Fire Extinguishing Materials

Types - Uses

By
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1 – Introduction :

The fire is a major blight accompanied the humans since the discovery of fire , and despite the many tools used to fight the fires but this lesion has become over the generations and times a source of significant risk to human life and property, and this is why countries are training men and women and children to rescue and fire services.

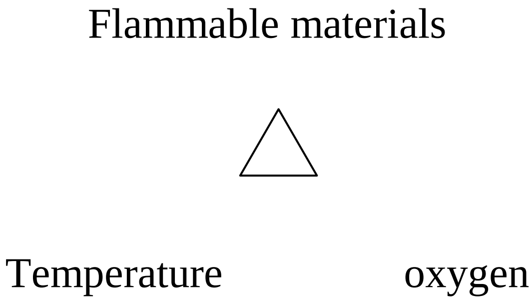
Accompanied by progress in the means of fire progress in materials and fire fighting components as well , and put a special article each fire Deactivate . There is a fire caused by electric current with a high or low volt . There are fires, timber, forestry, straw and paper, houses, homes , factories, and the liquid volatile soluble in water as ketones , acetones & alcohols , and liquid volatile insoluble in water such as benzene , kerosene , diesel , other carbohydrates, & petroleum , and there are fires all types of plastic as poly ethylene , poly propylene and PVC, buna rubber and other

It has also in all countries , insurance companies against fire and risks and to compensate for damage in the event of a fire, most states also enacted special laws for Industrial Security and Safety department stores and factories in order to remove the threat of fire to the greatest extent possible.

2 - What is a fire & resulting :

The fire is burning uncontrolled for more than one substance or flammable materials or inflammation and produces intense heat, as a result of the ignition.

There is no doubt it even starts and the inflammable material so that it continues after the ignition has to be certain to provide many conditions. And usually symbolizes the fire triangle, the following:



3 - How to fight fire :

The fire fighting in general depend on the removal of one or some or most of these conditions causing the combustion, which may be summed up as follows :

1 - Removing burning material

2 - Separate the oxygen from the surface of burning material (water or foam or other).

3 - Surface coverage of the burning materials such as foam, and others.

4 - Cooling (by water or foam).

5 - Inhibition of combustion by adding foam or powder or carbohydrates halides such as carbon tetra chloride & ethylene tri chloride and others.

4 - Fire Classification :

Fires are classified into five major categories :

1 - fire class (A) :

A fire resulting from the combustion of solid organic materials such as wood - straw - paper - rubber - fabric - plastic - coal and charcoal .. Etc..

2 - fire class (B) :

A fire resulting from the combustion of liquid substances such as petroleum and its derivatives - alcohols - oils - tar.. Etc..

3 - fire class (C) :

A fire resulting from the combustion of gaseous substances such as propane - butane - hydrogen – acetylene .. Etc..

4 - fire class (D) :

A fire resulting from the combustion of combustible metals and their alloys such as sodium metal - lithium - magnesium - potassium - aluminum - cesium ... Etc .

5 – Fire - class (E) :

A fire caused by electrical current and electrical arcs such as: fire of cables , condensers and electrical machinery and electronic computers .. Continued with the passage of electric current during the fire, and may be a current of tension (V) is high or low.

5 - basic materials in the fight against fires :

I – water :

It is the first and cheaper basic materials in the fire fighting and successfully used often in most types of fires of class (A).

Perhaps the water is taken directly by the fire fighting operations of the rivers or lakes or the barrels of fire-fighting water adequate and does not constitute any significant problems, but that water reserves are reserves in small tanks to fight the fire, when it happens and happens to be adding some chemicals to it to be valid for use when needed .

Perhaps the most important additives for water :

A - add Anti - freezing additives :

Such as potassium chloride - magnesium chloride - calcium chloride – glycols - glycerol.

B - additions prevent Corrosion inhibiting additives :

, such as alkyl Phosphate - alkyl carbonate - sodium silicate - potassium chromate - sodium nitrate - tannin - sodium bromate - a long chain (high) amines.

C - Accessories conservation Preservatives:

To prevent the growth of algae and fungi and is the most important :

(1) Raschit salt

Na - salt of p - chlorine m – cresol

(2) ammonium compounds such as organic Quartet as three - methyl amino compound acetylcholine ammonium chloride.

D - additions increase the effectiveness of extinguishing and fire-resistance:

It is important to add some material to the water to increase the effectiveness of extinguishing and fire resistance: for example, the addition of carboxy methyl and its salts for toughening the strength of the water and reduce its liquidity used with great success in resisting the forest fire big California in 1962, where water is viscous adhesive and remains on the plant and absorbs this heat more. Also, the addition of Poly ethylene glycol (with a high molecular weight) at 10 parts / million increase caused by throwing water from 36 to 54 meters. And also caused increase in the amount of water ejected from 900 to 1000 liters per minute.

II - the wet water :

The water does not reach the heart of the fire can be turned into water vapor. And does not have to put out the fire impact only steam .

There fore be added is usually the water of some materials to help wetting especially in extinguishing which are not wetting such as sawdust, hay, wool, hemp, paper ... etc. It was found that the addition of 0.1 - 5% of the wetting material in water the fire help to reach to the heart of the fire and thus reduce the amount of water used, as well as reduced damage for example huge fire of Buna - rubber can not switch it off with water drainage . But add 5 % of the wet material in the water makes the process of extinguishing the fire as possible. It was found that the addition of 1% of the wet material in the water the fire down the amount of water consumed up to 25% in the process of extinguishing a fire wood house

The main wet materials used :

- Sodium lauryl ether sulfate.

- Sodium poly glycol sulfate .

- allyl or cetyl alcohol which multiplication with ethylene oxide.

- Sodium lauryl sulfate.

- Poly glycol ether of high fatty alcohols .

The water container on wet materials is very good properties in extinguishing the fires of class «B» and preferably on the pure water exchange in use.

III - heavy foam:

The properties of the foam does not depend only on the chemical composition, but depends on the properties of many and varied, including: the proportion of the volume of foam cm^3 to the weight of the water in the foam in grams and call this ratio by a factor or percentage of the Foam value, some times called : a factor of expansion or expansion ratio.

1 - divide the **mechanical foam**, which contains the air bubble into three groups :

1 - heavy foam or low expansion:

Which is the ratio of the size of the foam to the weight of the water where the limits of 60 – 20 .

2 – medium foam or medium foam expansion :

Which is the ratio of the size of the foam to the weight of the water where the limits of 50 - 200.

3 - light foam or high-expansion :

Which is the ratio of the size of the foam to the weight of the water where the limits 500-1000

2 - The **foam chemical** : it is caused by a reaction of the alkaline salts of carbonic acid with the acid solution which results from the interaction of CO_2 , which put pressure on the solution in the firefighter and directed by a foam bubble containing carbon dioxide .

The most alkaline solutions : sodium carbonate, sodium bicarbonate.

And **the most acidic solution** : aluminum sulfate - sulfuric acid.

However, in some cases can be used pressed carbon dioxide directly with the alkali solution without the use of acid solution.

