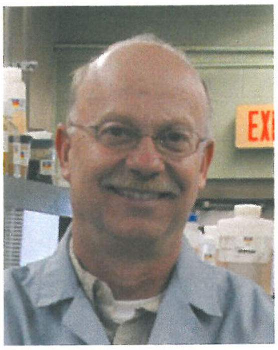
The Fluorinated versus Non-fluorinated Foam Debate



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Over the past several years a debate has raged over the use of fluorinated versus non-fluorinated foam. Much of the debate has centered on the environmental acceptability of fluorine- foams and their long-term viability in the market.

During this time, much confusion and misinformation was spread about the type of fluorine that is being used, and the environmental fate of the fluorine that is being used. At present, the C6 fluorotelomers that are being used have gone through a whole host of testing to determine the ultimate fate and risk in the environment. This data has been presented at a number of conferences and in a number of scientific journals, and by now should be sufficient to allow environmental and toxicological professionals to come to independent conclusions relative to the acceptability or non-acceptability of the risk associated with the use of fluorine-containing foams. Certainly, the risk profile for fluorine-containing foam appears to be quite acceptable by most measures being employed today.

Also missing in the debate is one of the properties that makes fluorine-containing foams so effective. One often sees articles and hears about the film forming capability of fluorine- containing foams such as AFFF and FFFP and how the ability to form a film makes this type of foam so effective. And, indeed, this is a major advantage that fluorine-containing foams exhibit. What is missing however is the second important property that the use of fluorochemicals brings to fire-fighting foam. That property is the ability to shed fuel as the foam is applied to the surface of a burning hydrocarbon fire. This ability to shed fuel or resist fuel contamination of the foam blanket is called oleophobicity (Quite literally "oil fearing or oil hating").

Perhaps the best way to describe oleophobicity is to look at what would happen if we were to place a single bubble of a fluorine-containing foam versus a single bubble of fluorine-free foam on the surface of a hydrocarbon fuel such as kerosene or petrol.

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What seems to be lacking in the debate so far is the relative effectiveness of fluorine-containing foams versus fluorine-free foams and what must be taken into account when choosing to use one over the other.

Fluorine-containing foams have a long history of successful extinguishments of major fires throughout the world. As such, it is relatively easy for a trained professional to make an informed decision regarding the use of fluorine-containing foams. The decision is not so easy for fluorine-free foams. Most of the data that supports the use of fluorine-free foams has been based on performance fire testing using small scale fires. The problem with using only this type of information to decide on which type of foam to use is that the fire tests are carried out under controlled conditions and using foam qualities that are difficult to obtain with conventional air aspirating foam hardware such as branch pipes or foam pourers.

The fluorine-containing foam bubble will try to repel any of the hydrocarbon fuel because of its oleophobic nature. The fluorine-free foam on the other hand uses detergent-type surfactants that actually attract the hydrocarbon fuel. They are called oleophillic (Quite literally "oil loving"). A single bubble of a detergent-based foam will act much like the wick on a kerosene lamp. Before long it will actually be flammable as the hydrocarbon fuel wicks up along its surface. In fact, the reason that detergents are used in cleaning applications in the first place is their ability to emulsify grease and oils and free them from the surface of whatever is being cleaned; be it your automobile, your clothes or your dinner dishes.

So, how do fluorine-free foams work to

control or extinguish a fire? Quite simply, they rely on a very stable foam blanket to be placed on the surface of the burning fuel. At the immediate interface between the foam blanket and the surface of fuel there is a layer of contaminated foam bubbles that will readily burn. However, a good fluorine-free foam will have a layer of uncontaminated and very slow draining foam to cap over the contaminated foam and so prevent that contaminated layer from burning. This is essentially the same way in which regular protein foam has worked for years.

