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The JOIFF Foam Summit

Lessons Learned and Tactics Forgotten

Choosing the Correct Foam

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Fluorinated vs Non-Fluorinated Foam?

- Firefighters the world over are faced with difficult decisions as to whether to switch to Fluorine Free Foams or to stay with the proven technology of using fluorinated foams.

- **There is no "RIGHT" or "WRONG" answer to this dilemma. The answer always starts with "<u>It Depends</u>"**

- Our goal here today is to provide some information about the two types of foams and to open up a discussion on when to use various foams based on the type of fire and tactics to be deployed.

Firefighting Foam at a Crossroads

- Worldwide Legislation on PFAS substances has sent the firefighting foam industry into a turmoil

- Outright bans or severe restrictions on use of perfluorinated substances are causing us to look closely into how we fight fires with foam.

What is a PFAS Substance?

- The term **"PFAS"** is used to describe per and **poly fluorinated alkyl substances**
- **PFAS substances are found in:**
  - Oil and grease resistant food packaging
  - Nonstick cookware
  - Stain resistant carpeting and fabrics and leather
  - Water resistant and breathable clothing
  - Paints and varnishes
  - Inks
  - Firefighting Foam

Fluorinated Surfactants

- **PFAS (per- and polyfluoroalkyl substances)**
  - Broad term that describes a range of products with differing characteristics, structures and intended uses
  - PFAS include long-chain substances such as PFOS and PFOA that are considered to be persistent, bioaccumulative and toxic (PBT) and are subject to regulatory restrictions in many areas
  - PFAS also include short-chain substances such as the C6 fluorosurfactants used in modern class B foams, which are considered to be low in toxicity and not bioaccumulative according to current regulatory criteria

Background – What is AFFF?

- **Aqueous Film Forming Foam (AFFF)**

- **AFFF agents are the most effective fire fighting foams currently available to control and extinguish hydrocarbon fuel fires by acting in following ways:**

  -- as aqueous foams, they act as primary fire extinguishing agents, and

  -- as aqueous **film formers** (as their name implies) they act as fuel vapor suppressors, augmenting the fire-extinguishing efficiency of the foam and preventing the ignition or re-ignition of the hydrocarbon fuel vapors

Background – Composition of AFFF

- **Fluorinated Surfactants**
- **Hydrocarbon Surfactants**
- **Organic Solvents**
- **Water**
- **Minor Ingredients Include:**
  - Corrosion Inhibitors
  - Inorganic Salts
  - Biocide
- **Polymer (Polysaccharide) in Alcohol Resistant AR-AFFF**

Fluorosurfactants in AFFF

- Fluorosurfactants are **THE** key ingredient in Film Forming Foams (i.e. AFFF, AR-AFFF, FFFP, AR-FFFP)

- They bring two important characteristics to the foam:
  1. Film forming capabilities
  2. Fuel sheading characteristics (oleophobicity)

Fluorinated Surfactants

- **Modern Fluorotelomer AFFF (C6)**
  - Foam manufacturers have now transitioned to the use of only short-chain (C6) fluorosurfactants
  - Do not contain or breakdown in the environment to PFOS or PFOA
  - Considered lower in toxicity and have significantly reduced bioaccumulative potential
  - Foams made with only short-chain (C6) fluorosurfactants likely contain trace quantities of PFOA and PFOA precursors as an unavoidable byproduct of the manufacturing process

Fluorinated Surfactants (continued)

- **Modern Fluorotelomer AFFF (C6)**
  - Hazards of Modern C6 Fluorotelomers used in AFFF are characterized by their potential breakdown product, perfluorohexanoic acid (PFHxA)
  - PFHxA is well studied with a robust body of data
    - Not a carcinogen
    - Not a mutagen
    - Not genotoxic
    - Not an endocrine disruptor
    - Not a reproductive developmental toxicant

So, What Does This Mean to Us? – On the Horns of a Dilemma

- **Stay With Fluorinated Foam or Switch to FFF?**
  - C6 Foams do not fall under the US EPA Drinking Water Advisory as they do not contain PFOS or PFOA in any significant quantities. (70 ppt combined concentration)
  - The question becomes – Will C6 foams be regulated in the near future because of PFAS awareness?
  - Fluorine Free Foams (FFF) have not been proven to be as effective in large fuel in-depth fires. But that doesn't mean they cannot work!
  - Fluorine Free Foams can have their own environmental issues. e.g., higher aquatic toxicity – but NOT persistent!

A Closer Look at When to use Fluorinated Foams

- Basically, fluorinated foams are recommended anytime the fire is large and "fuel in depth"

- High vapor pressure fuels are often more difficult than lower vapor pressure fuels – fluorinated foams tend to be better here

- Fluorine Free Foams are inherently oleophilic so will pick up fuel if plunged below the fuel surface. In contrast, fluorinated foams are oleophobic.