Recent also can be used hydrolysis protein solution and saponin with preservatives with pressurized carbon gas to form the foam.

Recently also used sodium salts solution of high fatty alcohols sulphonated derivatives such as sodium lauryl sulfate - or sodium lauryl ether sulfate and other compact with carbon dioxide to form the foam.

Due to the heavy foam to contain a high proportion of water, its cooling effect is good, that heavy foam used to extinguish fires, wood, rubber, paper, plastic ... etc.

The heavy duty foam succeed in extinguishing fires, houses, halls and warehouses, where the high density foam allow heavy foam cover large areas.

Also served on the composition of heavy foam carpet foam to cover the airport runways while the emergency landing of the aircraft so as to prevent the spark from the friction generated by the fuselage with the runway from the ignition and fuel the plane

Due to the inefficiency of heavy foam often in extinguishing the fire on one side and due to the large content of water, which causes minor damage can not be neglected after extinguishing the fire. Make the specialists in the science of fire and prefer turning more and more towards the medium and light foam.

Add to that the heavy foam, especially of protein , zero - effectiveness and impact in extinguishing fires solvents.

There fore many of the companies producing industrial production of synthetic foam materials suitable for use against fires of hydrocarbon (oil) and organic solvents (ie non - solvent soluble in water).

IV - medium and light foam :

The expandable foam more than 20 times to divide the foam, medium and light foam. While the production of foam medium does not need to be ventilated tubes, we find that the production of foam you need to light the pipe. As the liquid foam solution with water pumped in the first pipe foam (foam) before the start by spray jet. Then hits the foam to foam at the same time the sieve with the air. and then stand where the air stream to turn into foam bubbles.

Use :

Given the multiple properties of the liquid foam with a foam medium, it can be used to extinguish the many fires that originate liquids or solids. It is well suited to dictate the rooms, or gases in the fight against health damage.

No doubt, the liquid foam with a light foam is more appropriate in many cases. As the layer thickness of 1 meter of the foam after the rescued and turned to the media do not cover more than 1 mm , so the damage caused then much less of the liquid foam heavy or medium where we find that the layer thickness of 1 meter of the liquid heavy foam into a water layer thickness of 15 cm after rescued.

And there fore fit the light liquid foam fire - extinguishing equipment (such as chambers of computer, etc.) as well as to fires burning flammable fluids as benzene & gasoline and others.

In general, synthetic liquid foam is much better than the protein liquid foam because the salty or sulfur or hard water does not adversely affect negative and so succeed in extinguishing fires, fires, marine vessels, which have to use sea water as there is no other water.

V - Gas carbon dioxide CO_2 :

A type of fire fighting and simple for easy he receives, because it is produced as a by product alcoholic fermentation processes where the purified and dried from the effects of moisture carried by the filled cylinders under pressure, it may some times reach 80 kg / cm^2 .

There is now a modern method for gas emissions from gas furnaces combustion and steam boilers by the use of mono or di ethanol amine to absorbing carbon dioxide without other gases, and when heating the mixture liberated carbon dioxide which are pure , pressure and bottled while the re - use of mono - or di ethanol .

This is in addition to traditional methods of production as reacted inorganic acid as hydrochloric acid with sodium carbonate or sodium bicarbonate.

Perhaps the property of carbon dioxide in the fire back to that gas density is higher than air density , when put on the material burned it covered and isolated so the oxygen the air, as it is when out of the cylinder filled out under pressure in liquid form it is converted to a gas absorbing this intense heat, which also help to extinguish the fire. The successful use of carbon gas in fire-fighting equipment (fire class E) and special effect that does not leave a solid or liquid (because the gas). Also succeed in extinguishing the fires that occur in chemical laboratories and buildings closed.

VI - hydrocarbon halides : (Haloginated Hydrocarbons) :

Used to extinguish the fires of electricity (like carbon dioxide does not have an impact where a solid or liquid to evaporate as the impact of heat) and also used successfully to extinguish the fires of goods, machinery, precious and valuable. And influence in return for the liberation of fire or the presence of the ion of halogen, who works as an inhibitor of the fire. There halides containing the root of one or more of halogen, such as one a carbon tetra chloride - ethylene tetra chloride - the ethylene tri chloride - or halides, which contain the roots of one or more halogen . May contain chlorine, bromine or chlorine fluorine and other fluorine chlorine , such as di flouro chloro bromine . But limiting the use of these compounds, especially in enclosed spaces that drugs and toxic vapors, as they break down the impact of heat to the drugs and toxic compounds such as phosgene and other .

VII - dry powder :

When you mention the dry powder used to extinguish the fire comes to mind fine sand which is often used in extinguishing fires, covering the surface of the ignition from oxygen air. But which we mean powder fire extinguishers dry are powders that spry under pressure of carbon dioxide or nitrogen or halides of carbohydrate gas over the fire is working to cover the surface of ignition on the one hand and decompose the impact of temperature absolute carbon, which also works on the reservation oxygen helps more on fire on the one hand, as it absorbs a large amount of heat during the process of decomposition and disintegration of these which also helps to speed the fire engine.

Most important types of powders used with great success :

1 - Carbonate and bicarbonate of sodium or potassium powder, which is used in extinguishing fires of class B , C , E .

2 - Ammonium phosphate powder which is used in extinguishing fires of all categories A, B, C, D, E.

3 - Ammonium or potassium sulfate powder, , which is used in extinguishing fires of class A , B , C , E .

4 - sodium chloride powder which is used in extinguishing fires of alkali metal (fire class D) .

And characterized by powder easily transport and storage from liquid materials. They also modify& neutral the gases produced by combustion of some materials. In addition, it can store the powder at a temperature - 50 ° C to + 60 ° C.

For example, when the combustible material PVC. And the launch of hydrochloric acid to amend the carbonate material combustion gases in addition to fire and this recipe is not characterized by the combustion of other materials. The powder, and especially in the wildfires can be mixed with the liquid foam which gives a multiplier effect in the process of extinguishing fires.

If it is important that the powder with a very large virtual surface (ie very soft fine) to the small amount of which cover the largest possible surface ignition.

And usually range from the physical properties of different types of powder are as follows :

1 - Bulk density (80 – 125 g / 100 ml) .

2 - Density (1.9 – 2.6 g / cm^3) .

3 - Specific surface (2000 – 6000 cm^2 / 1 g) .

4 - percentage size of the particles under 40 microns between 50 – 85 % .

5 - the proportion of particle size below 63 microns between 55 – 95 % .

6 - the amount of carbon dioxide needed is 1 kg per 10 kg of powder.

Fearing caking powder or ossification during transport and storage in addition to elongated sealing materials anti caking or ossification , such as magnesium stearate .

Experience has shown the U.S. in the field of fire that 9 kg of dry powder equivalent to (150) liters of liquid foam, or 45 kg of carbon dioxide in effectiveness.

VIII - Light Water :

Types of liquids is a high-expansion foam, and is used to fight fires of liquids lighter than water, such as petroleum and its derivatives, which floats above and a thin layer of water and also float on the surface of the solvent that will prevent fires and floating so as not to expand the fire.

