

Transfer from C8 to C6 in Foam Technology

An Agents
Development
Perspective

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Fire Protection Products

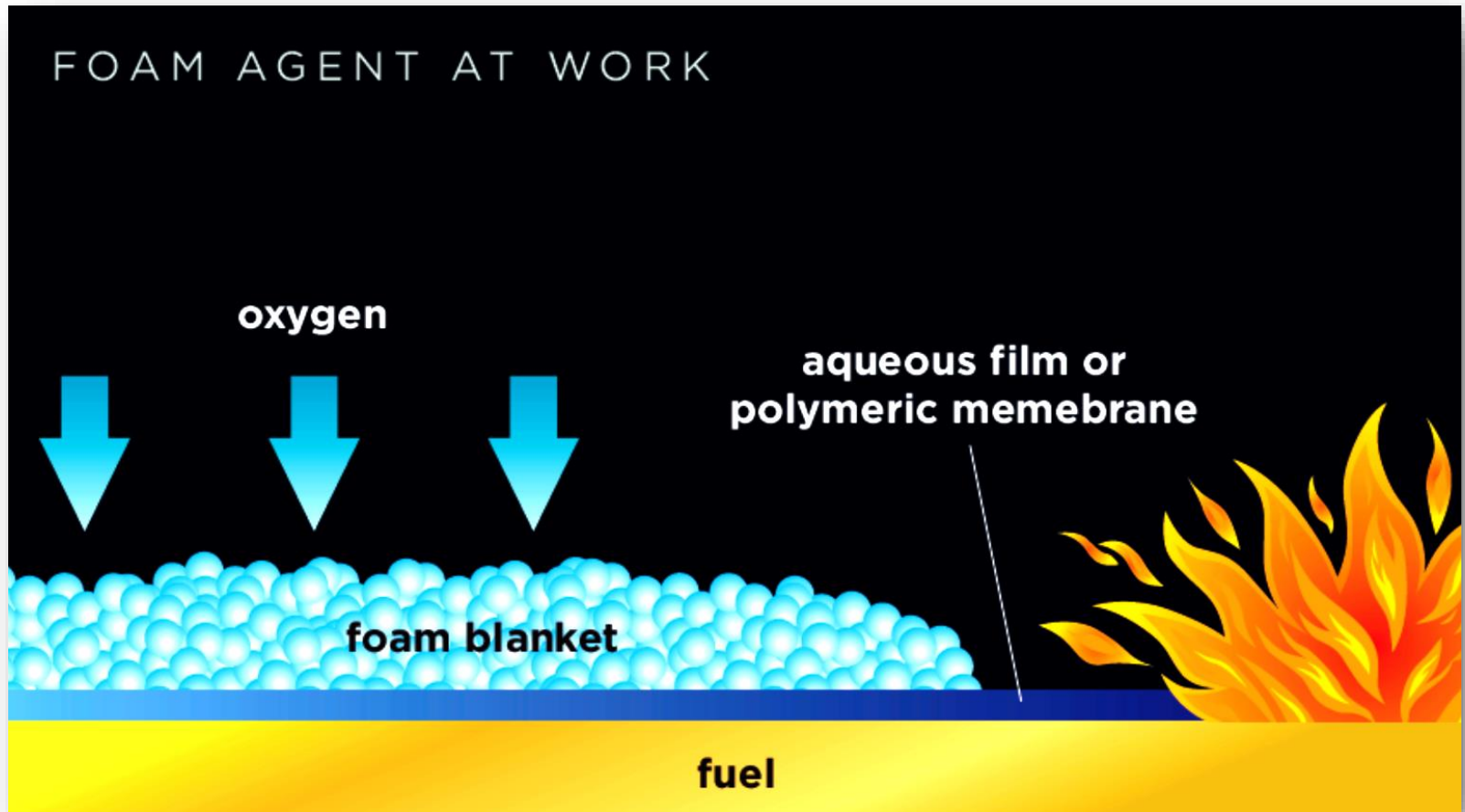
Transfer from C8 to C6 in Foam Technology – An Agents Development Perspective

