Foams for today and tomorrow

What type of firefighting foam concentrate will you be using in ten years' time? George Potter reports from a three-day international foam workshop held in Centro Jovellanos, Spain.

During the last ten to 15 years, foams used for firefighting have undergone extreme scrutiny as a result of numerous conflicts with environmental conditions. These conflicts have led to the withdrawal of several products from use by fire and emergency response organisations around the world and the suspension and even cessation of the manufacture and distribution of some of these foams. A case in point was the discontinuation by 3M of the manufacture and sale of their Light Water AFFF foams several years ago.

The principal environmental concerns are directly related to water and soil contamination as results of firefighting operations, mainly involving petroleum-related fires, and even training exercises performed by industrial firefighters and public services fire brigades. Even testing operations performed on fire protection installations have come under criticism in recent years.

The principal effects of these conflicts have been the prohibition of the incorporation of determined substances into the chemical structure of foam concentrates. The principal substance in question is PFOS (perflourooctyl sulphonate), and while PFOA (perflourooctanoic acid) is not yet restricted, it is being seriously investigated. Other ingredients under close scrutiny are the organohalogen components used in AFFF agents. The outcome of these restrictions has led a number of firefighting foam manufacturers to research into viable and reliable substitutes.

One of the major handicaps facing producers and end users is the vast array of regulations and standards applied to the performance characteristics of foams. Europe has in place several EN standards regarding the physical properties of the various foam concentrates available and includes conformity testing procedures and protocols. The US has its own standards – NFPA, UL and FM amongst others, which

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Initial application of low-expansion foam onto the 3,500-litre diesel fuel fire, 225m² with a large obstacle. One line applies flourine-free foam and another AFFF-AR foam. Complete extinction is achieved in approximately two minutes.

stipulate characteristics and test procedures. There are also the MIL Specs, originally US military services specifications, but now used in a number of other nations as basic specifications for their own armed forces. Then there is the ICAO, the governing body of international civil aviation, which has its own particular standards for foam performance characteristics for aircraft firefighting operations. Many countries do not have their own specific regulation in place but have adopted and or adapted some of the existing European or US regulations.

These and other considerations led to the development and celebration of the recent workshop held in Spain titled: *What type of firefighting foam concentrate will you be using in ten years time?*

The workshop

The three-day workshop was organised jointly by Auxquimia[1] (ICL PP) and the Jovellanos Fire Training Centre[2], located near the city of Gijón, with active backing and participation by LASTFIRE[3] and JOIFF[4]. These entities are well respected in their fields and spheres of influence, and each one's activities are related directly with those of the others in the development of the event. The workshop was held in the Jovellanos facilities, the presentations in the centre's assembly hall and live fire foam demonstrations in two of the several large-scale industrial fire scenarios, including a 225m² diked horizontal storage tank.

The primary objectives of the workshop were:

- To achieve a standard of expertise along the supply chain of foam concentrate acquisition
- Upgrade knowledge to create an accurate specification guideline
- Improve the ability to properly understand quality reports
- Foment better understanding on key issues of design criteria
- Upgrade knowledge and understanding of the risks involved in flammable and combustible liquid and gas storage.

Day one

The first presentation was made by Stefano Rotti, responsible for safety and the fire brigade at the Milazzo Refinery in Italy. In his talk he described the complications encountered during the operations to contain, control and extinguish a major storage tank fire in 2014, in which he was the Incident Commander. The early morning fire began with the ignition of a floating roof tank with between 40,000 and 50,000m³ of oil, caused by the collapse of the floating roof. During the fire, they were able to remove several thousand tonnes of product from the tank. The refinery's emergency response brigade was mobilised, including off-duty personnel, who battled the blaze for a week before confirming total extinction. Due to the fact that the refinery is located on the island of Sicily, he could not depend on assistance from off-site fire and emergency services, whose resources are limited.

The following presentation was by Dr Niall Ramsden, key speaker and coordinator of the LASTFIRE Group, with five assembly hall presentations as well as supervising the practical exercises which included a 225m² bund fire. Ramsden's first message gave a brief overview of the history of foam and foam concentrates, from the early protein foams through to AFFF-AR low viscosity (Newtonian) and fluorine-free, alcohol-resistant formulations. He described their characteristics and how they worked on different fires. He also discussed the new environmental considerations that are affecting foam researchers and manufacturers.

Following Ramsden was Javier Castro, general manager of Auxquimia, who discussed foam-related terminology and foam properties. Summarising, he described the abundant technical and common terminology used to define foam concentrates and the physical characteristics of modern foams. His presentation covered the fundamental aspects of evaluating different foam concentrates depending on the specific risks that must be protected.

