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Inside

Firefighting with the power of Pi

Putting out full-surface fires in minutes, Swiss Fire Protection R&D's PiFoam system sets a new global standard for fire-fighting at some of the world's biggest tank facilities

SINCE 2001, hydrocarbon storage tank fires have cost global industry almost US$5 billion and destroyed more than 125 tanks. More than that, they have also been responsible for the loss of more than 200 lives. While some of these fires – often caused by natural occurrences such as lightning – may be difficult to prepare for, the ability to respond quickly and to limit their destructive capabilities is not.

The biggest fuel tank fire ever recorded occurred in 2001, when lightning struck an 82-metre diameter, 300,000 barrel gasoline storage tank at the Orion Refinery fire in Louisiana. Although eventually controlled by firefighters who managed to pump out fuel from the tank while applying a mixture of foam concentrate and water, the fire burned for around 13 hours, crippling the integrity of the tank. The total cost of the blaze was estimated at US$50 million, not including the production shortfall and environmental damage.

The key to containing fires such as these is foam, which must be used to close off the burning surface from oxygen. The foam also prevents the liquid itself from boiling, stopping combustible vapour moving through the foam blanket and compromising its effectiveness. Time is also critical. Studies have suggested that a tank fire burning longer than five minutes is likely to heat the tank wall to above 500°C, after which point its integrity is likely to be severely compromised. Even if the fire is then contained, the infrastructure is unlikely to be used again.

These problems have only been magnified in recent years, with the largest storage tanks now reaching around 120 metres in diameter. The result is a flammable surface area of almost 11,500 square metres - a substantial amount of fuel to insulate, even with high-performance foams. Moreover, there is currently no fire protection system in the world capable of extinguishing fires quickly in tanks with a diameter larger than 40m. In these instances, the only option is to allow the fuel to burn out.

In response to this challenge, Swiss Fire Protection Research & Development (SFPRD) has developed an entirely new kind of fire extinguishment suite. The group says that its proprietary Pressurized Instant Foam system – or PiFoam – is faster, more reliable and more cost-effective than virtually any other solution on the market. Designed automatically to extinguish a tank fire within just 3 minutes, the company believes it sets a new global benchmark for fire protection. *InnovOil* spoke with SFPRD director Andreas T. Peller to learn more.

Behind the curtain

PiFoam has its roots in technology developed by Hungarian scientist Dr Istvan Szocs, also the creator of the widely used Impulse Fire Extinguishing System (IFEX). Seeing potential, in 2016 Peller and other SFPRD executives formed a joint venture company

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to develop the foam technology into a viable commercial system. Working with an engineering group for over a year, PiFoam was refined, and with the addition of several new patents its third and fourth-generation systems are now ready for deployment.

PiFoam's effectiveness is derived from several key features, but most notably its ability to introduce a full, 360° curtain of foam around the tank within 30 seconds of activation. Once a fire is detected, the system opens a single valve to begin applying pre-mixed foam to the burning surface from a pressurised reservoir. The foam is introduced much faster and in greater volumes than rival suppression systems, putting out the fire quicker, while the rim of the tank is protected by a ring of foam from the outset, preserving its integrity.

Acting quickly is vital to protecting the tank and the wider facility. "If one tank catches fire and you're not fighting it soon enough, there is a good chance it will ignite the adjacent tank too," explained Peller. Once the fire is out, the fuel or product can be cleaned and filtered, and the asset is ready to be used again – saving millions in potential lost production and repairs.

Typically, there are three main categories of techniques for fighting tank fires: mobile units, semi-stable systems and fixed systems. Mobile units manned by firefighters are flexible and reliable, but can often take up to 30 minutes to respond to a fire, or longer if the site is remote. When they do, the chances of containing the blaze are often small, and the damage can be severe.

Semi-stable systems use a mixture of manned vehicles and automated systems, and typically have access to fixed sources of foam and water on-site. They are flexible, cost-effective and quicker to act, but still have sizable operational and capital costs. They also require much higher maintenance inputs in servicing numerous sets of equipment.

Fixed systems attached directly to the tanks are very quick to intervene and effective at containing damage. However, they require high capex inputs for installation and high opex costs over their lifetime. Sophisticated large machinery such as pump stations and foam generators must be regularly serviced to ensure the fire suppression will work. Even when operators do invest in a well-maintained system, an explosion could still destroy the foam chambers mounted on the tank's side, rendering the equipment useless.

