. There are concentrates that, when mixed, will create a mess. It is very important if you are in charge of purchasing concentrate for your department that you don't simply go "low bid" on your concentrate purchases. I have seen departments that change concentrates every time they put their concentrate out for bid. That isn't smart purchasing in terms of performance, and it can cause concentrates to be mixed, ending up costing your department a lot of money. The prevention of mixing concentrates has to begin with the person responsible for purchasing. The firefighter in the firehouse isn't going to be the one concerned with mixing different concentrates, especially in the middle of the night when he is refilling the concentrate tank and is ready to get back in bed.

If your department uses Class A and Class B foam tanks on your apparatus, be sure all personnel know which concentrate belongs in which tank. If you have more than one type of concentrate stored in the firehouse, be sure they are not stored together to help avoid accidental mixing of the two. If you have any old concentrates that you no longer use stored in the firehouse, make them hard to access. I assure you that if the old concentrate is the easiest one to access, that is going to be the one the firefighter grabs when he needs more concentrate.

If the time comes that you decide to change concentrates, be sure you flush all components of your delivery system, especially your concentrate tank, until you no longer make bubbles. Spending time flushing your system before you add the new concentrate will save you a lot of

grief and aggravation. I assure you that you do not want the hassle or cost of mixing two concentrates that don't get along well with each other. The end result of mixing concentrates is very expensive and time consuming to fix.

WHICH FOAM FOR WHICH JOB

One of the first questions asked when beginning the conversation about foam, especially for Class A fires, is why they should be used. In our world today, we have more synthetic fuels than ever. As the research has clearly shown, our fires today are different than they were 40 years ago. To help combat those fires, our water needs help. That help can be found in a proven concentrate. The addition of a concentrate to your water will enhance it and allow it to work more efficiently. It is like adding an octane booster to your fuel. The addition of a concentrate allows the water to be absorbed easier into the fuels it contacts. A lot of the fuels found in houses today are treated to repel water so they are protected when your favorite beverage is spilled. This protection is great for something that is spilled but not so great when water from an attack line hits it. The addition of a proven concentrate allows the fuel to grab and hold the water. When the fuel holds the water, it is harder to burn. When heat is applied to the wet fuel, the water is there and able to absorb the heat energy rather than the fuel absorbing the energy. If the water absorbs the energy, it prevents the fuel from reaching its ignition temperature and burning.

The addition of a concentrate allows bubbles to be made. You might not think much about those bubbles, but it is important to realize that when you see a bubble you see water. When you flow untreated water, especially during overhaul, you aren't always able to see where that water goes. When you add a concentrate to your water and create bubbles, you are now able to see the water in the form of bubbles. The bubbles are like tracer bullets. The bubbles also allow your water to remain in place and not flow away like plain water. The greater density created by the bubbles allows the same amount of water to occupy a greater amount of surface area. This is important because the water does the work!

An easy way to demonstrate the difference concentrates is to do a few simple experiments. To do these experiments, you will need two empty drink bottles, some foam solution mixed with the proper percentage of concentrate, some water, and two pieces of identical fuel (such as boards). Put four tablespoons of the foam solution into a bottle, shake it up, and create finished foam. Take the same amount of plain water and place it in the other bottle and shake it up. Observe how much more area inside the bottle is taken up with the foam compared with the plain water. Remember, the same amount of water is in each bottle. Once you have noticed the difference in the surface area taken up by adding the foam concentrate, you are ready for the next experiment.

Shake the two bottles you have mixed up once again. Once you have finished shaking the bottles, remove the caps and pour the contents of each bottle onto separate pieces of fuel. When pouring the solutions onto the fuel, move the bottles around to spread the solutions onto the fuel. Take time to watch the behavior of the foam solution compared to the plain water. You should notice the foam solution staying in contact with the fuel more than the plain water. If you have a

thermal imaging camera, look at the fuels and observe the differences related to the surface area covered. It is important to remember that you are using the same amount of water in each test.

These experiments should clearly demonstrate that adding a proven concentrate to your water will allow more surface area of the fuel to be covered with water. It will also demonstrate how much more water will be absorbed by the fuel using treated water rather than plain water.

Early in your journey into the world of using foam, you need to research the types of fires you will be using your concentrate on. This is an important step to ensure the concentrate you are using will work on the types of fires you will encounter. If you are in an area surrounded by wildland, you want to focus on a concentrate that performs well on Class A fires. If you protect a large amount of hydrocarbons that are generally found contained such as tank farms, you want to focus on a concentrate that performs well on contained hydrocarbon fires such as an aqueous film forming foams (AFFF). If you are like many departments, you will have a mix of fuels, so trying to find a happy medium would be your best option. The great thing about the concentrate world today is that there are a large number of options available to fit the needs of most departments. I can't stress enough the importance of making sure your concentrate meets the needs of the types of fires it will be used with.

