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Performance Comparison Keeping in Mind Environmental Repercussions of Fluorine Free Foam and Standard Fluorinated Foams Used in Fire Fighting Industry

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Abstract: ***Fluorine Free Foams (F3) are very different to other firefighting foam. F3 is a superior quality synthetic fluorine free foam (F3) concentrate, designed for extinguishing and securing Class A and Class B chemical fires. F3 has been designed specifically for general emergency responders who are faced with a variety of risks in a range of situations.***

Keywords: Mind Environmental Repercussions, Fluorine Free Foam, Fluorinated Foams, Fire Fighting Industry

1. Introduction

The environment is everything that keeps us alive as well as our home. It enables us to survive by providing things like the food we eat, the water we drink, the air we breathe, our shelter, and more. As a result, protecting the environment ought to come naturally to us.

Chemical compounds and plastics possess high energy densities, and most of these materials are combustible. These materials possess properties of water repellence as well as are volatile in nature. Foam makes it feasible to put out such fuels.

Since foams are just so light, they can float on practically any liquid surface, which makes it possible to cover and extinguish liquid fuels. Water may wet and stick to surfaces that are water resistant because to the surfactants in foam. Only 0.2 to 10 percent of the volume of water in foam significantly lessens the collateral harm brought on by fire water. Foam can cover enormous spaces because of its extremely low density.

What is PFAS and PFOS?

PFAS:
Per - and poly - fluoroalkyl chemicals, such as synthetic organofluorine compounds, are referred to as PFAS. Multiple fluorine atoms are joined to an alkyl chain in these chemical compounds. These compounds' perfluoroalkyl is identified as - CnF2n - . This chemical group has more than 4000 members.

Additionally, it includes a division called fluorosurfactants. These substances have a hydrophilic head and a fluorinated tail. The reason they are referred to as surfactants is because of their head and tail structures. These surfactant molecules are far more efficient than hydrocarbon surfactant molecules at lowering the surface tension of water. Fluorosurfactants often have the ability to lower surface tension to a level that is around half that which can be achieved with hydrocarbon surfactants.

Typically, fluorocarbons are lipophilic. Because of this, these formations frequently gather at the liquid - air contact. Furthermore, these molecules do not experience attraction forces, which is what gives molecules their lipophilicity. The fluorine atoms have a strong electronegativity, which lowers the surfactant surface's polarizability.

PFOS:
Perfluorooctanesulfonic acid is PFOS. It belongs to the class of chemical compounds known as PFAS. PFOS is regarded as a global pollution and a fluorosurfactant that is anthropogenic. This substance can be created through industrial synthesis, or it can develop as a by - product as polymer materials degrade. Electrophilic fluorination and telomerization are the two main methods used to produce this chemical on an industrial basis.

PFOS's chemical name is C8F17O3S. Like other fluorocarbon compounds, it is a hydrophobic and lipophobic substance. Additionally, the sulfonate group gives this molecule more polarity. We can see that these chemicals are remarkably stable in both industrial settings and the environment, where they operate as pollutants. In addition, when compared to hydrocarbon surfactants, PFOS can reduce the surface tension of water.

The key difference between PFAS and PFOS is that PFAS refers to a group of compounds having multiple fluorine atoms attached to an alkyl chain, whereas PFOS refers to a member of the PFAS group having a carbon chain containing 8 carbon atoms.

PFAS is a large group of man - made compounds including PFOS, PFOA etc. The term PFAS stands for per - and poly - fluoroalkyl substances while the term PFOS stands for perfluorooctanesulfonic acid.

Fluorine Free Foams (F3):
Fluorine Free Foams **(**F3) are very different to other firefighting foam. F3 is a superior quality synthetic fluorine free foam (F3) concentrate, designed for extinguishing and securing Class A and Class B chemical fires. F3 has been designed specifically for general emergency responders who are faced with a variety of risks in a range of situations.