The most important components of some fluorine derivatives of fatty acids or sulfonic such as : Fluoro cabrelic acid , and fluoro octyl sulfonic acid , With butyl glycol and water.

IX - Other materials :

Sand - iron powder - oil - nitrogen.

Where the use of sand and iron powder in extinguishing fires, phosphorus, magnesium and sodium.

While the oil can be used in fire resistant magnesium.

Nitrogen is used in extinguishing fires, laboratories and factories.

6 - Installation of fluids used in foam fire extinguishers : This fluid is composed of foamed organic materials with high energy to reduce surface tension, chemical compounds with proven and extensive foam, with the addition of materials against freezing, and materials with high energy at emulsifier , with the addition of some materials of improved characteristics.

It is there fore possible to say that the fluid foam consists of :

*** Basic components of the foam :**

These materials may be based :

1 – **By product cheap protein** left over from meat packing plants, slaughter houses and tanneries, and with a series of complex interactions and chemical treatments to make it fit to form the foam.

2 - Organic materials reducing surface tension as sulfonated fatty alcohols salts , and ether of sulfonated alcohols salts , and ethoxilate fatty alcohols , acids and salts of sulfonic acid , etc. ...

*** organic solvents :**

Which soluble in water and work as anti - freezing or Cloudy when a lower temperature as it affects a significant impact in improving the homogeneity of the liquid is the most important :

- Mono or Di Butyl Glycol
- Glycerin
- n. Propanol
- Propane diol
- Hexylen Glycol
- 2 Mthyl 2 - 4 Pentandiol

*** foam stabilizers in general:**

Such as: - Lauryl alcohol C 12 - C 14

- High fatty acid amides .

*** foam stabilizers at low temperature :**

Such as : Urea .

*** Other compounds :**

1 - **EDTA compound** (Ethylene Di amine Tetra Acetic acid) is working to form complex compounds soluble in water with heavy

metals in the water, particularly magnesium and calcium, which helps to increase the foam.

2 - **Salts of inorganic phosphate :** working to absorb the high heat of combustion which helps to quickly extinguish the fire.

3 **- dyes and pigments :** this means to distinguish the foamy liquid foam another.

7 – Definitions :

A - Definition of foam :

Is a set of small bubbles filled with gas and the combined carbon dioxide gas (for Chemical Foam). The air-filled (in the case of Mechanical Foam) .

Which is lighter than oil and petroleum products and use these to cover the surface of the foam material to extinguish burning oil removal by oxygen and cooled to prevent further escalation of vapors.

B - Foam liquid :

Trading in the markets in the plastic containers can accommodate from (20 -50 kg) or in barrels of iron capacity (200 kg), almost liquid foam is not used alone but mixed with water and then called the solution of the foam.

C – Foam Solution :

A liquid foam mixture with water before bombed by ejector , and not a effect of foam solution on the fire without aeration and then called the expanding foam.

D - Expanded Foam :

in which case the final solution , which turns to foam after mixing with air.

The foam is divided as we have already stretched into three types according to the percentage expansion enjoyed by :

1 - **Low expansion foam** from 60 - 20 times or heavy foam.

2 - **Medium expansion foam** from 50 - 200 times .

3 - **High expansion foam** from 500 - 1000 once or light foam.

The proportion of liquid foam mix with water to form foam solution shall be at rates ranging between 2 - 6 % , depending on the type of liquid foam and the type of ejector and the pressure used, but in general the concentrations of liquid foam with water as follows :

4 - 6 % in the low pressure .

3 - 5 % in average pressure .

2 – 4 % in the high pressure .

8 - Conditions that must be provided in the liquid foam :

1 - To be a synthetic organic origin , or protein, or Fluorine protein . Though now synthetic is preferred.

2 - To be suitable for extinguishing oil fires . like gasoline, kerosene , diesel fuel and effective , especially those that are relate to aircraft fires.

3 – Concentrate : Refers to the percentage of soluble solids that must be met by not less than 15 % .

4 - Viscosity at a temperature (20 ° C) less than 15 Din ^{O} or its equivalent from the other units of measure viscosity.

5 - **Degree of the pH** of a solution of 10 % 7 - 8 should be any liquid or foam tends to neutral slightly alkaline so as not to erode the tools and equipment coming into contact in iron storage or during use.

6 - Free of toxic or noxious or polluting the environment, and not be give toxic gases when to be use .

7 - Specific gravity of 1.00 - 1.20 g / cm ^{3}.

8 – Smell it is moderate and not revolting and not disgusting

9 – Storage : not hydrolysis or spoil dowering the length of storage , in ordinary or aerated place at temperature up to degree (50 ° C) , and not freezes at temperature (- 10 ° C) .

10 - Compatibility with the all types of liquids or powders of other foam.

11 - Percentage of expansion :

From 60 - 20 for Low expansion foam

And 50 - 200 for medium expansion foam.

And 500 - 1000 for high expansion foam .

12 - Percentage of water filtration : a guide to stabilize the foam :

10 % after 5 minutes. And 50 % after 25 minutes at least.

13 - Free from suspended , precipitate and non - soluble material .

14 - Maintain the general characteristics when it use of salt or calcium or sulfur or cold or hot water.

15 - Should have stretched foam flow with good cohesion when it ejection under pressure of between 2-15 kg / cm ^{2} .

16 - Should have liquidity foam that allows it to defamation of:

A - Cannon launcher with high extrusion capacity.

B - Hoses and foam launchers known.

C - Foam brushes airport landing strip.

Synthetic Extinguish Foam
Technical Specifications

Composition :

A - Organic Anionic Foaming Materials , different chemical formula basis of Ethoxylates higher sulfate alcohols :
Sulphate Alcohols Ethoxylates .

B - multiple wet organic materials and Non Ionic surfactants

C - organic material Anti – Corrosion - based :

Fatty Amine Salt Alkyl Phosphates .

D - material attached to the foam-based :

Fatty Acid Alkanol Amides

Properties :

I : The liquid foam, " **Synthetic and protein**" of the best fluid foam of appropriate and safe to put out the fire no matter what their origin, especially fires, crude oil and petroleum products like gasoline, kerosene, diesel and fuel oil, so it is fit for use on a large scale in various oil fires. As well as forest fires, wood and alcohol, inflammable materials.

II : It should to accept to requirements and conditions of international standard specifications, particularly French and Swedish and the U.S. standard, especially in relation to :

A - rate of expansion of the solution concentration 4 % at least 100 times.

B - does not increase the proportion of fire fighting for 60 seconds.

C - Time of the return fire at least 10 minutes .

III : No effect of the Hard , Sulfur and Salt Water , and others to effect a negative way . So even succeed in extinguishing fires, ships and oil tankers, fire, marine , where there is only salt or Sulfur or hard water.

IV : free of suspended material and precipitate and non - soluble.