- Foam Chemistry Background
- Foam Technology
- Challenges with the Transfer

Foam Chemistry Background



How Foams Work

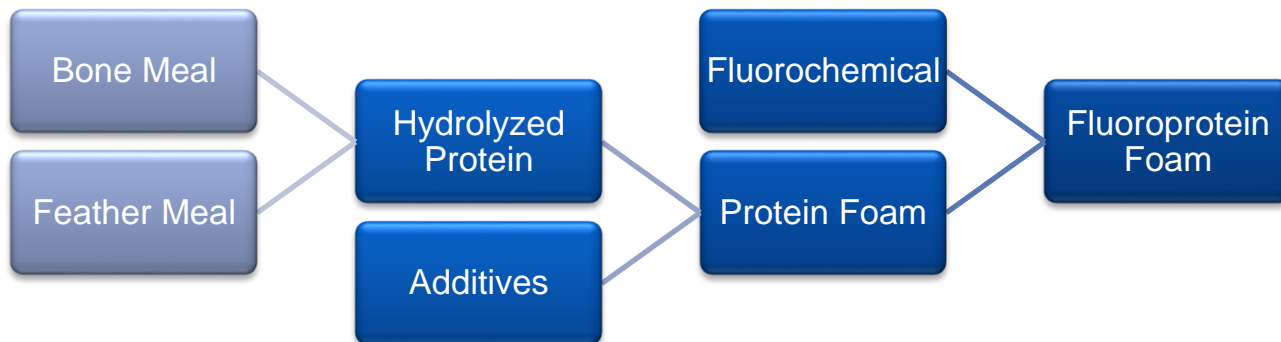


Types of Foam that contain Fluorochemicals

- Fluoroprotein
- Film Forming Fluoroprotein (FFFP)
- Aqueous Film Forming Foam (AFFF)
- Alcohol Resistant (AR-AFFF)

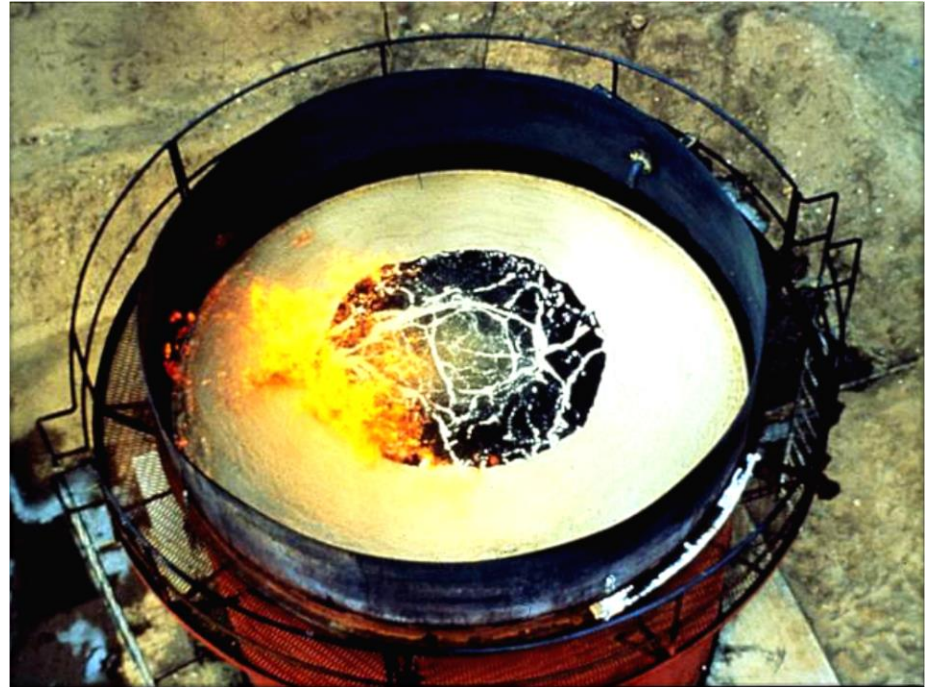
Fluoroprotein Foam

- Standard protein foam is derived from bone and feather meal
- fluorochemicals are added to increase the oleophobicity of the foam
- Fluoroprotein foams offer decreased extinguishment times over protein foams
- Faster mobility than protein alone
- Foam blanket is often less durable than standard protein foam

