A joint exercise between Hampshire Fire FRS (UK) and the Esso Fawley Refinery using high volume pumps.

A future for AFFF foam?

Tom Cortina, spokesperson for the US-based Fire Fighting Foam Coalition expresses the organisation's views on the effectiveness of AFFF for class B fires.

As with all foams, the primary consideration is performance on the particular fuel on which the foam will be employed. Alcohol Resistant (AR) foams that employ foam stabilizers in addition to the conventional polymers typically have higher performance levels. One should look for foam concentrates that have the lowest approved application rate on the fire. Application rates are typically published as l/min/sq. meter or gals/min/sq foot. In addition to performance on fires, the viscosity of the foam concentrate can come into play from a logistics standpoint. Generally, lower viscosity foam concentrates are easier to handle and proportion than are higher viscosity products. And, as ambient temperature decreases, the ability to proportion the foam concentrate accurately may become an issue. The end user should ensure that the foam concentrate they choose is functional with the proportioning equipment they intend to use it with and at the minimum temperature at which they anticipate using the concentrate. One other key issue that must be remembered is that all of the current alcohol resistant (AR) foam concentrates currently on the market must be applied gently on polar fuels. (This is often referred to as a Type II application.) This means that the foam cannot be directly plunged into the burning fuel. Instead, it must be directed at a horizontal surface and allowed to flow onto the burning fuel surface.

The US Environmental Protection Agency (EPA) has instituted a global stewardship program where fluorochemical manufacturers have voluntarily agreed to reduce 95% by year-end 2010 (and work to eliminate by year-end 2015) emissions of PFOA (perfluorooctanoic acid), PFOA precursors, and higher homologue chemicals. As a result, telomer-based fluorochemicals that are used in firefighting foams after 2015 are not expected to contain eight (C8) and longer perfluorinated carbon chains, in order to comply with the EPA program. This will require some reformulation and likely some type of re-approval of many current foam products between 2010 and 2015. The manufacture and import of PFOS-based foams is banned in several countries and regions, including the European Union, Canada, and the United States. Existing stocks of PFOS-based foams must be removed from service by 2011 in the European Union and by 2014 in Canada. It is FFFC's understanding that PFOS-based foams are still being manufactured in China. One of the reasons for the continued production may be the misconception that PFOS-based AFFF agents are more effective than telomer-based AFFF agents. This is simply not true. AFFF agents are equally effective whether they contain PFOS-based fluorosurfactants or telomer-based fluorosurfactants.

The main market driver for the use of aqueous film-forming foams (AFFF) in general is that they are the most effective agents currently available to fight Class B flammable liquid fires at airports and in military, industrial, and municipal settings. This fact has been consistently proven in fire tests conducted over the past 30 years and in tests being performed today. The fluorosurfactants are key ingredients that provide the required low surface tension and positive spreading coefficient that enables the formation of an aqueous film on top of lighter fuels. It is this film formation capability that gives fluorosurfactant-containing foams their effectiveness against flammable liquid fires. AFFF agents provide rapid extinguishment, burn-back resistance, and protection against vapour release. Obviously, if there is a polar solvent hazard, an AR-type foam must be employed. The use of gasoline/ethanol blends such as gasohol (nominal 10% ethanol and 90% gasoline or petrol) and E-85 (nominal 85% ethanol and 15% gasoline or petrol) has increased the potential for large flammable liquid pool or tank fires occurring with these types of products. Beyond their use for polar solvent fires, AR type foams have been used very successfully on large tank fires. Their choice in this situation is based upon the stable, slower draining foams that can be produced from these types of concentrates.

Some fluorine-free foams can provide an alternative to AFFF in some applications, but they are not currently able to provide the same level of fire suppression capability, flexibility, scope of usage, and independent validation. A recent paper from the University of Newcastle shows that even the best available fluorine-free foam would need to be replenished three times as often as AFFF to provide the same level of fire protection. Fluorine-free foams are often championed as "environmentally-friendly" alternatives to AFFF. Although such foams may not contain fluorine, their environmental profile related to biodegradation, acute toxicity, chemical oxygen demand (COD), and biochemical oxygen demand (BOD) is typically no better than fluorine-containing products, and in many cases is not as environmentally responsible in use as AFFF.

A recent study of commercially available firefighting foam agents indicates that fluorine-free foams are at least an order of magnitude higher in aquatic toxicity than AFFF agents. The two resulting reports are:

- *AFC-3A 3% AFFF, Arctic Foam RF3, Aer-o-Water 3EM, F500,* *3M RF3 and platinum 3x3 AR AFFF, Acute Effects on the Fathead Minnow, Pimephales Promelas*

• *Toxicity Test Results of Six Firefighting Foams using Fingerling Rainbow Trout.*

To receive the full reports, email: cortina@alcalde-fay.com

Dynax and alcohol-resistant technology

Chang Jho from the New York-headquartered Dynax Corporation explains the benefits of polysaccharide gum-based technology.

Currently, alcohol-resistant firefighting foam agents are generally formulated with a hydrophilic biopolymer, such as polysaccharides. This technology originally jointly developed by National Foam and CP Kelco Corporation in the US in the early 1970s has since been widely used and become the method of choice for formulating alcohol-resistant foam agents.

The polysaccharide is the key component that makes the alcohol-resistant foam what it is. On fires involving water-miscible, polar fuels, the polysaccharide precipitates out of the foam blanket forming a membrane at the foam- fuel interface. This membrane acts as a barrier protecting the rest of the foam blanket from coming in contact with the fuel layer below it. Without this protective membrane, the foam blanket is readily destroyed by the polar fuel.

One of the major problems with the polysaccharide-based AR-AFFFs has been that the polysaccharide gum swells and builds high viscosity. Early versions of AR-AFFF's, therefore, suffered from very high viscosity which in turn limited some proportioning methods; that is until fluorochemical-based "foam stabilizers" were developed.

In the early 1990s, Ciba-Geigy developed a water-soluble polymeric fluorochemical and Dynax has further improved the chemistry of this new class of additives, and termed them "foam stabilisers" which drastically reduced the need of polysaccharide gums in AR products.

This new technology is based on the fact that these fluorochemical foam stabilizers are water soluble, but inherently repellent to polar solvents such as acetone and alcohol. This solvophobicity and synergistic effect with the polysaccharide gum is what made possible the development of highly concentrated AR-AFFF agents such as low viscosity 3x3 in the early 1990s. The use of fluorochemical foam stabilisers has led to the steady reduction and elimination of polysaccharide gums in the formulation of even higher concentrated alcohol resistant products such as 1x1 AR-AFFF without the problems associated with the use of polysaccharides.

Fawley Refinery is the largest refinery in the UK, covering some five square miles and supplying 15% of the UK's oil products. Refining activity on the site dates back to 1921.