FIRE
MIDDLE EAST

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HEALTH & SAFETY

HAZARDS & RISKS

EMERGENCY RESPONSE TRAINING

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FIRE STOPPING

Is CAFS a solution?

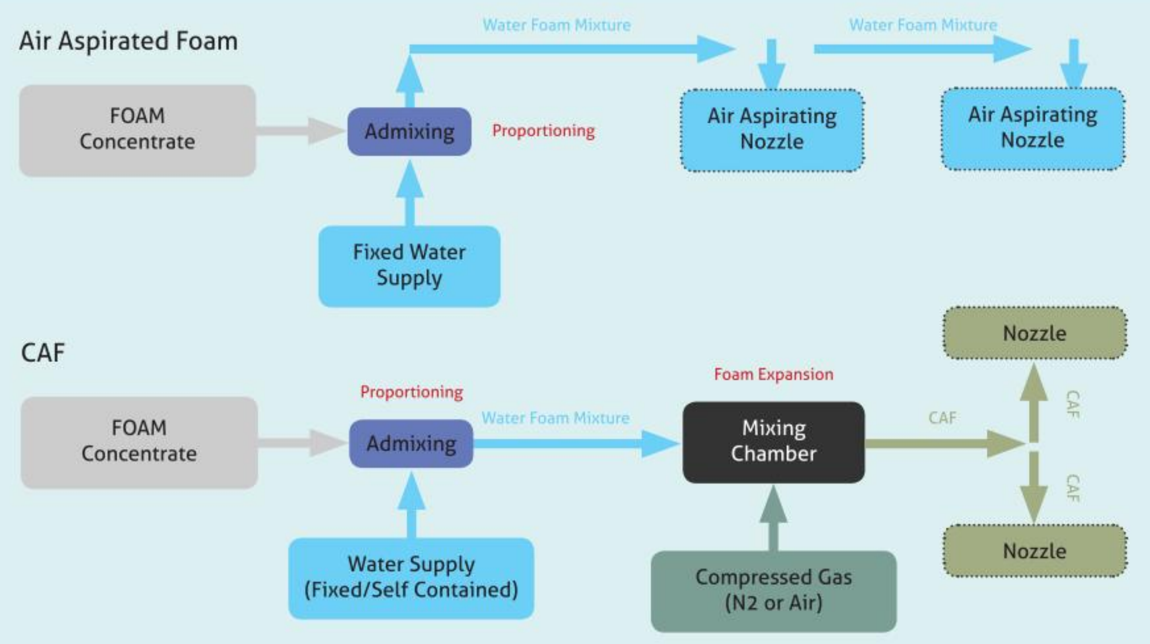
"Compressed Air Foam (CAF) is a homogenous foam produced by the combination of water, foam concentrate, and air or nitrogen under pressure"

NFPA 11 (2016) Standard for low, medium and high expansion foam under point 3.3.10.1

In parts of the world there are legislative moves to either restrict or ban the use of all fluorinated foam agents which is further adding to the debate on the performance of FF foam agent writes ANDY HALL, Hall Fire Safety Consultant. In amongst the debate on new formulation foam agents we have seen a resurgence and renewed interest in the use of CAFS (Compressed Air Foam System).

GLOBAL ENVIRONMENTAL LEGISLATION has led to new "Pure C6" formulations for fluorinated foam agents (e.g. AFFF, FP, FFFP and their alcohol resistant versions), as well as Fluorine Free foam agents appearing on the market. In line with the US EPA PFOA Stewardship programmes goal since the end of 2016 all the major foam manufacturers discontinued older "C8" containing formulations for their fluorinated foam agents. Since then the market has had to deal with claims and counterclaims regarding the firefighting performance of C6 v FF, or in some cases about particular brands of foam agent.