It is important that concentrates only be used on the class of fire they are designed to be used on. This is the reason it is so important to determine the fuels you will be using your concentrate on. All bubbles are not created equal and shouldn't be treated as such. When using any type of concentrate, you should know what concentrate you are using and how it should be applied. You don't want to use the same application method with an AFFF as you would an NFPA 18-compliant concentrate. You don't want to use AFFF for Class A fires, as the active ingredients in AFFF won't provide the same level of performance as a product designed for Class A fires. While many concentrates will work on fires outside their intended use, that isn't what they are designed for; therefore, serious consideration should be given before using them outside of their intended use. You should remember that not every bubble is created equal! Stating that all foam is created equal is like saying a car is a car.

The types of concentrate available to the fire service can be very overwhelming, to the point it is hard to find a place to begin talking about them. A good place to start is to look at the NFPA definitions of the different types of concentrates that fall under their standards. The NFPA standards already mentioned that each has a different type of concentrate that falls under its responsibility.

NFPA 11 addresses concentrates that generally fall under what most firefighters consider as "foam." NFPA 11 defines nine different types of foam concentrates. The most popular concentrates defined and generally the most commonly found foam concentrates are AFFF and alcohol-resistant aqueous film forming foam (AR-AFFF). These concentrates are designed to be used on hydrocarbon fires, with the AR-AFFF being used on water-soluble fuels. These concentrates work by forming a film that suppresses the fuel vapors and prevents them from burning. These concentrates are generally used at 1%, 3%, or 6% solution. When you talk with the foam purists, the NFPA 11 concentrates are generally referring to the foam that should be

used on Class B fires. It should be noted that NFPA 11, Annex A, Section A.1.1 states that "foam is not suitable for three-dimensional flowing liquid fires or for gas fires." For these types of concentrates to effectively perform, they must be able to form a blanket over the fuel; this is often not possible with flammable liquid fires that aren't confined.

NFPA 18 doesn't address firefighting foams but rather wetting agents. According to NFPA 18, Section 3.3.8, a wetting agent is "a concentrate that when added to water reduces the surface tension and increases its ability to penetrate and spread." In reviewing the definitions within NFPA 18, the word "foam" isn't even addressed. This is confusing for me as a firefighter, because a product meeting NFPA 18 is referred to as a wetting agent and not a foam, even though the NFPA 18 concentrate meets the definition of foam according to NFPA 11.

NFPA 18a creates even more confusion when trying to figure out what is foam and what isn't foam. Again, NFPA 18a doesn't address the word "foam" in its definitions. NFPA 18a addresses water additives, which have a different definition than wetting agents. NFPA 18a, Section 3.3.29 defines a water additive as "an agent that, when added to water in proper quantities, suppresses, cools, mitigates fire and/or vapors, and/or provides insulating properties for fuels exposed to radiant heat or direct flame impingement."

NFPA 1150 does address foam. According to NFPA 1150, Section 3.3.10, foam is defined as "aggregation of bubbles lighter than water created by forcing or entraining air into a foam solution by means of suitably designed equipment or by cascading it through the air." As you can see, two NFPA standards use two definitions for the same word. This is one reason the fire service is confused about foam. Since this standard is primarily for Class A, foam it is important to note the definition of Class A foam can be found in Section 3.3.3. Class A foam is defined in the standard as "foam for use on fires in Class A fires."

CONSIDER PERFORMANCE

In your decision-making process to determine what concentrate you will use, it is vital that you take the performance of the concentrate into consideration. Using the NFPA standards to determine how the concentrate is tested will help you determine if you are choosing the best concentrate for your department. Prior to making any concentrate purchase, you should consult the standard the concentrate you are considering meets. NFPA 18 and NFPA 18a have performance testing for Class A and Class B fires. NFPA 1150 has provisions for exposure protection for Class A concentrates. NFPA 11 conducts testing to determine how well the concentrate will perform extinguishing Class B fires. The testing varies greatly from standard to standard to the point that you should examine the standard the concentrate you are using meets so you know the performance testing it was subjected to. I highly recommend you obtain the testing data from the manufacturer for any concentrate that states it is certified or classified as meeting a standard. You have a right to know how the concentrate you are using performs under the conditions in the standard. If a manufacturer will not provide you with copies of independent testing, which clearly shows how the concentrate performed, you should be concerned about that concentrate.