V : Do not oxidize or break up or spoil the length of storage, no matter how, and potentially store up to degree 50 ◦ C in place of plain or aerated and freezes or annoyed if the temperature dropped to the point - 20 ◦ C.

VI : Does not cause any erosion of the equipment and machinery coming into contact during storage or during use, as the interaction mild PH = 7.

VII : Free of toxic materials or harmful to health or contaminated the environment. Also not be put to use toxic gases while, and it is subject to disintegration and decomposition biologically.

VIII : Compatible with all types of liquid and powder used in other foam fire extinguishers.

IX : The viscosity at a temperature of + 20 ◦C up to 10 Din religion or its equivalent from the other units of measure viscosity. The viscosity can be adjusted as desired by the buyer to the more or less.

X : Specific weight at a temperature of + 20 ◦ C up to 1.05 g / cm^3.

XI : The Concentrate more than 15 % .

XII : the proportion of water filtration (Water drainage time) :

10 % after (5) minutes at least.

50 % after (30) minutes at least.

XIII : Mild smell is disgusting and repulsive and does not advocate such as those that characterize other liquid foam.

IVX : Foam it stretched flow has good cohesion with the ejection under pressure of between 2-15 kg / cm 2.

VX : Foam it increasingly stable and density at high temperature. It also contains substances that make Foam it also dense and stable even in ice water. There fore, successful use in various temperatures.

VXI : The amounts used of the liquid foam as pumping devices and pressure and type, but in general rates are used as follows :

% 4 - 2 in the high pressure .

% 5 - 3 in the pressure medium .

% 6 - 4 in the low pressure .

VXII : packaging in plastic package in the capacity of 25-30 kg or plastic drums capacity of 200 kg net , and according to the desire of the buyer, and all types of packaging suitable for transport, shipping and storage.

General Foam Information

For years, foam has been used as a fire-extinguishing medium for flammable and combustible liquids. Unlike other extinguishing agents – water , dry chemical , CO_2, etc., a stable aqueous foam can extinguish a flammable or combustible liquid fire by the combined mechanisms of cooling, separating the flame / ignition source from the product surface, suppressing vapors and smothering. It can also secure for extended periods of time against reflash or reignition. Water, if used on a standard hydrocarbon fuel, is heavier than most of those liquids and if applied directly to the fuel surface, will sink to the bottom having little or no effect on extinguishment or vapor suppression. If the liquid fuel heats above 212ºF, the water may boil below the fuel surface throwing the fuel out of the contained area and spreading the fire. For this reason, foam is the primary fire-extinguishing agent for all potential hazards or areas where flammable liquids are transported, processed, stored or used as an energy source.

Before reviewing the merits of the different types of foam concentrates, there are certain terminologies associated with foam that must be understood :

Foam :

A fire fighting foam is simply a stable mass of small air- filled bubbles, which have a lower density than oil, gasoline or water. Foam is made up of three ingredients - water, foam concentrate and air. When mixed in the correct proportions, these three ingredients form a homogeneous foam blanket.

Foam Solution :

This is a solution of water and foam concentrate after they have been mixed together in the correct proportions.

Foam Concentrate :

This liquid concentrate is supplied from the manufacturer which when mixed with water in the correct proportion forms a foam solution.

Finished Foam :

Foam solution as it exits a discharge device, having been aerated.

Drainage Rate :

This is the rate at which the foam solution will drain from the expanded foam mass or how long it will take for 25 % of the solution to drain from the foam. This is often called the quarter life or 25 % drain time. Foam that has a fast drain time is normally very fluid and mobile, spreading across the fuel surface very quickly. While foams with longer drain times are normally less mobile, they move across the fuel surface slowly.

Expansion Rate :

Volume of finished foam divided by the volume of foam solution used to create the finished foam; i.e., a ratio of 5 to 1 would mean that one gallon of foam solution after aeration would fill an empty 5-gallon container with the expanded foam mass.

Low Expansion Foam :

Foam aerated to an expansion ratio of between 2 to 1 and 20 to 1.

Medium Expansion Foam :

Expansion ratio between 20 to 1 and 200 to 1.

High Expansion Foam :

Expansion ratio above 200 to 1.

Dilution Rate , Mixing Rate , Or Proportioning Rate (correct amount of foam concentrate to be mixed with water) :

The amount is normally shown on the pail or drum of concentrate. The container will normally display a figure or combination of figures. Normal figures shown are 1%, 2%, 3% or 6% or a combination of 1 % and 3 %, 3 % and 3 %, or 3 % and 6 %. If the container of foam concentrate has 3 % shown, it means that for every 100 gallons of foam solution required , 3 gallons of the foam concentrate must be used in the solution with the balance being 97 gallons of water.

If 6 % were displayed, this would mean that 6 gallons of the foam concentrate would be required to be mixed with 94 gallons of water to form the 100 gallons of foam solution. From the above, it becomes obvious that a 3 % foam concentrate is twice as concentrated as a 6 % foam concentrate. On the same size and type of flammable liquid fire, half as much 3 % foam concentrate would be required than if the 6 % foam concentrate had been used.

Sea Water Compatible :

Can foam concentrates be used with sea water as well as fresh water ? Modern day foam concentrates can be used successfully with either sea, fresh or brackish water.

How Foam Extinguishes A Flammable Liquid Fire :

Fire burns because there are four elements present. These elements are heat , fuel , air (oxygen) and a chemical chain reaction. Under normal circumstances if any one of the elements is removed / interfered with, the fire is extinguished. Fire fighting foam does not interfere in the chemical reaction. Foam works in the following ways:

- The foam blankets the fuel surface smothering the fire.
- The foam blanket separates the flames / ignition source from the fuel surface.
- The foam cools the fuel and any adjacent metal surfaces.

- The foam blanket suppresses the release of flammable vapors that can mix with air.

Before we review the different types of mechanical foam concentrates, please understand that there are two different basic flammable or combustible fuel groups.

- Standard hydrocarbon fuels such as gasoline, diesel, kerosene, jet fuel, etc. These products do not mix with water or are not miscible in water, i.e. these products all float on top of water and, for the most part, they do not intermix.
- Polar solvent or Alcohol type fuels are fuels that mix readily with water or are miscible in water.

It is imperative that when you are preparing to fight a flammable liquid fire, you identify which fuel group the involved flammable liquid belongs. This is necessary, as some foam concentrates are not suitable for use on the Polar solvent/Alcohol type fuel spills or fires.

Following is a list of mechanical foam concentrates that are the most common types currently used by fire fighters today :

- Aqueous Film Forming Foam (AFFF)
- Alcohol Resistant (AR - AFFF)
- Synthetic - medium or high expansion types (detergent)
- Class "A" Foam Concentrate
- Wetting Agent
- Fluoro protein
- Protein
- Film Forming Fluoro protein (FFFP)

Aqueous Film Forming Foam Concentrate (AFFF) :

Available in either a 1 %, 3 % or 6 % type concentrate. These concentrates are manufactured from synthetic type materials such as :

- Synthetic foaming agents (hydrocarbon surfactants)

- Solvents (i.e., viscosity leveler, freezing point depressant, foam booster)
- Fluoro Chemical surfactants
- Small amounts of salts
- Foam stabilizers (slow drainage, increases fire resistance)

AFFF generated foams extinguish hydrocarbon flammable liquid fires the same way as the protein or fluoro protein foams; however, there is an additional feature. An aqueous film is formed on the surface of the flammable liquid by the foam solution as it drains from the foam blanket.