PiFoam retains the benefits of a fixed system, but at a lower cost and greater effectiveness. Much of this is down to the functionality of its pressurised design. "Our system is really simple," Peller said. "We don't generate the foam when the crisis is going on but we premix the water and foam concentrate in advance, store it in a pressure vessel and pressurise it with a specific gas mixture that is soluble in water. The whole system essentially relies on one (or more) valve(s), and when there is a fire you only have to open this valve to release all the foam under force of pressure."

Because no pumping or mixing is required, the PiFoam system can apply a much larger volume to the fire at a far quicker rate than other solutions. This is also what enables the foam to be applied in a continuous ring, rather than at 4-8 fixed points along the tank, as with traditional systems. Under US National Fire Protection Association (NFPA) standards, foam must be applied at a minimum of 4.1 litres/m2 of surface/minute to contain a blaze on an 80m tank; a PiFoam system of this size will maintain output of more than 20 litres/m2/minute. Attempting this level of surface coverage with conventional systems would require eight times more water and 5-10 times larger equipment, all at enormous cost.

Peller qualified: "We can put out any surface fires within three minutes, and we do that by putting out the same amount of foam in three minutes as a traditional system would put out in one hour."

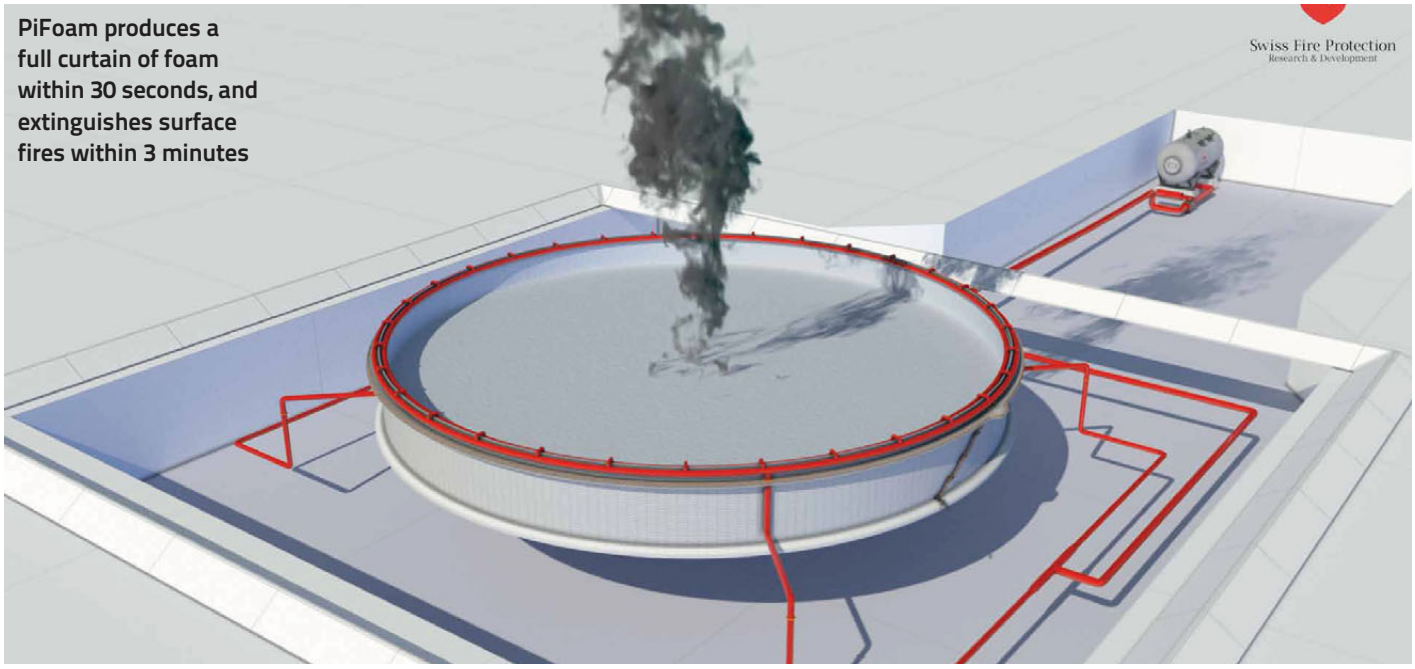
As well as lowering response time, PiFoam also uses less equipment. No additional foam generators are needed to aerate the mixture, and no pumping stations used to send water to the tank. "Because the gas is dissolved in the liquid, the foam will expand by itself, and by the time it reaches the end of the pipe you have ready-made foam," he continued.