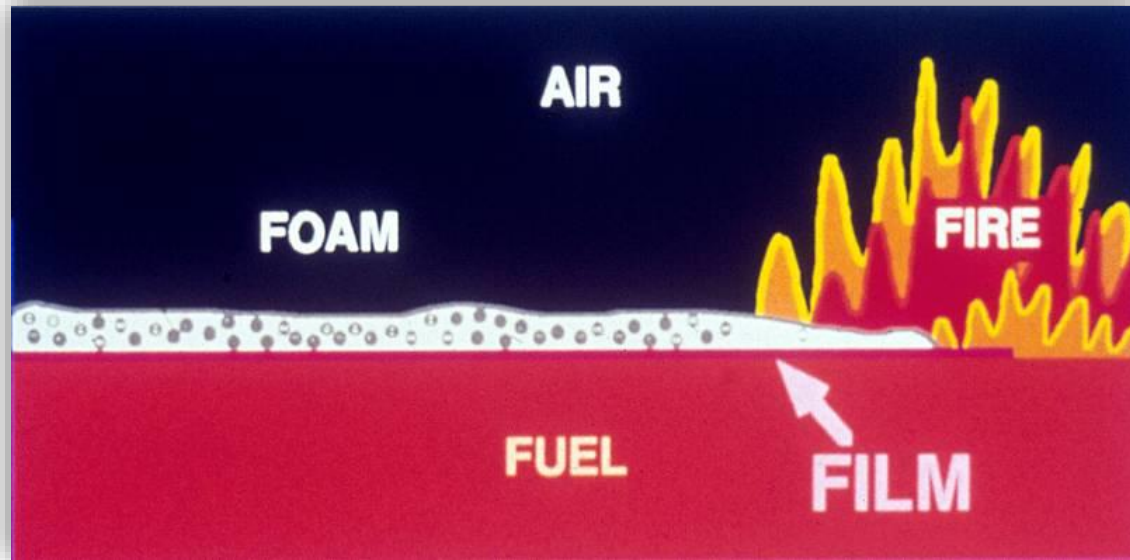


Film Forming Fluoroprotein Foam

- More fluorochemical is added to a fluoroprotein formulation which lowers the surface tension to the point where a film is formed
- Extinguishment times decreased over fluoroprotein foams
- Foam blanket is often less durable than standard protein and fluoroprotein foams