Ramsden came on again with a very important presentation, *A sales demonstration is not a test.* Quite often, salespersons from different manufacturers will set up flashy demonstrations that can look outstanding but will have very little in common with reality. Ramsden described the major differences between typical test pans and the LASTFIRE test pan; similar diameters but significantly different in the properties of the steel used for each and, above all, the wall heights. The pans conforming to EN standards are 15cm high while the LASTFIRE pans are 50cm high, causing the test fires to retain much more heat around the borders of the fires. This makes the extinction much more demanding in regards to foam properties and the methods of application. Ramsden discussed the myriad conflicting standards that applied to

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Top: the fire is in a standard test pan. The black, higher-walled pan in the background is the LASTFIRE test pan. Bottom: when the test is carried out using the LASTFIRE pan, the fire's characteristics are notably different. More heat is concentrated along the wall and the two baffles simulate possible obstacles that could be present in a real fire.

foam specifications and testing around the world.

Following Ramsden was Antonio Acuña, business consultant and member of the European Standard Committee, who discussed the problems that can arise when matching foams to extinguishing systems. Acuña's presentation centred on the effective design of extinguishing systems to assure that foam concentrates perform effectively. He also emphasised the variety of standards and specifications applied to foam.

After Acuña's presentation, the group of 50+ delegates walked to the live fire training installations where Ramsden, assisted by several of the site's instructors and technicians from Auxquimia, demonstrated the diversity of foam application branch pipes – aspirated and non-aspirated for low-expansion foams, medium and high expansion foams and CAFs. The major demo was the attack, control and extinction of a 225m^2 bund fire in the centre's horizontal storage tank drill scenario, with 3,500 litres of diesel fuel burning, using fluorine free foam vs. AFFF AR foam on two parallel hand lines with an application rate of 400lpm/m^2 on each.

Day two

The following day began at the Auxquimia plant a few kilometres from Gijón. This visit included a tour of the installations; explanations of laboratory test procedures and live fire demonstrations of foam applications onto distinct types of liquid fuel fires in standard compliant pans, with comparative burns in LASTFIRE pans.

The laboratory procedures showed how technicians verify their foam's properties and characteristics in small-scale test fires. Once the concentrates meet the specifications, they are again tested on large-scale fires using standardised applicators.

Following the factory visit and demonstrations, the group returned to Jovellanos for presentations on current and future environment regulations. Niall Ramsden began with examples of how foams had seriously contaminated water sources in numerous countries; how these events had provoked important reconsiderations on the components of foam concentrates; and how in turn these had influenced foams' performance characteristics and abilities to control and extinguish fires.

Peter Davidson, director of safety, commercial and projects at the UK Petroleum Association, discussed the present and future situations of PFOAs in the UK. Here again the environmental issues were foremost, with a direct bearing on the foam concentrates to be used in the near future and beyond.

Cletus Packiam, Chief of the Airport Emergency Services at Singapore's Changi Airport Group, presented the very practical application of these questions as results of the experiences at Singapore's three international airports. As Packiam explained, his specific needs are for reliable foam concentrates that will be capable of controlling and extinguishing aircraft-related fires yet at the same time be environmentally friendly. The Changi Airport Group is one of the world's busiest commercial airports, and one of the few ICAO Category 10 airfields capable of handling the Airbus 380 and similar-sized aircraft.

Day three

The first session of the final day was started by Dr Ramsden with an emphasis on assurance; what the user must know in order to have the right foam concentrate at his facility and make sure that it continues to perform on an on-going basis. This assurance is based on proper specifications, correct calculations on foam requirements, adequate storage and regular programmed testing and exercises. Also to be considered is system testing; disposal/water testing – environmental effects; foam requirements; and foam tactical issues.

Antonio Acuña came again discussed foam compatibility and miscibility – most foams are not compatible with others, and not all concentrates can be mixed with others. There are numerous factors that must be considered when specifying, purchasing, storing and using foams, amongst these are viscosity, flow rates, storage conditions, periodic controls and verifications, shelf life and many more – and all these considerations will directly affect foam concentrates and how they may be expected to perform over long periods.

The next speaker was Eric Paillier, emergency and fire safety coordinator at the French petrochemical company Total. His presentation contemplated Total's experiences after being affected by a major foam supplier whose delivered products did not meet either Total's performance requirements or official certification tests. As a result an investigation was undertaken to find adequate substitutes.

The outcome of these investigations was the conversion to a reliable 1% AFFF-AR concentrate as the principal foam for its mobile fire apparatus fleets while retaining a 3% concentration for fixed systems. Total has more research tests scheduled but the results so far have been positive; lower expenditures for foam concentrate, more reliable protection levels, reduction of the mobile fire apparatus fleets in plants and more efficiency in personnel, amongst others.

Simon Brown, Area Commander of the Hertfordshire Fire & Rescue Service, UK, gave a detailed account of the storage tank fire at the Buncefield Oil Depot. During the two and half days of the incident, 20 petroleum storage tanks were affected, hundreds of metres of large-diameter hose were

High-expansion foams are generally applied from specifically designed fixed applicators and cover much more volume than other foams.

deployed to provide adequate water supply, some 700,000 litres of foam concentrate were used by nearly 150 fire fighters from 31 public service brigades and four industrial brigades. A number of critical lessons were learned from this incident, possibly the most important being the need for adequate training and experience in dealing with huge fires and having adequate resources available both on site and from suppliers.