THE DIFFERENCE BETWEEN A NORMALLY (AIR ASPIRATED) FOAM SYSTEM AND THE CAF SYSTEM



With the air aspirated, foam solution travels along the pipe or hose to a discharge device where the air and energy are added to create the finished foam. With CAF an additional Mixing Chamber is added where the foam solution and air / N2 are accurately mixed to create the finished foam (CAF). The discharge devices for CAF DO NOT add air or energy and are in fact just "aiming devices".

Whilst independent testing shows an increasing number of fluorinated and FF agents achieving good performance levels with top side testing to UL 162, FM 5130, EN 1568 Parts 3 & 4, and ICAO performance standards, question marks remain over performance when used with sprinklers, or to test criteria to simulate a tank fire created by Lastfire, an international forum of oil companies developing best practice guidance in storage tank fire hazard management.

FAR FROM NEW

In firefighting particularly, CAF is not a new technology and evidence exists of CAF being used as early as the 1930's in parts of Europe on mobile devices. After the second world war when foaming of a runway prior to a landing an aircraft with landing gear malfunction was still operational practice there are reports from Sweden that their Foaming Trucks used a type of CAF. With the change to Film Forming foams in the 60's from protein foam for use on Class B fires, the aviation sector and military also moved away from the use of CAF in their operations.

Moving forward to the early 80's we see the re-emergence of CAF when Mark Cummins developed a water expansion system known as the "Texas Snow Job" and promoted the use of CAF with Class A detergents for use in municipal and forest (wild) fire applications. Through the 80's and into the 90's further development with pump manufacturers such as W.S. Darley & Sons led to the development of rotary air compressors, centrifugal pumps and direct-injection foam proportioning systems being used on mobile firefighting appliances. Municipal brigades in Germany and Australia, as well as parts of the USA and Canada have also used CAF with Class A foams and/or wetting agents for use on structural fires.

MODERN AVIATION FIREFIGHTING

The Aviation sector started to look at CAF again in the 90's and early 00's as it was believed that CAF offered "better performance" over normally aspirated foam. Copenhagen Airport, Kastrup has used CAF equipped ARFF vehicles since 2007 and Kim T. Olsen, Assistant Fire Chief, advised that because of the limited amount of water and foam agent on the vehicle for ARFF applications better performance means that they can effectively control a larger PCA (Practical Critical Area) with the same amount of agent, or achieve control in a faster time for the same size PCA. Additionally, he added that at Copenhagen, Kastrup we were very concerned with the negative environmental impact from using fluorinated foam agents and whilst we were already switching to an ICAO Level B Fluorine Free foam we did believe that Fluorine Free foam delivered as a CAF would achieve improved performance over normally aspirated foam.

Kim Olsen's beliefs were backed up by testing carried out by the UK's Civil Aviation Authority in cooperation with amongst others Copenhagen Airport and Changi Airport Group, Singapore at CNPP test facilities in France in 2012. In the Test Report PN 12 8913 dated 7th June 2012 they reported on comparative testing on an 86m2 kerosene fuel fire with normally aspirated and CAF generated ICAO level B AFFF, and Fluorine Free foam. In these tests the foam solution flow rates for normally aspirated and CAF were the same, and each of the tests with CAF showed faster control and extinguishment, as well as improved burn back resistance with the CAF performances with the AFFF and Fluorine Free foam very similar.

INTERNATIONAL STANDARDS

A quick review of EN 16327 Fire-fighting – Positive pressure proportioning systems (PPPS) and compressed-air foam systems (CAFS) indicates that this standard provides no information on fire

CAF discharge onto training prop at Copenhagen airport training facility

Pump / CAF compartment on Rosenbauer Panther ARFF vehicle at CPH

performance with CAFS. In fact, the only mention in section 3.5 dry foam is "Finished foam from CAFS is tested as described in Annex D, which is based on EN 1568-3 principles". Annex D covers testing for Expansion Ratio, and quarter drain time which any fire performance based on fire testing of the agent as a normally aspirated agent as in EN 1568-3... No recognition of the improved fire performance of a CAF generated finished foam.