This film is very fluid and floats on the surface of most hydrocarbon fuels. This gives the AFFF unequaled speed in fire control and knockdown when used on a typical hydrocarbon spill fire. In certain circumstances, it is possible to notice the fire being extinguished by the "invisible" film before there is complete foam blanket coverage over the surface of the fuel.

AFFF foam solutions can be applied to a flammable liquid fire using either aspirating or non-aspirating discharge devices. The difference between the two is that the air-aspirating device entrains air and causes it to mix with the foam solution within the device. The non air-aspirating device is incapable of this process.

- The AFFF / Water solution requires relatively low energy input to expand the foam solution into an expanded foam mass.
- AFFF foam solutions are unique in that in addition to forming an expanded foam mass, the liquid that drains from the blanket has a low surface tension, which gives it the ability to form the aqueous film that floats on the fuel surface.

When flow rates and pressures are similar, AFFF solutions used with a non air-aspirating discharge device will generally discharge/throw the foam a greater distance than the foam that is discharged from the air-aspirating discharge device. A non-aspirating AFFF will generally extinguish a low vapor pressure fuel spill fire slightly faster than the foam discharged from an air-aspirating device. This is because the non- aspirated nozzle generated foam has a lower expansion and will be more fluid; therefore, it will move faster across the fuel surface. AFFF foam solutions are unique in that in addition to forming an expanded foam mass, the liquid that drains from the foam blanket has a low surface tension, which gives it the ability to form the aqueous film that floats on the fuel surface.

When using AFFF foams, application technique is not as critical as with Proteins or Fluoro proteins. AFFF foam can also be used successfully with the sub-surface injection method.

NOTE : The sub - surface method of discharging foam into a storage tank can only be used with tanks that contain standard hydrocarbon fuels NOT polar solvent/alcohol type fuels.

The recommended application rate for AFFF 3 % - 6 % generated foam solution on a hydrocarbon spill fire with low water solubility is .10 gpm / sq. ft. Remember the protein and the fluoro protein foam solutions require an application rate of .16 gpm /sq. ft.

AFFF is suitable for use in a premix state and is suitable for use with dry chemical extinguishing agents.

Alcohol Resistant - Aqueous Film Forming Foam (AR – AFFF) :

AR-AFFF's are available in a 3 % - 6 % type or 3 % - 3 % type concentrate. Flammable liquids that readily mix with water are a more difficult fire to extinguish as opposed to a hydrocarbon fire. Polar solvent / alcohol liquids destroy any foam blanket that has been generated using standard AFFF or fluoroprotein type concentrates. Water in the generated foam blanket mixes with alcohol causing the foam blanket to collapse and disappear until the fuel surface is completely exposed again. To overcome this problem, AR-AFFF type concentrates were developed. Using plain AFFF concentrate as a base material, a high molecular weight polymer is added during the manufacturing process. When AR-AFFF is used on a polar solvent fuel fire, the polar solvent fuel tries to absorb water from the foam blanket. A polymer precipitates out forming a physical membrane/barrier between the fuel surface and foam blanket. This barrier now protects the generated foam blanket from destruction by the alcohol fuel.

AR - AFFF concentrates are very viscous. Initial impression of this type of foam concentrate may lead one to believe that the concentrate has “gelled” and somehow gone bad. However, a thick, gel-like appearance is normal. This appearance is caused by the presence of polymers, which are the main components required for polar solvent applications. Modern AR-AFFF concentrates are designed to work through proportioning equipment such as in-line eductors, bladder tanks and balanced pressure pump systems.

AR - AFFF 3 % - 6 % type of concentrate is designed to be used at the 3 % application rate when used on a standard hydrocarbon fuel fire and 6 % when used on a polar solvent/alcohol fuel. Current 3 % AR-AFFF type concentrate is designed for 3% application on either type group, i.e. 3% on hydrocarbons and 3% on polar solvent fuels.

When AR-AFFF is used at the correct proportioning rate on hydrocarbon fuel, fire fighting performance and application rate are the same as for standard AFFF agents. An “invisible” film is formed, the speed of covering a fuel spill with the foam blanket is similar and the application technique using either air-aspirating or non air-aspirating nozzles can be used. When used on an alcohol fire, an air-aspirating nozzle will give a better performance over the non air-aspirating nozzle. The increased expanded foam mass generated by the air-aspirating nozzle will give a more gentle application onto the surface of the alcohol liquid fire than will the non-aspirating nozzle. The intensity of the fire, distance the foam must be thrown, and the application rate also play an important part in determining the type of nozzle and method of extinguishment. The application technique and performance factors are the same for both the 3 % and the 3 % - 6 % types of AR-AFFF concentrates.

Synthetic / Detergent (High Expansion) Foam Concentrate :

Normally used at a concentrate rate between 1.5 % to 2.5 %, this type of foam concentrate is manufactured from a combination of hydrocarbon surfactants and solvents. High expansion foam solution is normally used through devices that give high expansion ratios such as the medium or high expansion type foam generators.

In areas such as a basement, mine shaft or a ship's hold where volume fire control is required, a high expansion foam generator can be used to fill an entire room with large amounts of very light expanded foam bubbles. Depending on the generator being used, high expansion ratios of 400 to 1 up to 1,000 to 1 can be achieved.

Fire control and extinction is achieved by rapid smothering and cooling. Fires involving solid material as well as flammable liquids can be controlled and extinguished using high expansion foam. It also has a special value for dealing with spillages of liquefied natural gas (LNG). A deep layer of 500 to 1 expanded foam will provide a thermal insulation barrier around the LNG spill, which reduces the heat intake, and therefore the rate of evaporation is decreased. Because of the high expansion ratios being achieved, there is very little water used; even with large discharges of the high expansion foam. High expansion foam has little water content within the bubble wall making it very light and not suitable for outdoor use. Medium expansion foam normally has an expansion of around 50 - 60 to 1. This foam is denser and can be used outdoors but is still affected by weather conditions.

Class “A” Foam Concentrate :

This is a bio degradable mixture of foaming and wetting agents. When mixed in correct proportions with water, it can change two properties of the water. Class “A” foam will increase wetting effectiveness, which allows for greater penetration into Class “A” fuels. It also gives water a foaming ability, which allows water to remain and cling to vertical and horizontal surfaces without run off. This allows water to absorb more heat. By adding a small quantity of a Class “A” foam concentrate into a water stream, the effectiveness of the water can be increased up to 5 times.

Wetting Agent :

This type of agent is very similar to Class "A" Foam with regard to increasing wetting effectiveness of the water but does not have the foaming abilities.