"This is also the reason why this system can be scaled up very easily. With our system you simply just have to raise the diameter of the pipe network and the size of the pressure vessel, and that's why we can easily achieve 60-80 litres/m2/minute – more than ten times the performance of the usual systems."

Applying foam faster also means less resources are used, as less infrastructure is disintegrated by the fire during suppression. This too lowers costs. Rather than over-specifying foam and water requirements to contain a blaze, the system can be designed exactly to specifications in the knowledge that the fire can be safely managed.

New formulations

PiFoam also worked to improve on the composition of the foam itself. While the



PiFoam produces a full curtain of foam within 30 seconds, and extinguishes surface fires within 3 minutes

suppression system will work with a range of commercially available products, the company has developed a proprietary mixture which is less poisonous than rival formulations and – crucially – is completely biodegradable.

"We understood that all methods of firefighting use the foam a little differently, so we developed a solution with our application in mind. We have created a foam family covering different liquids, applications and environments, which is also completely non-toxic and it works perfectly with our system," Peller said.

Stored in optimal conditions – away from extreme heat or cold – the mixture will be good to use for up to 10 years, with PiFoam conducting yearly sample tests to ensure its effectiveness is maintained. And for facilities that are located in extreme environments, PiFoam has formulations that can be tailored to the appropriate performance – for example, with anti-freezing additives.

Although each storage facility will have its own requirements, PiFoam generally uses a similar blueprint in each. The pressure vessel is housed either in a building or underground, and contains enough pre-mixed foam to combat fires in a certain number of tanks, as specified by the operator. They can also be designed to work independently of electrical or water networks, for use at unmanned and remote installations.

In a project currently under development for Chevron in Kuwait, the company is working on a system capable of suppressing three full-surface fires and up to seven rim seal fires simultaneously, occurring on tanks as large as 77m. This requires storing almost 1,000 cubic metres of foam in a 2-km long underground pipe network. While this is certainly on the large size, it demonstrates just how scalable the model is.

It also highlights why using a single reservoir for suppression makes sense, as PiFoam can be used with all current foam-dispensing devices. "If you have this central storage, you can easily protect not just the storage tanks but the dyke areas, the pump stations, any other technological areas. With the same capacity we can easily protect a whole site, without any additional systems," Peller explained. The company is currently working on a multi-area solution such as this for Oiltanking Hungary.

Saving millions

PiFoam's economics are as persuasive as its performance. SFPRD calculated capex and opex costs for a hypothetical storage facility, consisting of twenty 50m crude oil tanks over a 20-year period of operation. Although capex costs for semi-stable and mobile systems are low (around US$3 million), very high operating expenses suggested they could cost operators in the region of US$16-20 million over their respective lifetimes.

By comparison, the estimated cost of an NFPA-compliant fixed system came to US$6.6 million, of which just under US$5 million was capex (although a more powerful system with greater performance could cost considerably more).

The cost of a PiFoam system over the same period was estimated at just US$3.9 million, of which US$3.3 million covered the cost of installation. Opex over the 20-year lifetime was calculated at US$600,000. "Our system is cheaper to build in most cases on a capex side," added Peller, "But the biggest advantage is the operational cost because, as simple as it is, our system is very easy to maintain. You have to check pressure, which is done automatically, and you have to test the valves – they are really the only moving part."

SFPRD calculated a "break-even" cost for these systems – that is, a dollar amount of damage that would be inflicted in the event of a full surface fire without an extinguishment system, compared with annual opex costs – and concluded that PiFoam users would see payback within seven years. The high opex of mobile and semi-stable options suggested that these facilities might never offer any ROI.

As a relatively new technology, PiFoam has yet to be considered as an international standard. However, its improved performance and capabilities over the status quo are undeniable and in the case of much larger tank operators, it offers a viable solution for fire extinguishment rather than simply containing the fuel until it burns out. Outside the tank itself, it also provides a viable solution for combatting 2D fires in various settings, from loading stations to refineries, to ship engine rooms.

Offering more flexibility, better performance and better economics, PiFoam may well represent the future of fire extinguishment systems. And with more than 4 billion barrels of crude held in various stockpiles around the world, and countless volumes of other fuels and products, any system offering more capable protection is no bad thing. ■

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