A new approach to extinguishing fires on combustible-liquid storage tank

One of the trickiest challenges a fire fighter will ever face is a full-surface blaze at a storage tank containing flammable fluid. Any grade-school student can deduce that water is useless in suppressing such fires because its higher density causes it to sink into the burning liquid. Far fewer people understand that it is also very difficult to stop flames using the foam-based extinguishment systems that are commonly employed today, especially if a tank is larger than 40 metres in diameter. Swiss Fire Protection R&D AG (SFPRD) sees an urgent need for a new approach that can stop such conflagrations from devouring millions of dollars in infrastructure every year and putting lives at risk.

Andras T. Peller

Tank farms are high-hazard environments by their very nature. No matter how stringent a facility's fire-safety protocols, lightning may strike at any time. Machinery may malfunction. In modern times, there is the ever-present threat that militants may target oil refineries or chemical plants. Any of these unforeseeable events may ignite a blaze that can easily spin out of control, given the huge quantities of flammable material on site.

The risk is hardly theoretical. Since 2000, the international media have reported on more than 70 major fires at storage-tank farms that have killed 243 people, injured 1,669 and inflicted damages in excess of USD 10 billion.

A single, everyday accident can unleash devastation. On 11 December 2005, faulty gauges led to an explosion at the Buncefield Oil Depot just outside London. The blast engulfed some 22 storage tanks in flames and wrecked homes and businesses in a 2 km radius. While no deaths resulted, about 40 people were injured. Tanks were reduced to heaps of charred metal. Damage claims amounted to nearly USD 1.4 billion.

Extinguishing the Buncefield catastrophe required a huge mobilisation of manpower and resources. Some 180 fire fighters attacked the blaze using 180,000 litres of foam dispensed from a dozen high-volume pumps. They also doused the site with 53 million litres of water. Despite the massive effort, the fire persisted for nearly five days.

▼ **Several Pi Foam pressure vessels protecting a ring-walled gasoline tank in the background at an Oiltanking facility in Central Europe.**

The difficulty in defeating storage-tank blazes like Buncefield certainly has nothing to do with a lack of heroism on the part of emergency workers. The trouble is that modern-day extinguishment systems cannot dispense foam with the necessary intensity.

Changing the parameters

SFPRD arrived at this conclusion after conducting an exhaustive analysis of recent storage-tank blazes. The data showed that a high number of extinguishment efforts failed even though the fire-fighting systems reached – or even exceeded – the foam intensity and application time prescribed in industry standards.

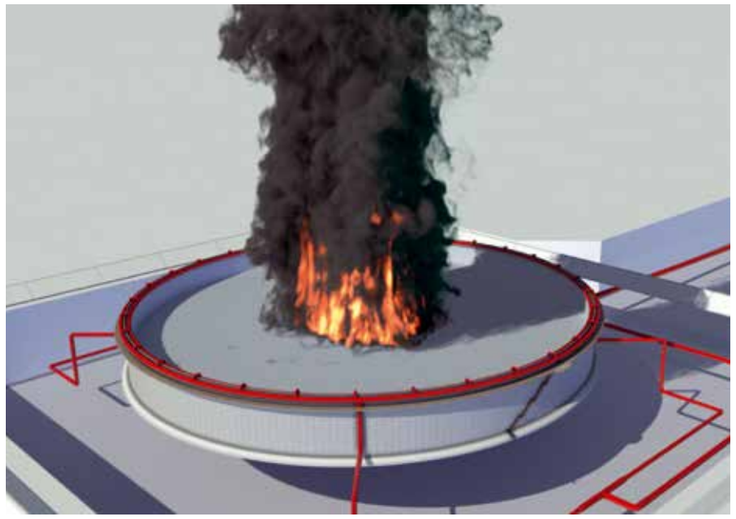
The research found that the provisions of prevailing industry standards are usually not adequate for extinguishing full-surface fires on "large" storage tanks (greater than 40 metres in diameter). For mobile extinguishment, NFPA 11 recommends a foam intensity of 6.5-8.1 l/ m2/min, while EN 13565-2 suggests 10-12 l/m2/min.