Fluoro Protein Foam Concentrate :

Available in either a 3 % or 6 % type of concentrate. This product is manufactured using the same method as Protein but with the addition of fluoro carbon surfactants. The addition of these surfactants in the concentrate improves the performance of fluoro protein foam over protein foam in two areas.

It makes the fluoro protein foam more resistant to fuel contamination/pickup and makes the foam blanket more mobile when discharged onto the flammable liquid. Because the fluoro protein foam is more resistant to fuel contamination, it allows the discharging foam to be applied directly to the fuel surface and the foam blanket will not become as saturated by fuel vapor. This type of foam can be used with a High Back Pressure Foam Maker by utilizing the sub-surface method of forcing expanded foam into the base of a cone roof storage tank containing a hydrocarbon fuel. The expanded foam enters the base of the storage tank then floats up through the flammable liquid to the surface where it covers the surface with a foam blanket. Fluoro protein foam is sometimes used in the hydrocarbon processing industry for storage tank fire fighting. It is necessary to use with air-aspirating discharge devices. The recommended foam solution application rate on hydrocarbon spills is .16 gpm / sq. ft.

Film Forming Fluoro - Protein (FFFP) :

FFFP is a derivative of AFFF and fluoro protein. These concentrates are based on fluoro protein formulations to which an increased quantity of fluorocarbon surfactants has been added. FFFP concentrates were developed to obtain the quick knockdown of AFFF with the added burn back resistance of standard fluoro protein foam. It appears that the FFFP concentrate performance factor lies somewhere between AFFF and fluoro protein. FFFP concentrates do not have the quick knockdown of the AFFF's when used on a spill fire such as an aircraft crash or a highway spill. When used on fuel in depth fires they do not have the burn back resistance of fluoro protein. FFFP foam can be generated with either air-aspirating or non air-aspirating nozzles. When used through a non air-aspirated nozzle they do not provide expansion ratios as good as AFFF when used through the same type of nozzle. The application rate is .10 gpm/sq. ft. when used on a hydrocarbon spill fire.

Protein Foam Concentrate :

Available in either a 3 % or 6 % type concentrate. This type of concentrate is based on hydrolyzed protein, foam stabilizers and preservatives. It will produce highly stabilized air foam. Protein foam must always be used with an air aspirating type discharge device. Protein foam can become contaminated with fuel if plunged directly onto the fuel surface; therefore, the application technique for Protein foam is quite critical. The foam should be applied as gently as possible to the flammable liquid surface.

The application rate for Protein foam solution on a hydrocarbon spill fire having low water solubility is .16 gpm/sq. ft. Protein foam, because of its stability, is relatively slow moving when used to cover the surface of a flammable liquid.

Shelf Life :

Shelf life is the term used to describe the length of time which foam concentrates remain stable and usable without a significant change in their performance characteristics. The shelf life depends upon the composition of the concentrate, the ambient temperature storage range encountered, the container materials and if the concentrate is stored in its original container. A shelf life of 20 - 25 years is possible if the standard AFFF, ARAFFF and other synthetic type agents are stored within the manufacturer's guidelines, temperature limits and in the original shipping container. Protein based foam concentrates are not totally synthetic and have a naturally occurring product in their formulations. If these products are stored within the manufacturers' guidelines including temperature limits and in their original shipping container, a shelf life of 10 years or more can be expected.

Compatibility :

Compatibility is the ability of one foam concentrate to be mixed with another concentrate of the same type and proportioning ratio without altering the chemical, physical or performance characteristics of the mixed foam concentrates. All foams are compatible when applied on a fire simultaneously.

Chemguard foam concentrates have been found to be compatible with most other foam concentrates of like quality and type. Chemguard does recommend a compatibility study to be made to determine the quality of the concentrate with which the Chemguard concentrate is to be mixed. AFFFs that are manufactured to the latest revision of Mil-F-24385 specification are mutually compatible by definition.

Environmental Impact & Toxicity :

Contemporary U.L. listed or Military specification approved foam concentrates are specifically formulated to provide maximum fire fighting capabilities while at the same time providing minimal environmental impact and human exposure hazard. All concentrates are readily biodegradable both in the natural environment and in sewage treatment facilities. Chemguard products are also formulated to have very low fish toxicity. The concentrates are not considered primary or secondary skin irritants; however, prolonged contact may cause some dryness of the skin since they contain detergents. Chemguard recommends that areas of the skin, which have come in contact with the concentrate, be flushed with fresh water. If any dryness of the skin is experienced, a good quality hand cream should be used to replenish the moisture in the skin.

Fire fighting foam

Firefighters sprayed foam on structures in the Mammoth Hot Springs complex on 1988 during the Yellowstone Fires.

Contents

1 - Introduction :

Fire fighting foam is a foam used for fire suppression. Its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion. Fire fighting foam was invented by the Russian engineer and chemist Aleksandr Loran in 1902.

The surfactants used need to produce foam in concentration of less than 1 %. Other components of fire retardant foams are organic solvents (e.g. tri methyl tri methylene glycol and hexylene glycol), foam stabilizers (e.g. lauryl alcohol) , and corrosion inhibitors.

Low-expansion foams have an expansion rate less than 20 times. Foams with expansion ratio between 20-200 are **medium expansion**. Low-expansion foams such as AFFF are low-viscosity, mobile, and able to quickly cover large areas.

High - expansion foams have an expansion ratio over 200. They are suitable for enclosed spaces such as hangars, where quick filling is needed.

Alcohol - resistant foams contain a polymer that forms a protective layer between the burning surface and the foam, preventing foam breakdown by alcohols in the burning fuel. Alcohol resistant foams should be used in fighting fires of fuels containing oxygenates, e.g. MTBE, or fires of liquids based on or containing polar solvents.

2 - Class A foams :

A fire truck demonstrating Class A foam in a CAFS system

Class A foams were developed in mid 1980s for fighting wildfires. Class A foams lower the surface tension of the water which assists in the wetting and saturation of Class A fuels with water. This aids fire suppression and can prevent reignition . Favorable experiences led to its acceptance for fighting other types of class A fires, including structure fires.

3 - Class B foams :

Class B foams are designed for class B fires — flammable liquids (such as nail polish and white out). The use of class A foam on a class B fire may yield unexpected results, as class A foams are not designed to contain the explosive vapors produced by flammable liquids. Class B foams have two major subtypes.

3 – 1 - Synthetic foams :

Synthetic foams are based on synthetic surfactants. Synthetic foams provide better flow, faster knockdown of flames, but limited post-fire security.

Aqueous film forming foams (**AFFF**) are water-based and frequently contain hydrocarbon-based surfactant such as sodium alkyl sulfate, and fluoro surfactant — such as fluoro telomers, perfluoro octanoic acid (PFOA), or per fluoro octane sulfonic acid (PFOS). They have the ability to spread over the surface of hydrocarbon-based liquids.

Alcohol - resistant aqueous film forming foams (**AR-AFFF**) are foams resistant to the action of alcohols, able to form a protective film when they are present.

