Fluides maîtrisés, Sécurité assurée !

terminal equipment

No safe substitute

FLAME ARRESTERS Research by Protego suggests that conservation vents are nosubstitute for flame arresters when dealing with potentially explosive atmospheres instorage tanks. The results of this work will emerge in a new ISO standard.

Protego's research and development group in Braunschweig, Germany has tested conservation vents in accordance with the new ISO 16852 test method. These tests have proven that conservation vents cannot be used to substitute a flame arrester if potentially explosive atmospheres are present in storage tanks. This research was conducted during the development of the ISO FDIS 28300 standard [1] and the test results are considered in this future ISO standard.

For several decades state organisations and engineering societies have published strict engineering guidelines for the design and safe management of storage tanks. Even though the best effort is made in applying the most current research work and engineering procedures, there is sometimes a conflict between standards, such as the fifth edition of API 2000 and the German TRbF 20 standard. API 2000 states that a flame arrester is not considered necessary for use in conjunction with a pressure vacuum valve venting to the atmosphere because flame speeds are less than vapour velocities across the seat of the pressure vacuum valve [2]. On the other hand the TRbF 20 standard clearly calls for flame arresters if the tank contains liquids that can create an explosive atmosphere [3]. This would be any liquid which is stored at, above or close to its flashpoint. The FM (Factory Mutual) approval guide requires installation of flame arresters on tanks storing liquids with a flashpoint at or below 43°C, or on tanks that heat the stored liquid to its flashpoint [4]. Vents are seen as a likely place of ignition and it is recommended that flame arresters should be installed to prevent tank explosion. [5]

These contradictions in different globally recognised standards and publications called for clarification during the process of developing the FDIS ISO 28300. For this reason Protego decided to perform research to determine if a conservation vent can truly assure that a flame does not transmit through the vent pallet and therefore prevent tank explosion.

Testing according to ISO 16852

To determine if a conservation vent is capable of preventing flash back into a tank, an ignition test was performed in accordance with ISO 16852:2008 [6]. Conservation vents produced by five different manufacturers were tested and two different tests were conducted:
(a) atmospheric deflagration test, and
(b) high velocity test procedure.

The atmospheric deflagration test investigates if it is possible to ensure a conservation vent will not fail if, for example, a lightning strike ignites a vapor cloud which is present around the conservation vent. If the explosive mixture outside the tank is ignited, it is the job of the endofline flame arrester to prevent flame propagation into the tank. The high velocity discharge test is used to investigate if the theoretical approach of some engineering guidelines (such as API 2210 [7]) is correct and no flash back through the vent valve is possible. An explosionproof vessel was filled with a propane/air mixture and vented through the conservation vent into the plastic bag until the plastic bag was filled completely. An air dryer was used to assure a constant oxygen concentration in the fuel/air mixture. Paramagnetic oxygen measurement was used to adjust the fuel concentration. The size of the conservation vents used for testing was DN 100 (4"). The set pressures and vacuums were typical of the values used on API tanks.

Propane with a gas purity by volume >95 per cent and air, which passed the air dryer, were mixed inside the compressor of the mixing machine. The flow of fuel and air was measured by flow meters. A bypass of 60 l/h of the gas mixture was injected into the oxygen measurement system. To detect a flash back an explosion panel was installed at the explosionproof vessel.

The air/fuel mixture was ignited approximately 1 metre above the point where the valve was connected to the explosionproof vessel. A chemical igniter with an ignition energy of 160 mJ was used. will burst and flames will propagate to the outside of the vessel.).


Protego's test unit in operation

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For the first series of tests the plastic bag was filled with a stoichiometric mixture of propane in air (4.2 vol per cent propane).

After closing the shutoff valve the gas mixture inside the bag was ignited. Each conservation vent was set at +10 mbar (+4" wc) and 2 mbar (0.8" wc). The second series of tests were performed with 5.5 vol per cent of propane in air. In the third test a rich mixture was used, 6.0 vol per cent propane in air.
At these air/fuel mixtures all conservation vents failed to prevent flame propagation resulting from atmospheric deflagration into the explosionproof vessel. In all of the tests the bursting diaphragm ruptured and a large fire ball propagated out of the vessel.

High-velocity test

The highvelocity test involved a conservation vent installed on top of an explosionproof vessel.
A stoichiometric propane air mixture was introduced into the vessel and discharged through the pressure side of the conservation vent. A pilot burner was installed close to the discharge side of the conservation vent as an ignition source.
The first series of tests was performed with a volume flow of 85 m³/h explosive gas mixture. The pressure valve pallet opened and closed due to the low flow. After ignition of the pilot burner a flame was stabilised at the seat of the valve.
After a few seconds the flame propagated through the gap between seat and pallet, resulting in an explosion inside the vessel. Consequently the bursting diaphragm of the explosionproof vessel ruptured and a fireball propagated to the outside of the vessel.

The second series of tests was conducted at a higher volume flow of 100 m³/h of propane/air mixture through the vessel, discharging on the pressure side of the conservation vent. Again just a few seconds after the ignition a flash back was detected. This research work proves that conservation vents cannot reliably function as flame arresters if an atmospheric deflagration occurs. Furthermore, the theoretical statement that a flame arrester is not considered necessary for use in conjunction with a pressure/vacuum valve venting to atmosphere because flame speeds are less than vapor velocities across the seat of the pressure vacuum valves cannot be confirmed. The performed testing and the results explain why the TRbF 20 standard clearly calls for flame arresters if the tank contains liquids that can create an explosive atmosphere in the vapor headspace of the storage tank. Furthermore it makes complete sense that the FM approval guide requires installation of flame arresters on tanks storing liquids with a flashpoint at or below 43°C, or on tanks that heat the stored liquid to its flashpoint.

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References

[1]ISO/FDIS 28300:2007 (E) Petroleum, petrochemical and natural gas industries – Venting of atmospheric and lowpressure storage tanks.
[2]API Standard 2000, Fifth Edition, April 1998, Venting Atmospheric and Low Pressure Storage Tanks
[3]Technische Rege n für Brennbare Flüssigkeiten TRbF 20, Läger , 01.02.2001, BArbBl Nr. 4/2001 S.60
[4]Factory Mutual 2007 Approval Guide, Flammable Liquid Equipment
[5]James I Chang, ChengChung Lin, A studyof storage tank accidents, Journal of LossPrevention in the process industries, 19 (2006) pages 5159.
[6]ISO 16852:2008, Flame arresters performance requirements, test methods and limits for use.
[7]API Publication 2210, Flame arresters for vents of tanks storing petroleum products.
[8]Förster, H, Flame Arrester Testing and Qualification in Europe, Proceedings of the 10th International Symposium on Loss Prevention and Safety Promotion in the Process Industries, Stockholm, Sweden, 1921 June 2001.

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