Whilst European standards are still looking at CAFS as part of a mobile firefighting unit, over in North America CAFS has moved forward as a "Engineered System". CAFS now has its own chapter (chapter 7) within NFPA 11.

Within the chapter rates of application are covered under 7.15 Discharge Density : "The design discharge density shall be in accordance with the applicable occupancy standards and in accordance with the manufacturers listing but in no case less than 1.63 lpm/m2 for hydrocarbon fuel applications and 2.3 lpm/m2 for alcohol and ketone applications". Compared to sprinkler listings with normally aspirated foams these are 70 – 75% lower rates of application.

Under 7.10.1 it also states, "Compressed air foam systems shall be designed and installed in accordance with their listing for the specific hazard and protection objectives specified in the listing."

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These tables are from the approval testing to FM 5130 carried out by two manufacturers of "Engineered CAF Systems", Messrs. Fireflex Systems Inc. from Quebec in Canada, and Messrs. ACAF Systems Inc. from Rhode Island, USA. Both companies have developed engineered CAF systems which also include the discharge nozzles and the engineering limitations in terms of pipe sizing and lengths, spacing and height limitations for discharge devices.

FUEL	CONCENTRATE	DISCHARGE DEVICE DESCRIPTION	SYSTEM TYPE	NOZZLE HEIGHT		MAXIMUM NOZZLES PER SYSTEM	SPACING OR MAXIMUM AREA OF COVERAGE PER NOZZLE FT² (M²)	SYSTEM CAPACITY		MINIMUM DESIGN APPLICATION RATE	MAXIMUM SPINKLER DENSITY
				MIN FT (M)	MAX FT (M)	(IF APPLICABLE PER ABOVE SYSTEM DESCRIPTION)		GALLONS (LITERS)	MINUTES	GAL/MIN/FT² (MM/MIN)	GAL/MIN/FT² (MM/MIN)
Hydro carbon	ANSULITE 3x3 Low Viscosity at 2% concentration	TAR 225L Nozzle	Fixed Spray-Type System	N/A	N/A	Use as directed in design manual to provide coverage over protected surfaces according to published distribution patterns. System can support 1 to 32 nozzles.	Refer to design manual for distribution pattern figures.	Deter mined by FireFlex software	5	0.04 (1.63)	0.30 (12.2)

FUEL	CONCENTRATE	DISCHARGE DEVICE DESCRIPTION	NOZZLE HEIGHT		MAXIMUM NOZZLES PER SYSTEM	SPACING OR MAXIMUM AREA OF COVERAGE PER NOZZLE FT² (M²)	FOAM CONCENTRATE REQUIRED		MINIMUM DESIGN APPLICATION RATE
			MIN FT (M)	MAX FT (M)			GALLONS (LITERS)	MINIMUM DISCHARGE TIME (MINUTES)	GAL/MIN/FT² (MM/MIN)
Hydro carbon	Solberg Re-Healing RF3	DN-7, pendent	6	49	2	169	17	10	0.05
			(1.82)	(14.94)		(15.7)	(64)		(.20)
			6	49	4	169	28	10	0.05
			(1.82)	(14.94)		(15.7)	(106)		(.20)
			6	49	8	169	47	10	0.05
			(1.82)	(14.94)		(15.7)	(178)		(.20)
			6	49	16	169	44	10	0.05
			(1.82)	(14.94)		(15.7)	(167)		(.20)

Normally Air Aspirated discharge

CAF discharge

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SUPERIOR PERFORMANCE?

When considering why do we see such superior performance with CAFS, Dave Munroe, President ACAF Systems responded "Engineered CAF provides a uniform finished foam of very small strong bubbles. These bubbles are better able to penetrate the flame plumes so that more foam bubbles reach the fuel surface faster, and then provide a superior fuel-vapour barrier than the bubbles from normally aspirated systems. This results in faster extinguishment and superior burn-back times"

Jonathan Roger, General Manager Fireflex Systems agreed pointing out the extensive development and testing work carried out by The National Research Council of Canada (NRCC) in the early 2000's which assessed the fire suppression characteristics of CAF as an agent compared to normally aspirated foam. He stated that "This testing carried out by the NRCC and many hundreds of fire tests carried out subsequently by Fireflex have demonstrated that foam fire suppression performance is directly related to the quality of the foam blanket".