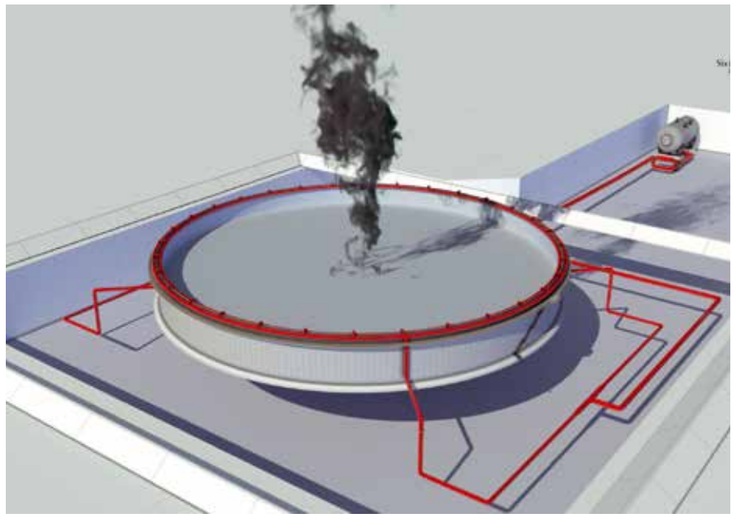
It seems the standards have not kept pace with developments in the combustible-liquid storage industry, which is producing tanks of ever-greater enormity. Surely, experts are already drawing up new fire-protection guidelines for these mega-tanks, but this process can take years.

When the updated standards come out, the required changes will entail significant budgetary demands. We can therefore expect a certain lag time before industry players adopt new fire-fighting technologies. So for the time being, the current parameters will remain in place.

That may be problematic. Mobile units – presently the preferred method of battling fires in the hydrocarbon industry – need anywhere from 30 minutes to two hours to set up their equipment before actual extinguishment can begin. During this time, burning liquids get hot enough to dissipate

▶ **The Pi Foam System introduces foam at the perimeter of the tank, instantly protecting the tank wall and then closing in on the fire surface like an iris.**





Andras T. Peller is a Director at Swiss Fire Protection Research & Development AG.

◀ A typical above-ground Pi Foam pressure vessel. Today, the bigger ones are almost always stored underground.

the foam with greater ferocity once it arrives. Instead of the foam extinguishing the fire, the fire consumes the foam.

The result is more property lost, more lives in the balance. SFPRD's conclusion: The tank-fire protection industry needs new parameters.

Critical factors: Intensity and speed

The first critical factor is the ability to apply foam at a suitable rate. If a foam blanket is thick enough, it can smother the flames before they have time to consume the foam itself. If it is too thin, it cannot cool the surface effectively and creates hydrostatic pressure. Combustible vapours bubble up through the foam, exacerbating the blaze and rendering the entire exercise useless.

Mobile units can dispense foam at a rate of up to 18,000 litres per minute, which sounds enormous. In practice, only half of this capacity actually reaches the burning liquid surface due to targeting losses and updraft.

The "real" foam-application rate for mobile systems is up to 9 l/m2/min. This may be sufficient for putting out fires in smaller tanks (less than 40 metres diameter) after hours of exhausting work. In large tanks, however, the foam blanket cannot achieve the adequate thickness before it starts to decompose in the flames. End result: The blaze is allowed to persist and potentially escalate out of control.

The second critical factor is to create a system that can begin extinguishment immediately, before the fire has a chance to intensify to unmanageable levels. Studies show that a full-surface blaze may heat a tank's walls to 500 °C – the point at which steel structures begin to lose their structural integrity – within five minutes. Once this happens, the tank usually must be demolished after the flames have subsided.

Mobile-extinguishment systems, as well as the related "semi-stable" systems, cannot save the tank because they require too much setup time. By the time extinguishment can commence, fire fighters often have no choice but to allow the fire to burn itself out while trying to prevent it from spreading to other tanks.

Plant managers may opt for built-in, or "stable" fire-fighting systems. These employ a network of pumps and generators that dispense foam directly onto a burning-liquid surface automatically. Extinguishment can begin within three minutes.

However, a stable system's foam intensity is limited by the capacity of its pumps. The rate of 4-8 l/m2/min, as prescribed by standards, cannot create a foam blanket fast enough to put out fires in large tanks before serious damage occurs. The flames eat most of the foam away.

SFPRD's Solution: Pressurized Instant Foam

SFPRD's associates have devoted years to finding a way to overcome these problems. The result is the Pressurized Instant (Pi) Foam System, an automatic foam-based system with a speed and intensity that can extinguish a fire on any tank, no matter how big, in three minutes or less.

The Pi Foam System can accomplish this feat because its pressure is not created by pumps; rather, the foam is stored in a vessel under pressure long before any fire event. The Pi Foam System's capacity is therefore scalable to any tank size.

The vessel is linked to a network of pipes that connect to foam dispensers strategically mounted along the rims of the tanks. When fire strikes, sensors send a signal that opens the vessel's valves, unleashing the foam with up to 20 times more intensity than "traditional" stable systems can muster. Foam loss is therefore significantly lower than any of the traditional fire-fighting systems.

The fire does not stand a chance. The tank emerges from the conflagration unscathed. And not a single fire fighter's life is threatened.

For more information, go to pifoam.ch, sfprd.com