Evaluation of the Firefighting Effectiveness of Fluorine Free Foams

Project Goal & Approach

The Fire Protection Research Foundation (FPRF) initiated a blind study to assess the firefighting capabilities (extinguishment and burnback times) of five commercially available, UL listed (UL 162) Fluorine Free Foams (FFFs) (three Alcohol Resistant (AR) and two Hydrocarbon approved (H)) and one short chain C6 Aqueous Film Forming Foam (AFFF) formulation (for baseline) as a function of application rate (gpm/ft^2) and foam discharge density (gal/ft^2) for a range of test parameters including foam quality/aspiration (air-aspirated and non-air-aspirated), fuel type (heptane, gasoline (MILSPEC and E10), and IPA), water type (fresh and salt) and fuel temperature (ambient and elevated).

The assessment was conducted on "approval scale" size fires (i.e., 50 ft^2 pan/pool fires) using two types of application: UL Type II with polar solvents and UL Type III with the hydrocarbon-based fuels. During the Type II tests, the nozzle was fixed and positioned/aimed such that the spray impacted a backboard located on the opposite side the pan (indirect application). During the Type III tests, the foam was manually applied directly onto the fuel surface.

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Sponsored by:

American Petroleum Institute
Angus International
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Shell Oil Company

Summary Observations

One hundred sixty-five tests were conducted during this assessment. To summarize the results, the baseline C6 AR-AFFF demonstrated consistent/superior firefighting capabilities through the entire test program under all test conditions and test fuels. The FFFs did well against heptane but struggled against some of the scenarios conducted with IPA and gasoline (both MILSPEC and E10), especially when the foam was discharged with a lower foam quality/aspiration. From an application rate perspective, the FFFs typically required between 1.5 to 3 times the application rates to produce comparable performance as the baseline AR-AFFF for the range of parameters included in this assessment. From an extinguishment density perspective, the extinguishment densities for the FFFs were typically 2-7 times greater than the baseline AR-AFFF and were determined to be both manufacturer and fuel type dependent.

The three major findings of the study include; foam quality/aspiration effects on the firefighting capabilities of FFFs, variations in extinguishment difficulty associated with fuel type and variations in capabilities between listed FFFs.

With respect to foam quality/aspiration, the lower foam qualities/aspiration rates caused between a 20-50% increase in extinguishment densities as compared to the higher foam qualities/aspiration rates and had a greater impact on the alcohol resistant foams than the foams approved strictly for hydrocarbon fuels.

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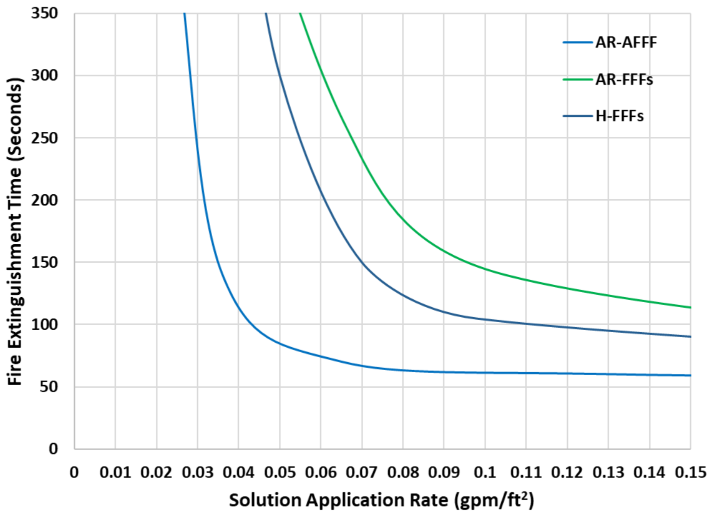

Figure 1: Fluorine Free Foam Firefighting Capabilities Comparison (hydrocarbon fuels and aspirated foam)

Summary Observations Continued...

With respect to the extinguishment difficulty between test fuels, it appears that MILSPEC gasoline is twice as hard to extinguish as heptane (the approval/listing test fuel), E10 gasoline is twice as hard as MILSPEC gasoline (four times as hard as heptane) and IPA is twice as hard as E10 gasoline (eight times as hard as heptane), all based on extinguishment densities (i.e., gal/ft^2 required to extinguish the fire). It was also observed that IPA could not be extinguished by directly applying the foam onto the fuel surface but rather required an indirect attack (bouncing off the pan sides) to be effective.

For the FFFs in general, the firefighting capabilities of the foams varied from manufacturer to manufacturer, making it difficult to develop "generic" design requirements. This may also be the case with AFFFs but only one was tested during this program (i.e., no data to assess variability).

When comparing capabilities of the types of FFFs, the H-FFFs typically out-performed the AR-FFFs requiring a 30% reduced application rate to achieve comparable performance. "L" curves illustrating the capabilities of the foam types against hydrocarbon fires as a function of application rate are shown in Figure 1 for higher quality/air aspirated foam.

In summary, the results demonstrate that FFFs have come a long way but there is still a lot more to learn about their capabilities and limitations (although there is a lot of promising data). As of today, FFFs are not a "drop in" replacement for AFFF. However, some can be made to perform effectively as an AFFF alternative with proper testing and design (i.e., with higher application rates/densities and air-aspirating nozzles). Ultimately, end users will need to design and install within the listed parameters in order to ensure a high probability of success during an actual event. This applies not only to the discharge devices but also to the proportioning systems as well (due to the highly viscous nature of some of the FFF concentrates).

Final report is available here