It is very important to note that simply meeting an NFPA standard doesn't give a true picture of how the concentrate performed. An example of how important reviewing the data is can be found using the Class B extinguishment test in Chapter 7 of NFPA 18. As you will see when you review the standard, there are various time benchmarks that need to be met to meet the standard. This chapter outlines the requirements for the Class B Fire Extinguishment Test. Section 7.3(6) states that "the fire shall be extinguished within 5 minutes of the start of application of the wetting agent solution." When you see an NFPA 18-compliant concentrate, all you know regarding Chapter 7 is that the concentrate put the fire out in 5 minutes or less. If you request and review the independent testing data as it relates to the concentrate passing this test, you will be able to determine exactly how long it took to extinguish the fire in Chapter 7.

Let's looks at an example of how important knowing exactly how a concentrate performed can be. Let's say that Concentrate A took one minute to extinguish the test in Chapter 7 and Concentrate B took four minutes to extinguish the same test. According to the standard, both concentrates meet the standard. In the field, if you are using Concentrate B to extinguish a Class B fire, you can expect to use three times more concentrate to extinguish the same fire Concentrate A extinguished. This difference doesn't only affect the amount of concentrate and water needed; it also affects the cost of extinguishing the same fire because you are going to have to use three times more concentrate to do the same job. If you don't take the time to obtain and review the data as it relates to the standard, you would never know there was such a performance difference in concentrates.

To gain as much knowledge as possible about your concentrate, consult the annex portion of the NFPA standard that applies to your concentrate. The annexes of each standard provide a good resource for more in-depth information related to the concentrate type. This area provides in-depth explanations to the concentrates addressed in the standard and many times offers comparison differences in the types of concentrates available for use in the fire service. These sections of the standards contain valuable information to use in your foam concentrate decision-making process.

THE COST DEBATE

We all know that money drives our world, and the use of concentrates is not immune to the cost debate. The cost debate really surfaces when considering using foam for Class A fires. I am told on a regular basis that water is free, so why should a department pay for foam? If you are using municipal water, you should know that it isn't free. There is a cost to produce every gallon of water that flows through your hydrant. If you think water is free, give someone a call in your water department and ask if the water is free.

I hear many agencies say they can't afford to use concentrates on their fires. I challenge them and say they can't afford not to use them. When you enhance your water and make it more efficient, you are able to extinguish your fires faster. The ability to extinguish a fire faster means less exposure and risk for the firefighters. In our fire service today, we are trying to reduce the risk of cancer through less exposure to the nasty stuff we find in fires. Using a proven

concentrate clearly reduces this risk to our personnel, as we spend much less time being exposed. Reducing the extinguishment time also reduces our risk of injury. Using a proven concentrate means less wear and tear on the apparatus and equipment as well as less fuel used for the apparatus to extinguish the fire. The cost savings experienced using a proven concentrate are often indirect cost savings, but the savings are there.

When determining the cost for the concentrate to be used, be sure you always look at the cost for the finished foam. Be careful not to get swept into the cost of the concentrate. Let's look at an example of how only looking at the concentrate cost can end up costing you money. We have two concentrates we are considering: Concentrate A is used at 1% and costs $30 a gallon, while Concentrate B is used at 3% and costs $12 a gallon. On the surface, looking at these two products Concentrate B looks like the better deal because it is $18 a gallon cheaper than Concentrate A. When you look at the cost to produced finished foam, however, you will see that Concentrate A is actually the more economical purchase.

To illustrate this, let's create 1,000 gallons of finished foam. Using Concentrate A, we will need 10 gallons of foam concentrate to make our 1,000 gallons of finished foam. Our cost is $30 a gallon, so the total concentrate cost to produce 1,000 gallons of finished foam using Concentrate A is $300. Let's use Concentrate B to create the same 1,000 gallons of finished foam. To create our 1,000 gallons of finished foam with Concentrate B, we need 30 gallons of concentrate at a cost of $12 a gallon. Our cost is $12 a gallon, so the total concentrate cost to produce 1,000 gallons of finished foam using Concentrate A is $360. When you calculate out the per gallon cost for the finished foam, you see that Concentrate A is actually the better purchase because its per gallon of finished foam is $.30 a gallon compared to $.36 a gallon for Concentrate B. Be sure when making your purchasing decisions that you always look at the finished foam cost and not the cost of the concentrate.

