Alcohol Resistant Foams and Viscosity

Today, we can fly to the moon and yet we still have problems with the mixing of pseudo-plastic foams. Luc Jacobs explains.

Luc Jacobs

Solberg Scandinavian AS

Every day there are issues with mixing foam at the right proportioning. Is this due to the foam? Is it due to the system? Is it due to lack of knowledge? Who does put the requirements of foam mixing in the specification when ordering a new system or fire truck?

One of the standards that lists foam concentrates and equipment is UL 162 (Foam equipment and liquid concentrates). The foam is listed in combination with a specific piece of equipment, so having a UL approval does not necessarily mean that particular piece of equipment works with any foam, or the other way around. The EU EN 1568 (Foam extinguishing media – foam concentrates], which is similar to the ISO 7203 (Fire extinguishing media – foam concentrates) will approve a foam according a certain expansion range. In theory the user should than be able to use that foam in any equipment designed for that foam expansion. This same EN 1568 standard gives some directions on the limitations in connection to the foam concentrate viscosity.

EU EN 1568-3 tells the user that if a pseudo-plastic foam with a viscosity above 120 mPa.s (at a specific temperature and at 375 s-1) or a Newtonian foam above 200 mm^2/sec could need special proportioning systems. This lets us assume that below those viscosities there would not be a problem. However, in our testing, with some viscous products or at lower use temperatures (so they get close to the 120 mPa.s) we have been seeing large deviations. With some equipment configurations we noticed no foam induction at all. Even "Newtonian" products, do not always mix properly, particularly when operating temperatures are lower.

When designing a foam mixing system, a few foam types, or at best, one foam type, are used for testing. The approval and last verification is often done with water only. If we take a simple inline inductor, one could say that water will mix

Basic understanding of pseudo-plastic viscosity

Distance X Diameter (area) is the key.

Pouring (or sucking) a pseudo-plastic viscose foam through a sieve or filter is not a big issue, but sucking it up through a straw can become so difficult, that the straw collapses and closes.

For example, a pseudo-plastic AR foam can be filtered through a 25 µm sieve, but cannot run through a 1m long, 6mm diameter tube. This can be explained by the fact that the orifice is not the mixing issue, but the length and diameter of the pick-up tube is.

From the EN 1568-3 standard:

Newtonian foam concentrates: foam concentrates that have a viscosity which is independent of the shear rate.

Pseudo-plastic foam concentrates: foam concentrates that have a viscosity which decreases with increasing shear rate.

at 6%, AFFF close to 7%, and FP close to 5%. When switching to AR type material it is even more important to keep a close check on the pressure drop over the inductor, a minimum of 30% is required (10 bar to 7 bar). Special AR type inline inductors will generate up to 50% pressure drop and are therefore generating more under-pressure to pick up the foam concentrate.

The orifice will then regulate the "proper" foam amount induced into the water flow. Often, after some years a poorly trained fire crew will have forgotten what the original configuration of nozzle, in-line inductor and foam concentrate they had. Switching equipment all the time will make them

Temperature influence

Say, you allow tolerances on the proportioning of a 3% foam concentrate of 0 percent to 30 percent (3,0% to 3,9%). You run the test and pass with 3,1% (temperature was 15°C). Next time, you run another system test and this time it is 5°C. Possibly you end up at 2.5% or lower. What now? Do you need to adjust the system?

The UL standard lists foam-equipment with a specific temperature range. EN 1568 tests at around 15°C.

vulnerable to all kinds of mixing errors. I have often seen people switching their low expanded foam branch to a medium expansion foam branch, which then suddenly operates at 4,5 bar. If the inline inductor is then designed for a 10 bar in 7 bar out low expanded foam branch, you will have problems.

Lowering the pump pressure will bring you to the required 4.5 bar nozzle pressure but that makes you unsure about the foam mixing. Typically, lowering inlet pressure (lower flow) will increase the foam mixing over the inductor. Another error is that when switching the nozzle more back-pressure can be generated, getting you below the critical 30% and not mixing any foam at all. With some equipment foam combinations will still work below the critical 30% pressure drop but this is more the exception than the rule. The good thing is that with proper knowledge and experience, one can almost always induce foam through an in-line inductor.

This example of the "simple" in-line inductor lists some of the proportioning issues; most of the same problems or obstacles can be encountered in bigger systems. Some foam manufacturers – including Solberg – developed AR multi-purpose "Newtonian" (or low viscous) foams. These foams perform on polar liquids and do not contain the special polymeric sugars which cause the pseudo-plastic properties. Still, their performance in tank fires and on polar liquids is not as good as the standard AR foams containing polysaccharides.

After listing all the issues it is time to think about the solutions. The first and most important

Key issues to use an in-line inductor with pseudo-plastic foams:

1. Type of foam and temperature: Viscosity (so back-pressure) will change with foam type and temperature.
2. Pressure drop <30% will mostly lead to lower foam pick-up or even no pick-up at all.
3. Inlet pressure: Typically an in-line proportioner will list an inlet pressure (often 10 bar).
4. Outlet pressure: Should be minimum 30% lower. Dependent on several parameters:
   - Back-pressure of the Nozzle.
   - Length of hose or elevations.
   - Flow.
   - Inlet pressure.
5. Flow: The concentrate mixing orifice is calculated on the water flow.
6. Pick-up tube: Constrictions, length, elevation.
7. Other parameters such as maintenance, or potential blockage of the "ball-bearing".

is training. Know your foam, equipment advantages and limitations. Secondly do not get fixed into the parameters and avoid buying fixed concentration mixing equipment, or if you do, at least be sure that the temperature influence is minor and that the foam has some performance flexibility, meaning that it works at lower and higher concentrations as listed and that the system is tested at several variable parameters and proven to mix properly.

Again the cold of winter and the heat of summer will have a bearing. Personally I favour the flexibility of foam use. Start the attack with a lower or standard concentration, increase foam mixing towards the end to make the stiff foam cover your need for burn-back and vapour suppression. Even on polar liquids one can easily start at low concentration, kill the heat, then close in, try to apply indirectly, and increase the concentration all the way up to give that strong foam blanket you need.

It is clear that I prefer a 3X6 foam, or a 1X3, if your equipment can mix as low as 1%.

Use a Flexible foam:

Even on a polar liquid, such as the new E85 car fuel, Solberg Re-Healing foam 3X6ATC, will give rapid fire control, even with lower than a 3% concentration. This heat control will allow you to approach, move in and then attack towards indirect application and increase the concentration. This will allow you, with less risk, to make that necessary, indirect application on polar liquids in a safe way.

Of course, this means that you need to calculate more foam than required – for example, 60,000 litre of 3% or 20,000 litre of 1% – but experience tells me that you will end up using more foam than was calculated. People want to be sure it foams so there is a strong temptation to increase the mixing. Inevitably in critical situations you will increase the foam mixing (even the experts do) if you do. In cases where you cannot it may mean that you will need to fight longer and hope that your foam quality is good enough to finally extinguish the fire.

Today I personally think that there is not enough direction on concentration flexibility. Standards and guidelines list minimum application rates but talk little about minimum foam concentration for initial attack, prolonged attack and final coverage for vapour suppression.

So, to finally repeat some of the points:

- Train. Know your equipment, foam concentrate and mixing issues.
- Test your equipment and measure the mixing concentration in different circumstances, temperature conditions and pressures.
- For manual application, buy flexible mixing equipment, and buy flexible foam concentrates.
- Know your equipment.
- Know your foam.
- Know the potential and optimal combinations of your foam and equipment. IFF

Luc Jacobs is a foams expert with Solberg Scandinavian AS
www.solbergfoams.com