3 – 2 - Protein foams :

Protein foams contain natural proteins as the foaming agents. Unlike synthetic foams, protein foams are bio-degradable. They flow and spread slower, but provide a foam blanket that is more heat resistant and more durable.

Protein foams include **regular protein foam** (**P**), **fluoro protein foam** (**FP**), **film forming fluoro protein** (**FFFP**), **alcohol**

resistant fluoro protein foam (**AR-FP**), and **alcohol-resistant film forming fluoro protein** (**AR-FFFP**).

Protein Foam from **non-animal sources** is preferred because of the possible threats of biological contaminants like prions.

4 – Applications :

Every type of foam has its application. High - expansion foams are used when an enclosed space, such as a basement or hangar, needs to be quickly filled. Low - expansion foams are used on burning spills. AFFF is best for spills of jet fuels, FFFP is better for cases where the burning fuel can form deeper pools, AR-AFFF is suitable for burning alcohols. The most flexibility is achieved by AR-AFFF or AR-FFFP. AR-AFFF must be used in areas where gasolines are blended with oxygenates, since the alcohols prevent the formation of the film between the FFFP foam and the gasoline, breaking down the foam, rendering the FFFP foam virtually useless.

5 - History of Fire Fighting Foams :

Water has long been a universal agent for suppressing fires, but is not best in all cases. For example, water is typically ineffective on an oil fire, and can be dangerous. Fire fighting foams were a positive development in extinguishing oil fires.

In 1902 a method of extinguishing flammable liquid fires by blanketing them with foam was introduced by the Russian engineer and chemist Aleksandr Loran. Loran was a teacher in a school in Baku, which was the main center of the Russian oil industry at that time. Impressed by the terrible and hardly extinguishable oil fires that he had seen there, Loran tried to find such a liquid substance that could deal effectively with the problem. So he invented fire fighting foam, which was successfully tested in several experiments in 1902-

1903.[1] In 1904 Loran patented his invention, and developed the first foam extinguisher the same year.

The original foam was a mixture of two powders and water produced in a foam generator. It was called **chemical foam** because of the chemical action to create it. Generally, the powders used were sodium bicarbonate and aluminium sulfate, with small amounts of saponin or liquor ice added to stabilize the bubbles. Hand-held foam extinguishers used the same two chemicals in solution: to actuate the extinguisher, a seal was broken and the unit inverted, allowing the liquids to mix and react. Chemical foam is a stable solution of small bubbles containing carbon dioxide with lower density than oil or water, and exhibits persistence for covering flat surfaces. Because it is lighter than the burning liquid, it flows freely over the liquid surface and extinguishes the fire by a smothering action. Chemical foam is considered obsolete today because of the many containers of powder required, even for small fires.

In the 1940s, Percy Lavon Julian developed an improved type of foam called Aero foam. Using mechanical action , a liquid protein-based concentrate, made from soy protein , was mixed with water in either a proportioner or an aerating nozzle to form air bubbles with the free flowing action. Its expansion ratio and ease of handling made it popular. Protein foam is easily contaminated by some flammable liquids, so care should be used so that the foam is only applied above the burning liquid. Protein foam has slow knockdown characteristics, but it is economical for post fire security.

In the early 1950s, **high expansion foam** was conceived by Herbert Eisner in England at the Safety in Mines Research Establishment (now the Health & Safety Laboratory) to fight coal mine fires. Will B. Jamison, a Pennsylvania Mining Engineer, read about the proposed foam in 1952, requested more information about the idea, and proceeded to work with the US Bureau of Mines on the idea, testing 400 formulas until a suitable compound was found. In 1964, Walter Kidde & Company (now Kidde) bought the patents for high expansion foam.

In the 1960s, National Foam, Inc. developed fluoro protein foam. Its active agent is a fluorinated surfactant which provides an oil-rejecting property to prevent contamination. It is generally better than protein foam because its longer blanket life provides better safety when entry is required for rescue. Fluoro protein foam has fast knockdown characteristics and it can also be used together with dry chemicals which destroy protein foam.

In the mid 1960s, the US Navy developed aqueous film-forming foam (**AFFF**) . This synthetic foam has a low viscosity and spreads rapidly across the surface of most hydrocarbon fuels. A water film forms beneath the foam which cools the liquid fuel, which stops the formation of flammable vapors. This provides dramatic fire knockdown, an important factor in crash rescue fire fighting.

In the early 1970s, National Foam, Inc. invented Alcohol Resistant AFFF technology. **AR - AFFF** is a synthetic foam developed for both hydrocarbon and polar solvent materials. Polar solvents are combustible liquids that destroy conventional fire fighting foam. These solvents extract the water contained in the foam, breaking down the foam blanket. Therefore, these fuels require an alcohol or polar solvent resistant foam. Alcohol resistant foam must be bounced off of a surface and allowed to flow down and over the liquid to form its membrane, compared to standard AFFF that can be sprayed directly onto the fire.

Compressed air foam system

A fire engine using CAFS to make foam on the ground

Contents

1- Introduction :

A **compressed air foam system** (CAFS) is a system used in fire fighting to deliver fire retardant foam for the purpose of extinguishing a fire or protecting unburned areas from becoming involved in flame.

2 – Description :

A CAFS tanker of the Australian Capital Territory Fire Brigade

A compressed air foam system is defined as a standard water pumping system that has an entry point where compressed air can be added to a foam solution to generate foam. The air compressor also provides energy, which, gallon for gallon, propels compressed air foam farther than aspirated or standard water nozzles.

Typical components include a centrifugal pump, a water source, foam concentrate tanks, a rotary air compressor, a direct-injection foam proportioning system on the discharge side of the pump, a mixing chamber or device, and control systems to ensure the correct mixes of concentrate, water, and air.

It is proven that CAFS attacks all three sides of the fire triangle simultaneously. The foam blankets the fuel, thereby reducing the fuel's capacity to seek out a source of oxygen. The CAFS solution adheres to ceilings and walls, more readily aiding in rapid reduction in heat. Also, the opaque surfaces of the foam, as it adheres to walls and ceilings, shield the fuel source from radiant energy. (Brooks, 2005; Brooks, 2006)

CAFS may also refer to any pressurized water style extinguisher that is charged with foam and pressurized with compressed air.

3 – History :

The idea that water is not a perfect tool for fire extinguishment has been long noted, as by W. E. Clark (1991), "The process of extinguishing fire by water is cumbersome and generally costly … the cost of installing water mains large enough for required flow, the installation and maintenance of fire hydrants, and the acquisition and maintenance of fire department pumpers, fire hose, and nozzles, make water a fairly expensive extinguishing agent … the use of water is hardly the ideal way to extinguish fire … there must be a better method waiting to be discovered." (p. 75)

Liebson (1996) adds , "Water is an inefficient extinguishing agent. It requires the use of large quantities at costs both financial and physical. These costs are imposed on the firefighter and the community."