- Flouro surfactants act repelling to almost any other chemical hence were the big equalizer and stabilizer
- Lack of oil repellence and high level of witting capability leads to a much more intense interaction between fuel and foam
- The stable sensitivity of the bubble wall is one key to a successful foam
- Fuel interacting with the foam composition destroys the bubbles, destabilize foam and lead to burning blankets.
- **Composition –** Fluorine - free foam is made up of three main ingredients: water, solvents, and hydrocarbon surfactants. The fluoro surfactant is free of PFAS.
- **Film formation & performance –** Fluorine - free foam does not produce an aqueous layer that can be used to put out flames because it contains no PFAS. It instead relies on a bubble cushion. Higher expansion rates and air - aspirating nozzles might be necessary to increase effectiveness because this bubble blanket has been shown to be somewhat less effective than fluorinated foams's film.
- **Environmental & health effects –** Fluorine - free foams are composed of substances with low environmental impact with almost all compounds being used are biodegradable in nature
- **Legislative regulations –** Fluorine - free foams have little to no environmental impact, thus it's doubtful that any laws regulating or banning them will apply to them. More rules may be established for training, testing, discharging, and disposing of foam.

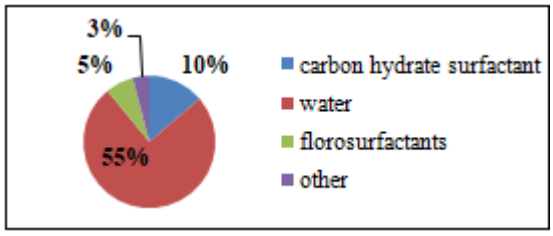


Figure 1: Fluorinated Foam Composition

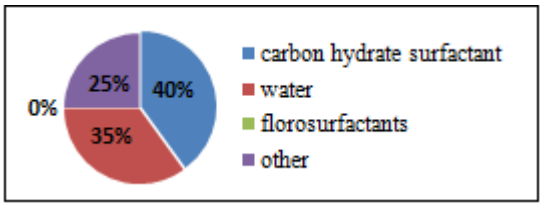


Figure 2: F3 Composition

Fluorine Free Foam (F3) VS. Fluorinated Foams:

It is well understood that fluorine - free foam requires more volume and special equipment to make it effective, but doesn't pose any risk to the environment. On the other hand, fluorinated foams is an incredibly effective extinguishing agent, but poses extreme risks to the environment and those who live within it.

- **Fluorine free foam (F3) is a synthetic** - based foam that contains surfactant blends and, in many cases, polysaccharides. It creates a blanket of bubbles above fire fuels and cools them to extinguish fires quickly.
- **Fluorinated Foams:** A foam made of synthetic materials called fluorinated foams contains fluorinated and hydrocarbon - based surfactants, such as perfluoroalkyl or polyfluoroalkyl compounds (PFAS). It produces a film that covers the fire fuels, thereby blocking any oxygen from reaching them and chilling them to stop hot fuels from re - igniting. It has traditionally been the preferred and most efficient method for putting out even the most difficult flames.

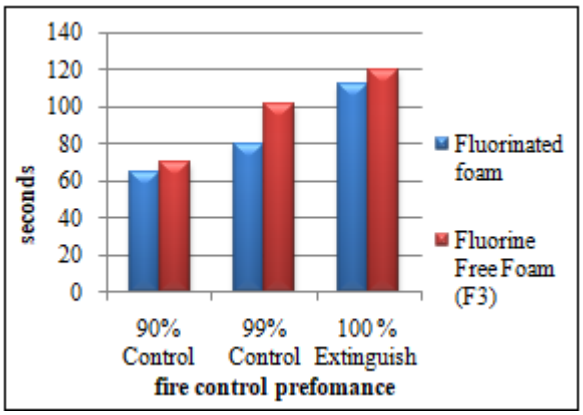
Practical Fire test on heptanes of using F3 foams and fluorinated foams to get their performance comparison. Following images shows some pictures taken during the test with representation of F3 foams vs. their counterpart fluorinated foams with 90 % control on fire.

FLUORINATED FOAM 90% Control

Fluorine Free Foam (F3) 90% Control

It is very much clear from the pictures that in the F3 foams even with 90% control the fire is spread over the testing tray and in the fluorinated foam the fire is controlled in almost area with fire happening in only one section

Florinated Foam VS Fluorine Free Foam (F3) Perfomance Charts:



2. Future Usage of F3 Foam

Use of non - fluorinated foam concentrates should be a priority for the entire fire fighting industry. But since there is considerable gap in the performance of Fluorine free foam (F3) and its counterpart so it has to be taken into picture that Fluorine free foam (F3) cannot be immediate substitute of standard fluorinated foams. Through coming research and development if the given reduces it can be easily considered that Fluorine free foam (F3) are going to easy substitute for the fluorinated foam compounds.

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