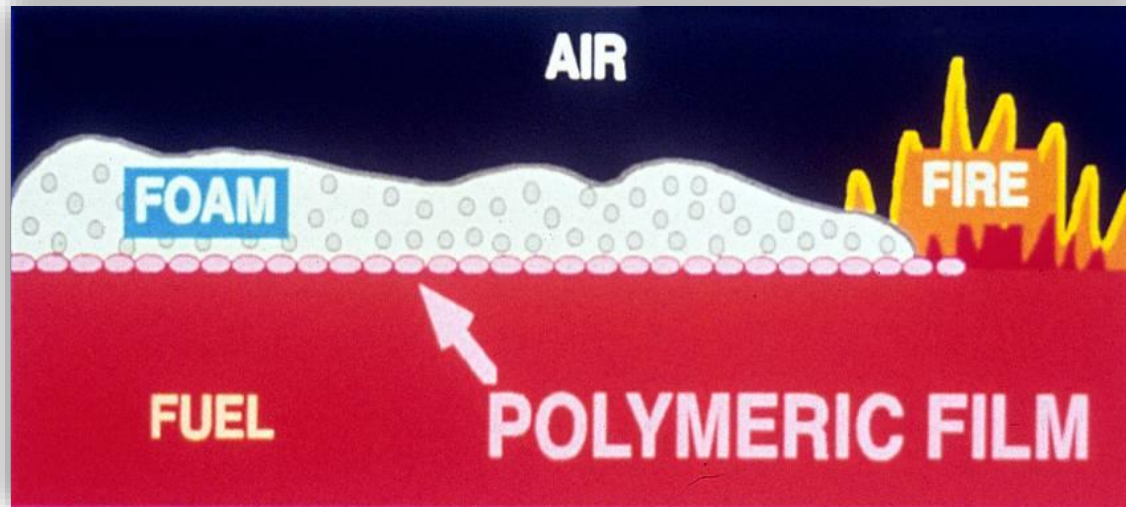


Aqueous Film Forming Foams (AFFF)



- Low surface tension
- Rapidly spreads across surface (highly mobile)
- Quick knockdown

Alcohol Resistant Aqueous Film Forming Foams (AR-AFFF)



- Adds a polymeric membrane
- Separates the foam and the fuel preventing typical breakdown seen in foams that are not alcohol resistant
- Polymer has the added benefit of increasing the drain time
- Maintains all the benefits of a normal AFFF

Foam Technology



Foam Technology – 3 Parts to Consider

- Fire Test Standards
- Agents Development
- Fire Testing

Fire Test Standards – the Requirements Part

Typical Measurements

Foam Proportioning
(% of foam concentrate)

Foam Quality

- Foam expansion (expansion ratio)
- Foam drain time (25% drain time)

Fire Performance

- Control time
- Extinguishment time
- Resistance to re-ignition (burn back)



Fire Test Standards – a portion from around the world

- EN1568-3, -4 (Europe)
- UL 162 (Underwriters Laboratories)
- FM 5103 (FM Global)
- MIL-F-24385F (US Navy, also FAA)
- LAST Fire (Resource Protection International)
- OF-555C (US Coast Guard as adopted by NFPA11)
- Defense Standard 42-40 (UK Ministry of Defense)
- IMO MSC.1/Circ.1312 (International Maritime Organization)
- ICAO (International Civil Aviation Organization)
- ISO 7203-1,-3 (International Organization for Standardization)
- DEF(AUST)5706 (Australian Defense)
- Chinese National Standard GB15308

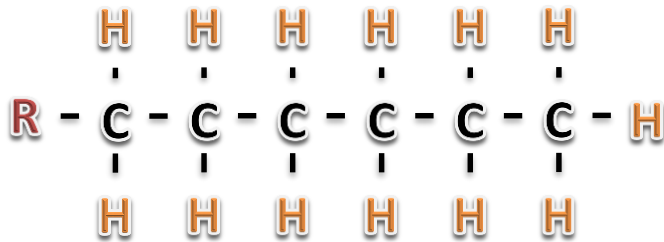
Agents Development – the Formulating Part

Formulating fire fighting foams for the transition from C8 to C6 based fluorochemicals

- These are generally the main components of a firefighting foam
 - Surfactants
 - Hydrocarbon surfactants
 - Fluorochemical surfactants
 - Solvents
 - Water
 - Glycols
 - Polysaccharides for alcohol resistant products
- Changing from C8 to C6 based fluorochemicals may require changes to more than just the fluorochemical portion of the product
 - C6 based fluorochemicals may not always be a 1:1 replacement for C8 based materials

Surfactants

Hydrocarbon Surfactants



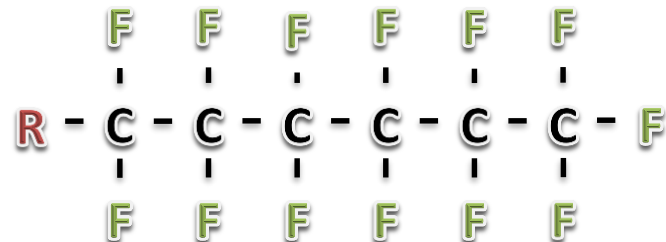
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1.008

