REDUCING DEVASTATING FIRES FROM HOURS TO MINUTES

The Pi Foam system can extinguish potentially devastating blazes – such as the Jurong Island and Pulau Busing terminal fires – in a matter of minutes

The Pi Foam system, a novel fire extinguishing system from Switzerland-based Swiss Fire Protection Research and Development AG, could very well be the best solution to protect storage terminals against devastating fires.

Tank terminals are, by their very nature, high-hazard environments. No matter how stringent and encompassing a facility's fire-safety protocols are, lightning may strike, and equipment may malfunction at any time. In an ever-changing geopolitical climate, there is the present and increasing threat that militants or others may target oil refineries or chemical plants.

Any of these unforeseeable events may ignite an incident that can easily spin out of control, given the huge quantities of flammable materials on site. This risk is far from hypothetical. Since 2000, the international media has reported on more than 70 major fires at storage tank facilities that have killed 243 people, injured 1,669 and inflicted monetary losses in excess of $10 billion. This figure only presents a fraction of the total number of incidents as some do not reach the pages of the international media but have still caused damage. This information only serves to stress the importance and urgency to implement new approaches that can stop such incidents from devouring millions of dollars in infrastructure every year and putting lives at risk.

JURONG AROMATICS FIRE, JURONG ISLAND, SINGAPORE, 2016

A lightning strike sparked a large fire in one of the storage tanks at Jurong Aromatics Corp's facility. Firefighting teams extinguished the blaze in five hours and luckily managed to contain it to a single 40m-diameter tank. However, the heat was so intense that it caused the 40m-wide and 20m-tall tank to buckle in on itself. The fire was subdued only after firefighters surrounded the tank with machines that doused the flames with water and foam. The Singapore Civil Defense Force (SCDF) had to bring in a 'large foam monitor' capable of spraying 6,000 gallons of foam per minute. Eventually the burning tank was contained within a protective wall. There were two other tanks at the facility nearby and 'fixed drencher systems' were activated to cool those down. The operation involved five fire engines, 29 support vehicles and three Singapore-made firefighting cars known as Red Rhinos. Total costs were estimated at $9 million.

TANKSTORE FIRE, PULAU BUSING, SINGAPORE, 2018

Tankstore's Pulau Busing terminal was hit by a lightning strike and caught fire. It took firefighters six hours to extinguish the blaze. The terminal had a total capacity of 2 million m^3 spread over 112 tanks, for the storage of petroleum and petrochemical products. The tanks were also equipped with a 'technologically advanced fire protection system'. The fire source storage tank was said to have contained fuel oil. The Singapore Civil Defense Force (SCDF) said the large operation involved 128 of its personnel and 31 firefighting and support vehicles. They were supported by members of the Company emergency response team (Cert) and agencies including the Police Coast Guard, Maritime and Port Authority of Singapore, Republic of Singapore Navy and National Environment Agency (NEA). The operation required the SCDF to ship necessary equipment and vehicles from Pasir Panjang Ferry Terminal to the island. Two large 6,000 gallons per minute foam jets were deployed to battle the blaze, while five unmanned water monitors were used to cool adjacent oil tanks and prevent the fire from spreading.

Swiss Fire Protection Research & Development's Pi Foam system in action at a test site

FUTURE PREVENTION

As a result of these major incidents across the globe, Swiss Fire Protection Research & Development AG (SFPRD) conducted an analysis of all the tank storage fires over the last 20 years. The data showed that a high number of extinguishment efforts failed even though the firefighting systems reached – or even exceeded – the foam intensity and application time prescribed by industry standards. It can be assumed that in most cases, the prescribed or even greater intensity is available for the fire brigades. But experience shows that code-based design is sometimes not enough for a quick extinguishment. Even if the fire is successfully overcome in a matter of hours or days, the tank itself is lost and the total loss of property cannot be prevented.

The difficulty in defeating storage tank blazes like the one at Pulau Busing Terminal fire or the Jurong Island terminal fire is not a result of a lack of heroism on the part of emergency workers. The most probable reason for this difficulty is that mobile extinguishment systems cannot approach the blaze safely and dispense foam with the necessary intensity to the right place.