A Closer Look at When to use Fluorinated Foams

- Fluorinated foams are available as 1X3 agents (logistical advantages here)
- Fluorinated Foams are less affected by lower foam quality (Expansion & Drain Time) than are Fluorine Free Foams
  - Can use non-aspirating foam nozzles = longer range and ability to punch through thermal updrafts of the fire
  - Provide “sloppier” foam that flows well on a fuel surface
  - “Sloppier” foam provides more cooling at the foam / fuel interface
  - Non-aspirated foams can be projected further than air aspirated foams. (It’s all about energy usage)

A Closer Look at *Fluorinated Foams*

- **PROS:**
  - Proven fire performance
  - Lower Critical Rate of Application than FFF
  - Less dependent upon “good” foam quality
  - Available in 1X3
  - Compatibility between like types of fluorinated foams
- **CONS:**
  - Environmental pressures not going away
  - Potential for ground water contamination
  - Potential health risks?
  - Are C6 products as good as older C8 products?
  - Post fire clean up cost

Fluorine Free Foams

- Most foam manufacturers have developed Fluorine Free Foams (FFF) that provide an alternative to fluorinated foams in many if not **most** applications.

- Some do not have fire performance across all fuels and in all operational circumstances equal to fluorinated products. Look for EN, UL or FM foams – not emulsifiers or wetting agents.

- 2011 paper by Naval Research Labs showed that AFFF agents extinguished gasoline and heptane fires about 70-80% faster than FFF, but we have come a long way since that study. The future is bright for FFF.

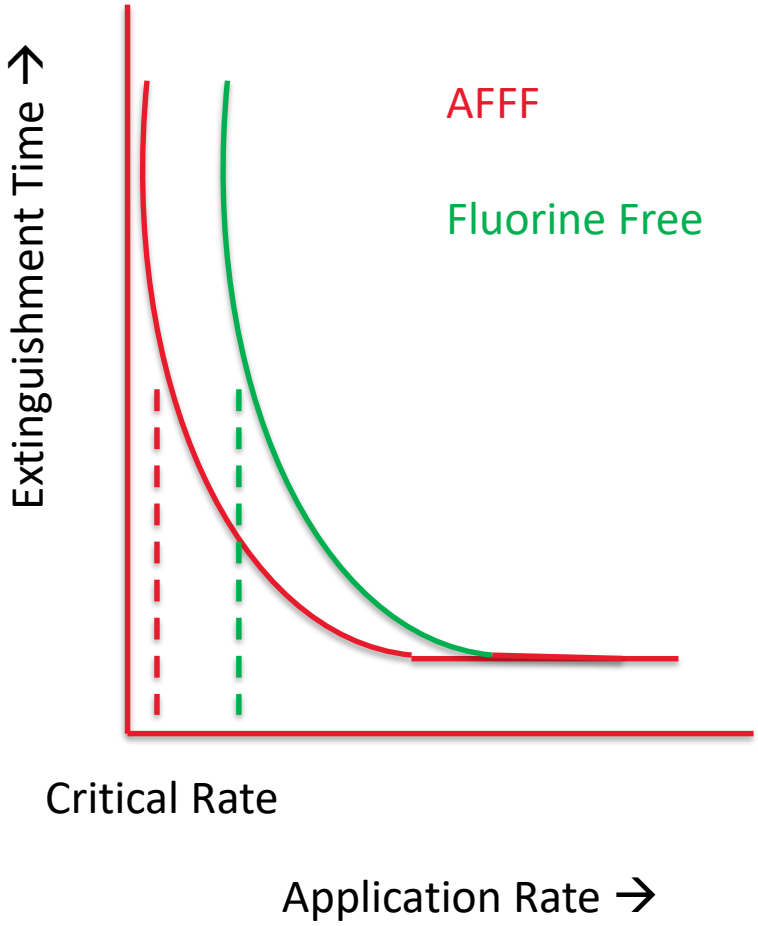
A Closer Look at *Fluorine Free Foams*

- **PROS:**
  - Not a PBT or PMT product (silicone surfactants?)
  - Proven effective in many scenarios
  - No known significant long-term health issues associated with these products
  - FFF foams are widely accepted for training
  - Post fire clean up cost

- **CONS:**
  - Not field proven for large fuel in-depth fires
  - Higher critical application rate than fluorinated counterparts (logistical issues here with large fires)
  - Much more sensitive to foam quality
  - Like products are often not compatible with each other in long term storage
  - Not available in 1X3 (logistical issues here with large fires)

Application Rates

- Generally an AFFF has a lower critical application rate
- As the application rate gets higher the extinguishment time gets shorter
- What is lesson here? – “Don’t Fight Fair” – bring juice to the fire. Application rate is King
- Increasing the application rate will lead to faster extinguishment time and more product saved.



Thinking Outside the Box

- Use Fluorinated Foam (1X3) for extinguishment of large fuel in-depth fires
- Use non-fluorinated product for post incident vapor suppression (typically, more foam used here than in extinguishment)
- Deploy FFF for most fires – have both types on hand
- Keep the fluorinated foam in the tank!!!! – Not on the ground!!! i.e. new / old generation discharge devices. Subsurface, Semi-subsurface, Foam Pourers / Chambers

Modified Subsurface Injection

Summary

- Avoid the PFAS alphabet soup
- C6 chemistry has a much lower environmental impact and toxicity profiles when compared to C8 chemistry
- The market is driving the use of fluorine free foams for all applications other than large fuel in-depth fires
- The performance gap between fluorine free and fluorinated foams continues to narrow
- Foam hardware design and application techniques can help alleviate fuel pick up problems associated with FFF
- Use third party certified products consistent with the intended end-use
- Hazard assessment and emergency planning is paramount to success with **ANY FOAM!!**

Thank You