The use of foam additives to water for extinguishment dates back to an English patent in 1877 for a method to produce chemical foam (Liebson, 1991, p. xi). The British Navy experimented with agents foamed by means of compressed air in the 1930s (Darley, 1994) and the U.S. Navy was using compressed air foam systems (CAFS) in the 1940s for flammable liquid fires. By the 1960s do-it-yourself car washes were using CAFS with low pressure and small-diameter hoses and nozzles, which flowed about 4 gallons per minute (gpm) of solution and 4 cubic feet per minute (cfm) of compressed air, with a nozzle reach of about 40 feet (Rochna and Schlobohm, 1992) .

In the mid 1970s Mark Cummins, while working for the Texas Forest Service, developed a water expansion system known as the Texas Snow Job. Mr. Cummins invented the CAFS and was issued the US Patent 4318443 in 1982. This pioneering Class A CAFS used dish-washing detergents or a pine soap derivative, which was readily available as waste from local paper manufacturing industries, as a foaming agent mixed as 8 to 9 parts agent to 91 to 92 parts water, flowing up to 30 gpm. The duration was limited by the use of compressed air cylinders rather than compressors (The US and foreign patent issued to Mark Cummins also included all types of air compressors and inert gas generators). By the mid-1980s, research by the United States Bureau of Land ManagementIn co-operation with Mark Cummins, led to modern design features of rotary air compressors, centrifugal pumps, and direct-injection foam-proportioning systems (Fornell, 1991; IFSTA, 1966) . CAFS received national attention in 1988 during the Yellowstone Park wildfires when the four-story Old Faithful Lodge was successfully protected by blanketing it with compressed air foam (Darley, 1994) .

In the spring of 1994, a compressed air foam demonstration vehicle manufactured by W.S. Darley & Co., was driven from coast to coast in North America by Troy Carothers. The purpose was to spread the word about CAFS and display this relatively new technology to United States and Canadian firefighting services. Many years earlier Darley Co. teamed up with Cummins on the WEPS (water expansion pumping system) demonstration vehicle. The 1994 Darley demo vehicle was operated by Troy Carothers who was involved with the initial design and assembly of the Darley AutoCAFS product. Carothers is now the Darley AutoCAFS Manager and oversees all aspects of CAFS development for Darley Co. This demonstration vehicle concept has continued annually since 1994.

4 - Foam types :

CAFS is able to deliver a range of useful foam consistencies, labeled from type 1 (very dry) to type 5 (wet), which are controlled by the air-to-solution ratio, and, to a lesser extent, by the concentrate-to-water percentage. Type 1 and 2 foams have long drain times, meaning the bubbles do not burst and give up their water quickly, and long duration. Wet foams, such as type 4 and 5, drain more quickly in the presence of heat . A major advantage of using CAFS is having the unique ability to produce a wide range of foam qualities or foam types to provide the most appropriate foam response to individual fire situations. This gives the fire officer the advantage of custom tailoring the best foam type for the tactical use and fire problem at hand..

After testing a dry type 2 foam in several situations, Johnny Murdock notes, "The emerging consensus is that the dryer foams (type II; maybe type I) should be used to suppress vapors, protect unburned structures, build wild land fire lines involving unburned fuels; … and that structural fire suppression requires a wetter foam (type IV or type V); and that both structural and wild land over haul require type V foam " . For structural firefighting with compressed air foam, Dominic Colletti recommends utilizing a 0.5 cfm (cubic feet per minute) to 1 gpm (gallons per minute) "air to foam solution" ratio, with a 0.5 % class A foam proportioning rate. This would produce flow rates from a typical 1-3 / 4" inch hose of 120 gpm of foam solution and 60 cfm of compressed air. This air to foam solution ratio produces a wet, quick draining finished foam that will quickly knockdown flame and reduce fire compartment temperature. This ratio also allows for a higher relative foam solution (liquid) flow rate to help maintain the highest levels of firefighter safety possible. (The Compressed Air Foam Systems Handbook, Colletti 2005.) . While Colletti's claims for flows are not agreed upon by many industry experts, as exhibited at the CAFS symposium held in Rosenberg, Texas in February 2007. A panel there agreed that flows of 1 GPM foam solution in tandem with 1 CFM air produce the most effective blanket. It was further agreed that the maximum combination of air flow mixed with foam solution flow out of a 1-3/4" line under normal pump pressures of 100–125 PSI could not physically exceed a total of 140–150. In other words, the simultaneous flow of 70 CFM of air and 70 GPM of water is approaching the maximum limit or carrying capacity of that diameter hose (1.75 inches). (Texas CAFS Symposium February, 2007)

5 - Water can conversion :

Air pressurized water (APW) fire extinguishers are commonly converted into makeshift CAFS extinguishers by drilling two 1/8-1/16 inch holes in the pickup tube above the water line. The unit is then filled with 1.5 gallons of water and class A foam, AFFF, FFFP or commercial detergent is added to the water in a 1 % ratio for class A fires and a 3 % - 6 % ratio for class B fires. Typically, the tip of the smooth - bore application nozzle is then cut off to allow the foam to properly expand. Keeping the nozzle will result in wetter foam but longer range. Cutting the nozzle will result in an expanded, dry foam but will lack the range of the standard water nozzle. CAFS extinguishers can also be fitted with air aspirators, commonly used on AFFF and FFFP foam extinguishers, which will result in a more expanded foam but will lack the heat resistance of non-aspirated foam, which does not break the bubbles.

6 - Problems :

On 17 December 2005 two fire fighters from Tübingen, Germany, died inside a burning building when one of the hoses inside the building burst and they were left without extinguishing agent. In the following reconstruction of the tragedy experts were surprised to find out that CAFS filled hoses are more likely to burst under heat because the foam is unable to cool the hoses sufficiently.

Some fire district engines have experienced that CAFS filled hoses have a higher incidence of clogging and decrease in pressure.

Foam path

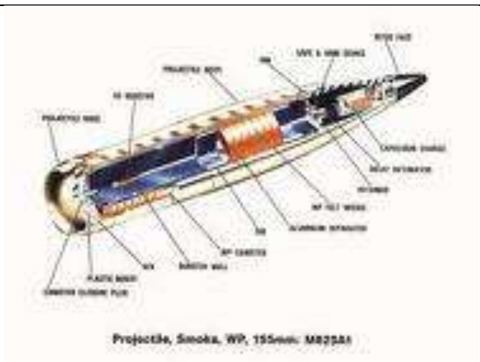
A **foam path** is the aviation safety practice of spreading a layer of fire suppression foam on an airport runway prior to an emergency landing. Originally, it was thought this would prevent fires, but the practice is now discouraged.

The U.S. FAA recommended foam paths for emergency landings beginning in 1966, but withdrew that recommendation in 1987, although it did not bar its use. In 2002, a circular recommended against using pre-foaming except in certain circumstances. In particular, the FAA was concerned that pre-foaming would deplete fire fighting foam supplies in the event they were needed to respond to a fire. Also, foam on the runway may decrease the effectiveness of the landing airplane's brakes, possibly leading to it overshooting the runway.

Foam is still used in aviation firefighting, usually in conjunction with Purple-K dry chemical.

FOEM FOTO


أنواع مطافئ الحريق

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