FOAM CONCENTRATES FOR FIXED SYSTEMS

NOVEMBER 2000

Put simply, fire fighting foams are stable masses of small, air-filled bubbles with a lower density than oil, gasoline or water. The foams are made up of three ingredients – water, a foam concentrate and air. The water is mixed with the concentrate to form a foam solution which is very fluid and flows readily over liquid surfaces.

Fire fighting foams are primarily used in applications where hazards include flammable and combustible liquids. They control the release of flammable vapors, and cool fuels and sources of ignition.

Fire fighting foam agents suppress fire by separating the liquid fuel from the air. Depending upon the type of foam agent, this is done in several ways.

- the foam blankets the fuel surface, smothering the fire.
- the foam blanket separates the flames from the fuel surface.
- the foam cools the fuel and adjacent heat and ignition sources.
- the foam blanket suppresses the release of flammable vapors that can mix with air.

Types of Foam

There are several types of foam whose properties suit them for specific applications. Some foams are thick, viscous and form tough, heat-resistant blankets over burning liquid surfaces. Other foams are thinner and spread more rapidly.

Some foams are capable of producing a vapor-sealing film of surface active water solution on a liquid surface. Others, such as medium and high expansion foams, are used as large volumes to flood surfaces and fill cavities.

Chemical Foams

Foams have been classified in different ways over the years. The earliest foams were based on a chemical reaction occurring between aluminum sulfate and sodium bicarbonate. The energy used to create the foam bubbles came from the chemical reaction. This type of foam is now largely obsolete.

Mechanical Foams

Mechanical foam is produced by mixing a foam concentrate with water at the appropriate concentration, and then aerating and agitating the solution to form a bubble structure. Therefore, unlike chemical foams, the energy used to create the foam bubbles of a mechanical foam comes from an outside source.

There are several types of mechanical foams:

- protein
- fluoroprotein
- aqueous film-forming foam (AFFF)
- alcohol-resistant concentrate (ARC)
- synthetic detergent (high/medium expansion)
- Class A

The differences between these foam concentrates depend on several factors:

- whether the concentrate is based upon naturally-occurring materials or synthetic materials.
- whether the synthetic chemicals are fluorinated or nonfluorinated.
- the type of fuel being protected.
- the expansion ratio.
- whether they will form an aqueous film on certain fuels.

Protein Foam

Protein foam is derived from naturally-occurring sources of protein such as hoof and horn meal or feather meal. The protein meal is hydrolyzed in the presence of lime and converted to a protein hydrolysate, which is neutralized and to which other components are added such as foam stabilizers, corrosion inhibitors, antimicrobial agents and freezing point depressants.

Foams derived from protein foam concentrates generally have very good heat stability and resist re-ignition. However, they are not as mobile or fluid on the fuel surface as other types of low expansion foams. Protein foams are susceptible to fuel pickup. Consequently, care should be taken to minimize submergence.

Protein foams are recommended for extinguishment of Class B fires involving hydrocarbons. Typically, these agents are used to protect flammable and combustible liquids where they are stored, transported and processed.

Fluoroprotein Foam

Fluoroprotein foam is derived from protein foam concentrates to which small amounts of fluorochemical surfactants are added. The fluorochemical surfactants are similar to those developed for AFFF foam agents, but used in much lower concentrations. The addition of these chemicals produces and easier flowing foam.

In applications involving hydrocarbon bulk storage and handling – such as refineries and petrochemical operations – these agents offer several advantages over protein foams. They provide better control and extinguishing ability, greater fluidity and superior resistance to fuel contamination. Fluoroprotein foams are useful for hydrocarbon vapor suppression and extinguishment of fuel-in-depth fires. They have been recognized as a very effective fire suppression agent for sub-surface application to hydrocarbon fuel storage tanks.

On some fuels, film-forming fluoroprotein foam forms an aqueous film like the AFFF foam agents. However, this reduces the burnback resistance that is characteristic of protein-based foams. Film-forming fluoroprotein foams tend to be a compromise between AFFF and fluoroprotein foam agents.

Aqueous Film-Forming Foam

AFFF is a completely synthetic foam. It consists of combinations of fluorochemical and hydrocarbon surfactants combined with high boiling point solvents and water. Surfactants are chemicals that have the ability to alter the surface properties of water. Fluorochemical surfactants alter these properties in such a way that a thin film can spread on a hydrocarbon fuel (such as gasoline) even though the aqueous film is more dense than the fuel.