The key here is to produce a very good quality foam and to apply it as gently as possible so as to minimise the amount of contaminated foam. This makes fluorine-free foams very effective on small to medium sized fires and especially spill type fires rather than fuel in depth fires. The firefighter, since he needs good quality foam, must use air aspirating branch pipes or nozzles or other discharge devices.

The use of air aspirating discharge devices of course means that the range of that device is limited by its flow rate and operating pressure. This is in contrast to a fluorine-containing foam that may be applied through non-air aspirating discharge devices. In fact, much of the foam application for fluorine-containing foam is through non-aspirated variable pattern water nozzles. The use of this type of nozzle provides maximum range as all the energy of the system goes into range rather than stealing some of the energy to aspirate the foam. It is a general rule of thumb that, with air aspirated discharge devices, as the foam quality goes up the range of the device goes down.

The fact that fluorine-free foam requires good foam quality and so requires an air aspirated discharge device brings with it some logistical fire ground considerations that must be evaluated.

First and foremost, the firefighter will be required to get closer to the fire. Obviously, the further away a firefighter can get from the blaze the better off he or she will be. In contrast, when using a fluorine-containing foam, not having to use an air aspirating branch pipe or nozzle will allow the firefighter to use a conventional variable pattern water nozzle. The use of this type of nozzle brings with it the ability to go to a fog pattern. If there is a thermal event, a firefighter using fluorine-containing foam can always go quickly to a fog pattern and back away from the fire. This would not be possible for a firefighter using an air aspirated branch pipe or nozzle.

Fluorine-free foams must be applied as gently as possible in order to avoid contamination of the foam blanket. As the flow rate of the discharge device increases so does the impact velocity of the discharge stream. When one gets up into high flow discharge devices, the impact velocity of the stream onto the fuel surface can get extremely high. For spill fires this is not too big an issue but for fuel in depth fires, such as might be encountered in a fuel storage tank or a bunded area, the submergence of the foam stream beneath the fuel surface can result in a large amount of foam that becomes contaminated with the fuel.

Remember, fluorine-free foams are not oleophobic. This can make extinguishment very difficult if not impossible under these conditions. Certainly the time that foam would have to be applied would be expected to increase significantly under these conditions. This means more foam concentrate would have to be positioned and used at the fire and the water supply must be sufficient to account for longer discharge times. Application rates may also need to be higher with fluorine-free foam as compared to fluorine-containing foam but this would have to be determined as part of a large fire pre-plan.

Another logistical issue associated with using fluorine-free foam on large fuel in-depth fires would be the amount of concentrate that would be required on the fire field. The fact that application rates may need to be higher and discharge times may need to be longer were already discussed above. These mean both larger quantities of foam concentrate would need to be brought to the fire and must be staged near the proportioning equipment. The other consideration for supplying foam concentrate to the fire scene is the mix ratio or proportioning ratio of the foam concentrate.

Fluorine-containing foams are available for proportioning at 1 percent and have been successfully used at this proportioning ratio on large fires. Fluorine-free foam is not available as a 1 percent concentrate; it is available as a 3 percent concentrate.

Fluorine-containing foams are available for proportioning at 1 percent and have been successfully used at this proportioning ratio on large fires. Fluorine-free foam is not available as a 1 percent concentrate; it is available as a 3 percent concentrate. However, this fact alone means that at least three times as much concentrate will have to be moved to the fire scene and staged near the proportioning equipment and in reality, probably more to account for higher application rates and extended discharge times.

In the final analysis, either fluorine-containing or fluorine-free foam can be used successfully on flammable liquid fires. The firefighter must, however, be aware of the logistical and safety issues that come with the use of fluorine-free foam.

For small to medium size spill fires either type of foam concentrate can be deployed successfully with about the same outcome. But, as the fire size increases and the depth of the fuel increases, more attention must be paid to overcoming the logistical and safety issues surrounding the use of fluorine-free foam on this type of fire. And, as with all firefighting, success or failure depends on the knowledge, skill and training of the firefighter. APF

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