ENVIRONMENTAL IMPACT

An area of great concern with regard to concentrates is their environmental impact. If you have spent any time reading current fire service news, you have probably seen information related to perfluorinated compounds (PFCs) such as perfluoro-octanoic acid (PFOA) and perfluoro-octane sulfonate (PFOS) mentioned in relation to foam. These compounds have been linked to cancer and were readily found in Class B foam concentrates in the past. PFCs and foam are going to continue to be a hot issue as more is learned about the effects on firefighters' and the public's health from these chemicals. To become as educated as possible about the health effects of a concentrate, consult the manufacturers safety data sheet. Also review the NFPA standard relating to the concentrate to determine what environmental testing takes place in relation to the standard. The standards mentioned above vary greatly with regard to the toxicity testing they conduct. When considering a concentrate, request that the manufacturer provide data related to the environmental effects of the product. The environmental effects of a concentrate vary greatly from manufacturer to manufacturer, and you have a responsibility to determine those effects before using the product.

DELIVERY SYSTEMS

Delivery systems are the means used to get the water and concentrate together to begin the process of making foam. The majority of the delivery systems in use by the fire service can be broken into two categories, fixed and portable. The fixed systems are found mounted on apparatus and are generally either injection, eduction, or compressed air foam (CAFS). The portable delivery systems are nearly always eduction systems. How you get your concentrate mixed with water is as important as the concentrate you are using. There are several factors to consider when determining which delivery system to use, which will be discussed later.

I would first suggest you determine how often you plan to deliver foam solution. If you are a department that doesn't plan to use foam on many of your fires, then investing in an expensive injection or CAFS system wouldn't be a wise decision. If you are going to use foam on the majority of your fires, then spending the money to put a fixed delivery system on your apparatus would be a wise purchasing decision. If you are going to be using your delivery system on a regular basis, make sure the system you select is easy to use. If you put a fixed delivery system on your apparatus that requires a lot of effort on the part of the operator, you are going to lessen the chance the system will be used, especially on the initial attack. We all know the pump operator has a very hectic and stressful job in the initial stages of a fire attack. If the delivery system installed requires that operator to use a lot of time to ensure intake and discharge pressures are certain pounds per square inch, then the operator is going to be much more reluctant to use the delivery system.

You will need to know what concentrate you will be using with your delivery system so you can ensure the delivery system will work with the concentrate. There are two important variables here; delivery percentage and viscosity. You need to know the percentage the concentrate needs to be delivered and the viscosity of the concentrate. All delivery systems have a minimum and maximum amount of concentrate they will deliver. You want to be sure the system you use works within the range of your concentrate. The last thing you want to do is purchase an on-board delivery system that only delivers concentrate from 0.10% to 1% and the only concentrate you have is 3% to 6% concentrate. The delivery system isn't going to be able to deliver sufficient concentrate to the pump to make the proper foam solution.

You will need to know the viscosity of the concentrate you will be using. The viscosity of the concentrate is the thickness of the concentrate in relation to water. The higher the viscosity, the thicker the concentrate. Viscosity is relative to the temperature of the concentrate. The lower the temperature of the concentrate, the higher the viscosity. This is very important is some areas of the world, where the temperature is cold and stays cold. Is it also important in areas where the temperature is warm, as there are many concentrates that have a high viscosity, even at warm temperatures. There are many delivery systems available that will not work with many of the higher viscosity concentrates. Prior to purchasing any delivery system, ensure it will deliver the concentrate being used at the proper percentage and be able to handle the maximum expected viscosity of the concentrate. The easier the delivery system is to operate, the more likely the system is to be used. We all know that easier is better!

DO YOUR RESEARCH

The decision to take this step is one that every fire department should be considering, but they should move slow and take the time to do their research and become educated. The last thing you want is a salesperson guiding your purchasing decisions. I personally have fallen victim to not being educated and letting a salesperson guide my purchasing decision. That situation happened before I became educated about concentrates and delivery systems. Unfortunately, that happened more than 13 years ago with an apparatus we purchased, and we continue to have to work around the bad advice given by a salesperson.

The process of moving into the everyday use of foam concentrates is a slow one and can often take years to complete. The important thing is you are taking the first step: reading this information and becoming educated. As you move forward with embracing the enhancement of your water, gather as much information as you possibly can, and become as foam smart as possible. An educated foam user is a successful foam user!

BIO:

SHAWN OKE has been a member of the Albemarle (NC) Fire Department for 29 years and chief for the past eight years. He has a bachelor's degree in fire engineering technology from the University of North Carolina-Charlotte; is a graduate of the National Fire Academy Executive Fire Officer Program; and is an at-large board member of the International Association of Fire Chief's Safety, Health and Survival Section. He cofounded the Kill the Flashover project. He specializes in wetting agent use and research.