An oil storage tank fire on Pulau Busing was extinguished by firefighters after a six-hour operation

UPDATED STANDARDS AND REGULATIONS

Traditional fixed systems are not mandatory in many countries, and even where it is for specific tanks, the authorities accept the semi-fixed systems as built-in ones. Although they can help to transfer the foam to the right place, they lack the most significant advantage of the built-in systems: the rapid start of extinguishment.

If and when updated standards or regulations are adopted, the required changes will entail significant budgetary demands. Thus, a lag time before industry players adopt the new firefighting technologies is to be expected which means that the current parameters will remain in place. This may be problematic. Mobile units, presently the preferred method of battling fires in the hydrocarbon industry, need anywhere from 30 minutes to several hours to arrive to the scene and set up their equipment before actual extinguishment can begin. During this time, burning liquids get hot enough to dissipate the foam with greater ferocity once it arrives. Instead of the foam extinguishing the fire, the fire degrades the foam. There is also the threat that the fire will escalate until the foam attack can begin.

The result is more property lost and more lives at risk.

COULD FIXED SYSTEMS BE THE SOLUTION?

There is an argument that an adequate fixed system can excel fire response in two 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 create high enough hydrostatic pressure, which means that combustible vapours bubble up through the foam, exacerbating the blaze and rendering the entire exercise useless. The biggest mobile monitors can dispense foam solution at a rate of up to 60,000 liters (16,000 gallons) per minute, but usual capacity is much smaller than that at around 15,000-20,000 liters.

Furthermore, in practice, only approximately half of this capacity actually reaches the burning liquid surface due to targeting and updraft losses. This may be sufficient for putting out fires in smaller tanks after long exhausting work, but in large tanks, even with multiple foam monitors, the foam blanket cannot achieve the adequate covering before it decomposes in the flames.

However, a traditional pump-station-based fixed 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 severe damage occurs as the flames consume most of the foam away. Consequently, a more intensive alternative is required but that would spiral up costs, which are already high in case of a traditional fixed system, due to the costs of the sophisticated machinery.

The second critical factor is to create a system that can launch 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 (932°F) – the point at which steel structures begin to become critical regarding their structural integrity within just five minutes. Once this happens, the tank usually must be demolished after the flames have subsided.

The Jurong Island fire was extinguished after a five-hour operation in 2016

This means that mobile extinguishment systems, as well as the related semi-fixed systems, cannot save the tank because they require too much travel and setup time. By the time extinguishment can commence the first tank on fire is already lost, firefighters 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 fixed firefighting systems. The traditional systems employ a network of pumps and generators that dispense foam directly onto a burning-liquid surface automatically. Extinguishment can begin within several minutes.

As a result, the ideal solution would be one that can provide both the immediate launch of extinguishment with a precise, loss-free foam introduction alongside a huge foam intensity, which is not limited by the performance of the machinery.

A NEW SOLUTION

In order to resolve similar problems in the future, SFPRD developed the Pressurised Instant (Pi) Foam System, an automatic foam-based system with a speed and intensity that can extinguish a fire on any tank, regardless of size, in three minutes or less.

This is achieved because the system's pressure is not created by pumps; rather, the foam is stored in a vessel under pressure, created long before any fire event. Therefore, the system's capacity is 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 a fire ignites, sensors send a signal that opens the vessel's valves, unleashing the foam with up to 20 times higher intensity (40-80 l/m2/min.) than traditional, fixed systems can muster. With the fire burning for such a short period of time, the temperature of the tank wall cannot reach a critical value, so no deformation or other significant damage will occur. The tank can be put back in operation in less time, leading to almost undisturbed business continuity – compared to the years out of service if the tank needed to be rebuilt. The product inside the tank is also saved. Finally, the system improves safety as firefighters do not need to get physically involved.

Contrary to conventional mobile and fixed systems, Pi Foam operates immediately, in significantly higher intensity. The amount of foam necessary for successful extinguishment is much lower if the intensity is considerably higher than regular rates. So, due to the lack of machinery, the system can produce high intensity with the same basic construction. This results in a smaller foam tank – and most importantly – significant cost reduction in construction and operation costs.

FOR MORE INFORMATION

www.pifoam.ch, www.sfprd.com