Niall Ramsden returned to outline three major vapour cloud explosions at three different petroleum storage facilities; Buncefield, Jaipur, India and Bayamon, Puerto Rico. Although each was subject to specific local standards and legislation, all had similar characteristics; high concentrations of flammable substances, numerous storage tanks involved, serious environmental consequences and important strains on emergency response resources. The principal point of Ramsden's final presentation was that similar incidents could happen at any time, anywhere, causing severe material, economic and human losses.

Alberto Menendez, global sales manager of Auxquimia, closed the seminar with an overview of what end users should expect from a foam concentrate manufacturer. There have been numerous situations where manufacturers have delivered products that did not meet international standard requirements and, in some cases, where they had even attempted to convince the clients that the products were satisfactory. What is fundamental for the end user is to have verification testing done periodically with complete documented results.

This event underlined the rapidly changing situation in the world of firefighting foam concentrates. What was not only acceptable and even highly recommended just a decade ago is fast becoming not only obsolete but also environmentally untenable. Foam concentrate manufacturers around the world are investigating and developing alternatives and substitutes, but as history has demonstrated, these may come under scrutiny in the not-too-distant future.

However, one thing is certain. A vast number of industrial activities, public emergency response entities, aviation and military fire services will continue to need reliable and effective firefighting foam concentrates in order to face the possible – and probable – major explosion and fire incidents at their facilities.

References

1. Auxquimia, Spain's leading manufacturer of foam concentrates, was acquired in 2014 by US-based company ICL Performance products, which has given ICL Group a prime quality foam producer, and Auxquimia access to international markets. Auxquimia was founded in 1974 as a fire protection and safety consultancy, and from there through the 1980s and 90s developed a wide range of foam concentrates for industrial, aviation and public fire protection.

2. The Jovellanos Fire Training Centre is

Spain's foremost emergency training site with the capabilities for a wide variety of live-fire training scenarios, ranging from shipboard fires through exterior surface fires of various classes to confined space interior fires and high-rise incidents, and aircraft fire incidents.

3. LASTFIRE, Large Atmospheric Storage Tanks Fires, is one of the leading research entities in the prevention and when necessary, combat of fires in large-diameter petrochemical storage tanks. Since their first research project in 1997 on the problems of fire protection in open top floating roof storage tanks, LASTFIRE has become a world-wide reference, working with high hazard petroleum companies to reduce potential fire and explosion risks, and when fires occur, how best and safely to mitigate them.

4. JOIFF, initially named the Joint Oil Industry Fire Forum when founded in the early 1990s, has become the world's foremost entity involved in industrial fire safety. JOIFF has created the only internationally accepted training qualifications and job competencies for industrial firefighters. Known today as the International Organisation for Industrial Hazard Management, JOIFF applies its expertise to fire prevention and protection in an ever-increasing range of high-risk industries around the world. It recently published a document titled *The JOIFF standard, guideline on foam*, which is intended to serve as a reference in regards to the acquisition, storage, handling and testing of firefighting foams.

TIME LINE: THE HISTORY OF FIREFIGHTING FOAMS

1902: The first successful firefighting foam is invented by the Russian chemist and engineer Aleksandr Loran and perfected enough to be marketed in 1904. This chemical foam, a mix of two chemical powders and water, forms a thick bubble mass that proves effective when used in extinguishers to combat relatively small liquid fires.

1940s: Protein-based mechanical foams are developed. These foams are easier to manufacture and their extinguishing capacities were notably improved.

1950s: High expansion foams are developed, initially oriented to the protection of mines in the UK and the USA. Further research and development makes their use for the protection of large aircraft hangers and similar large-volume, high-risk activities extremely practical.

1960s: Fluoroprotein foams are developed by the US company National Foam offering significant advantages over the preceding foams. In addition, research by the US Navy results in Aqueous Film Forming Foam (AFFF) to meet the needs for fast and reliable extinction of fires on aircraft carriers as well as airfields on land.

1970s: Alcohol-resistant AFFF (AR-AFFF) is developed, a type of foam that is capable of extinguishing alcohol and polar solvent fires that conventional foams are not able to extinguish.

1993: Class A foams are developed and a new era of fighting solid fuel fires begins. In reality, the Class A foams are an evolution of what had been known as 'wetting agents' or 'wet water' used with more than moderate success in combating wood, textile and similar fires in the 1950s and 60s. The Class A foams greatly improve the effectiveness of the wetting agents.

2002: Discovery of significant contamination of water into domestic water supply systems due to run-offs of firefighting water-containing foams. 3M announces the discontinuation of foam manufacture and the removal of possibly the most successful brand of AFFF, Light Water, causing numerous headaches around the world.