AFFF agents require a very low energy input to produce a high quality foam. Consequently, they can be applied through a wide variety of foam delivery systems. This versatility makes AFFF agents a good choice for municipal fire departments, airports, refineries, manufacturing plants and any other operation involving the transportation, processing and handling of flammable liquids and materials.

Alcohol-Resistant Concentrate

ARC produces a foam that is effective on fuels such as methyl alcohol, ethyl alcohol and acetone which have appreciable water solubility or miscibility.

Standard foam agents are mixtures of chemicals (natural or synthetic) whose bubbles collapse when applied to water soluble fuels. These fuels are said to be foam destructive. The early alcohol-resistant foams were based on mixtures of protein foams and chemicals called metal soaps. These chemicals are water repellent.

The most current alcohol-resistant concentrates are based on AFFF concentrates to which a water soluble polymer has been added. When these foam agents are applied to a water soluble fuel such as methyl alcohol, a polymeric membrane is formed between the foam and the water-soluble fuel. When this foam agent is used on a conventional (water insoluble) hydrocarbon fuel, it functions as an AFFF foam by forming an aqueous film at the fuel/air interface. Since the polymer is a naturally occurring chemical, small amounts of an antimicrobial agent are added to prevent biological degradation.

Synthetic Detergent

Synthetic detergent type foam agents are based on mixtures of non-fluorochemical, hydrocarbon type surfactants along with solvents and water. These foam agents do not form aqueous films or polymeric membranes. Instead, they function by forming an aggregate of foam bubbles on the surface of the fuel. They are used most frequently with high expansion foam generators yielding expansion ratios of 200 to 1000:1.

The reduced water content of high expansion foams makes them suitable for use in total flooding applications such as warehouses, ship cargo holds and mine shafts. They are especially useful on cryogenic fuels such as liquefied natural gas for vapor dispersion and control. Some of these foam agents are specially formulated to be used with low, medium and high expansion foam hardware at different proportioning ratios and are referred to as multiple expansion foam agents.

Class A Foams

Class A foams are typically formulated from a combination of specialty hydrocarbon surfactants, stabilizers, inhibitors and solvents. They reduce the surface tension of water for improved wetting and penetrating characteristics and create a clinging foam blanket that suppresses combustible vapors while cooling fuel. Class A foams can be applied using a variety of proportioning/discharge devices and have proven effective in fighting forest fires and many deep-seated fires such as tires, paper, coal bunkers and wooden structures.

Environmental Impact

Look for foam concentrates that are formulated to minimize environmental impact and human exposure hazards. Concentrates should be readily biodegradable – both in the natural environment and in sewage treatment facilities.

All foam agents should be metered into a facility to prevent overloading the plant due to foam formation. The agents are not considered skin irritants. However, prolonged contact may cause some dryness of the skin. Areas of the skin that come in contact with the foam concentrate should be flushed with fresh water.

Periodic Testing

NFPA Standard 11 suggests that periodic testing of foam concentrates be done on an annual basis and outlines the procedures to accomplish the testing. This helps ensure that maximum performance standards will be maintained. A complete copy of the standard can be downloaded from NFPA's web site at www.nfpa.org.

Foam Agent Limitations

Foams, except for the high expansion type (and then only with special considerations), are not suitable extinguishing agents for fires involving gases, liquefied gases or cryogenic liquids.

Three dimensional flowing liquid fires, such as overhead tank leakage or pressure leaks, are not readily extinguishable with foams.

Foams should not be used to fight fires in materials that react violently with water, such as metallic sodium and metallic potassium.

Foam is a conductor of electricity and should not be used on energized electrical equipment fires.

Judgement must be used in applying foams to hot oils, burning asphalts or burning liquids which are above the boiling point of water. Although the comparatively water content of foams can beneficially cool such fuels at a slow rate, it can also cause violent frothing and "slop-over" of the contents. This phenomenon occurs because the water, upon contact with the very hot fuel, immediately turns to steam.

Foams, except for the alcohol-resistant concentrate type, are not suitable for water soluble or polar-solvent liquids.

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