He went on to emphasise that "engineered CAF needs to be thought of as its own substance. It's not just a simple mixture of foam, water and air but you also need to consider the equipment and the design parameters so that the end result is the consistent highly stable foam blanket"

Photos of CAF discharge courtesy of Messrs Fireflex (top) and Messrs ACAF (botoom)

TESTING & APPROVALS

Jonathan Roger confirmed that "As per NFPA 11 the first requirement for the foam concentrate is that it is listed, and that in North America this means UL 162 and FM 5130. Fireflex tested and approved our systems with Ansulite AFFF 3% and Ansulite AR AFFF 3 x 3, and achieved outstanding performance on hydrocarbons based on using a 2% foam solution with the AFFF, and on alcohols and ketones with a 6% solution of the AR AFFF". He added "We have done some testing with a fluorine free foam agent and the results look very encouraging".

ACAF took a different approach and decided to test and approve their systems with a Fluorine Free foam concentrate explained Dave Munroe, "we achieved very similar performance with the 3% Fluorine free agent to what we had previously with a C8 AFFF.

Unfortunately, the supplier could not offer us a listed Alcohol Resistant Fluorine free agent when we went for approval so our approvals for polar solvents are with their C6 AR AFFF and we used a 6% solution".

OTHER TESTING

In 2016 SP Technical Research Institute of Sweden (now RISE) as part of the ETANKFIRE project, which is looking at the extinguishment of large ethanol tank fire ran a series of smaller scale fire tests with CAF in comparison to the same foam concentrate being delivered as a low expansion and medium expansion finished foam.

In the summary of the report 2016:56 it states "the results also showed the importance of improving the characteristics of the finished foam (i.e. higher foam expansion and longer drainage time) resulting in significantly improved fire performance.

Henry Persson, the lead scientist on the programme advised that "the fire tests carried out using CAF showed significantly better extinguishment and burn back compared to normally aspirated. Further we ran fire tests with CAFs with a foam chamber and even as a type III (direct) application and again the CAFs generated foam was successful, where the normally aspirated foam did not achieve extinguishment."

Application-based fire performance testing where CAF was used was also conducted in 2017 by Lastfire which embarked on a test programme incorporating small-scale and "real life" tank fire situations using both fluorine free and high purity C6 formulations. Within the test protocol the foams were applied as "normally aspirated" and also as CAF.

Although the full test reports are internal to the Lastfire member companies an article was published in Petroleum Review – August 2018 where one of the test conclusions was reported as "CAF application can be very forgiving of foam concentrate quality and gives the possibility of lowering application rates and still maintaining the same levels of performance"

Dr. Niall Ramsden of ENRg Consultants, coordinator of the Lastfire test programme confirmed that CAF application method was used with both Fluorine Free and C6 formulations "with similar fire performance". He also advised that "in October this year the next phase of testing will take place in collaboration with Dallas Fort Worth with a series of fire tests with a fire size of approximately 320 m2 and 50% of the tests will utilise CAF"

CONCLUSIONS FOR CLASS B FIRE HAZARDS

The evidence, based on the FM approvals and the fire testing carried out by LASTFIRE and SP (RISE), indicates that a CAFS generated finished foam out performs a normally aspirated foam created from the same foam concentrate.

Based on the FM 5130 testing the same fire could be extinguished with up to 70 percent less foam solution, meaning:

- Less water
- Less foam concentrate
- Less containment
- Potentially smaller pumps / pipes etc
- Lower clean-up costs

CAFS appears to address the questions being asked about the performance of Pure C6 foam v older C8 foams, and even more so, based on the information from ACAF Systems, the performance of Fluorine Free foams v fluorinated foams.