H

Hydrogen

Fluorochemical Surfactants



9

18.998

F

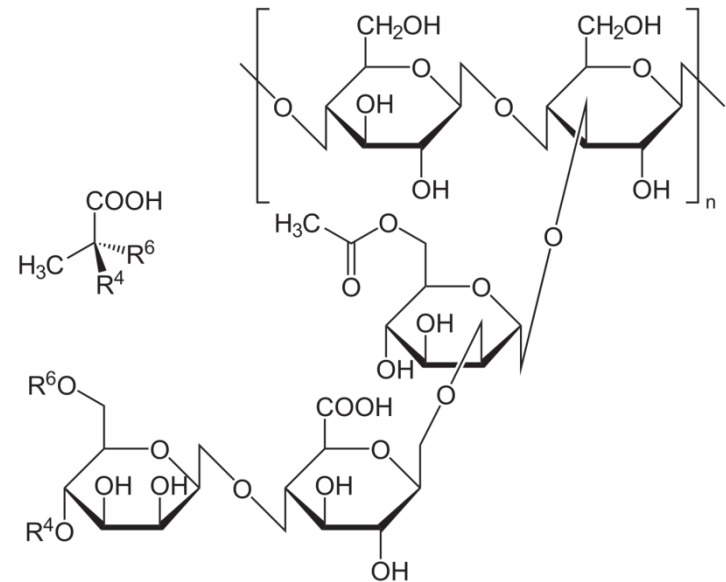
Fluorine

Solvents

- Can provide freeze protection
- Generally work to help put everything in solution

Polysaccharides

- Contribute to the polar solvent (water miscible) performance of AR-type products
- Use results in viscous finished products



Fire Testing – the Evaluation Part

Evaluating reformulated fire fighting foams to fire test standards

- These are generally the main components of a fire test:
 - Control Time
 - Total Extinguishment
 - Burn back Resistance
- There are many variables to control during a given fire test that can impact the results

Fire Testing – Variables

Variables to control

- Application Rate (flow rate/area)
- Nozzle type
- Fuel type
- Application type (forceful, gentle, type II, type III, sprinkler)
- Fire test pan shape, and freeboard height
- Application time (and waiting period)
- Preburn time
- Operator involvement



Foam Technology

- C8 based fluorochemicals aided in both the extinguishment and burn back capability of firefighting agents
- C8 based fluorochemicals were also critical to sprinkler performance
- Changing from C8 to C6 based fluorochemicals may require changes to more than just the fluorochemical portion of the product
- C6 based fluorochemicals may not be a 1:1 substitution for C8 when trying to maintain existing performance levels

Challenges with the Transfer



C8 to C6 Conversion

- In general, it is clear what we need to do in replacing the C8 components in firefighting foams – take out the C8 and put in C6 based raw materials
- In practice, there have been some challenges to this effort and it has been a very time consuming and expensive effort



Challenges of the C8 to C6 Conversion

- We have found that it may be necessary to increase the C6 based fluorochemical content in the product to achieve the desired performance level when replacing the C8 content
- It may also be necessary to change more than just the fluorochemical content in a product when replacing the C8 content
- Because of these two points, the cost of C6 based finished products are generally higher than historical C8 based ones
- Reformulated products also require new listings in many cases

Challenges of the C8 to C6 Conversion

- From a development standpoint, different types of foams have taken different amounts of time to reformulate for C6 compliance and ensure stability and performance requirements for the market
- The transition for C8/C6 containing formulas to solely C6 based ones has been most difficult for sprinkler performance
- Not necessarily from an extinguishment perspective, but with having a strong enough foam blanket to not open up during the water deluge portion of the test

Challenges of the C8 to C6 Conversion

- We consider these C6 based products as next generation, and in some cases they are being asked to pass multiple fire test performance requirements, or new performance requirements that come on the market
- Time to market has been impacted by needing to obtain agency approvals and also from a regulatory standpoint; having the appropriate global inventory registrations for the C6-based fluorochemicals in place

Thank You