Road Tanker Earthing

22
Autumn
2010

The loading and unloading of road tankers with flammable and combustible products, presents one of the most serious fire and explosion risks for site operations within the hazardous process industries. A study conducted by the API in 1967 identified static discharges as being responsible for over 60 incidents in road tanker loading operations and demonstrates just how long this potential threat has been acknowledged. The natural presence of static electricity in product transfer operations, combined with its associated ignition hazards, ensures that regulators take static control precautions for road tankers very seriously.

Static electricity and road tanker product transfer operations

Powders and liquids with low electrical conductivities are the prime sources of static charge generation because their electrical properties do not easily permit the transfer of excess charges. Instead, non-conductive and semi-conductive liquids and powders retain and accumulate charges after they make contact with conductive objects. The most common interface for charging of non-conductive and semi-conductive product is contact with metal plant equipment including pipes, filters, pumps, valves, barrels, totes, mixers and agitators. When the electrostatically charged liquid (or powder) is deposited into a container like a barrel, tote, or road tanker charging of the container will occur if there is nowhere else for the charges to go. In this situation the charges are “static”, accumulate on the surface of the container and set up a potential difference with respect to ground.

Over a short time period (less than 20 seconds) potentials in excess of 50,000 volts can be induced on a road tanker’s container when it is being filled at normal flow rates with a product that is electrostatically charged. The magnitude of the voltage induced is directly proportional to the quantity of charges making contact with the container.

This voltage represents the ignition source and the potential energy available for discharge via a static spark at voltage levels of 50 kV can, for a typical road tanker, be in excess of 1250 mJ. The vast majority of flammable vapours and combustible dusts can be ignited at these energy levels.

For sparking to occur in road tanker product transfer operations, other conductive objects must come into close proximity with the charged container of the road tanker. Examples of conductive “objects” include the fill pipe entering the opening on the top of the container, fall prevention systems like folding stairs, and drivers or operators working around the road tanker. The charges on the road tanker’s container attract opposite charges to the surface of the object and rapidly create an electric field between their respective surfaces.

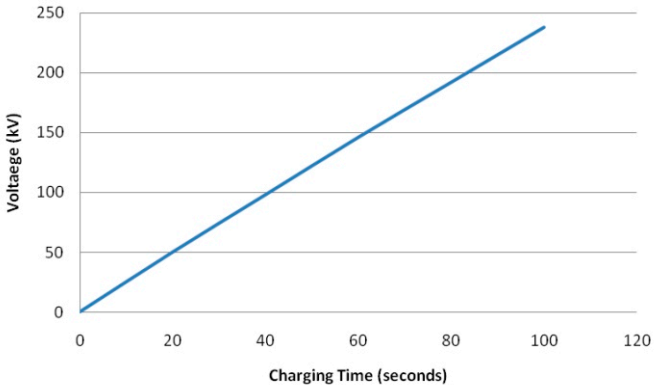

Fig. 1 Levels of voltage generated on a road tanker, by an electrostatically charged liquid at approved flow rates

It is the strength of this electric field that causes the “breakdown” of the air between the container and the object. When the air is “broken down” a conductive path for the excess charges to rapidly discharge themselves is created, leading to a static spark discharge.

If a combustible atmosphere is present in this space, ignition of the atmosphere is very probable. Under ambient conditions an average field strength of 30 kilo-volts is capable of causing the electrical breakdown of air over a spark gap of 2 cm.

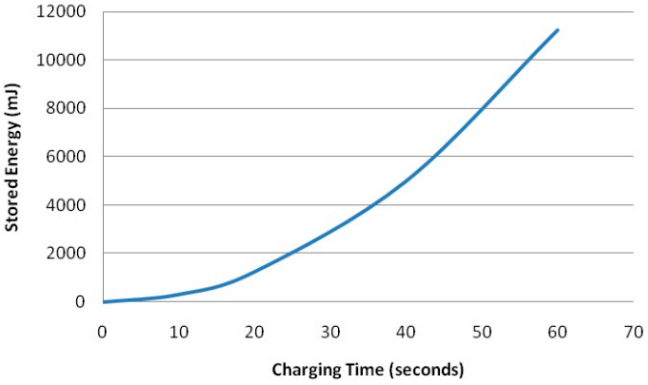

Fig. 2 Potential minimum ignition energies present on road tankers based on the time period of road tanker filling operations

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Standards and recommended practice governing the static control of road tanker product transfers.

As outlined earlier, regulators are extremely cautious about the ignition hazards presented by static electricity in road tanker product transfer operations. Three standards, in particular, provide clear guidance on what precautions should be taken. NFPA 77, API RP 2003 and CLCTR: 50404 state that grounding of the road tanker should be the first procedure carried out in the transfer process. Grounding effectively creates an electrical circuit that connects the road tanker to the Earth and it is this connection to earth which prevents static charges accumulating on the road tanker's container. The reason the charges can transfer from the road tanker to earth is because the Earth has an infinite capacity to absorb and redistribute static charges, with the positive effect of removing the ignition source from a potentially combustible atmosphere.

The electrical resistance of this circuit from the road tanker to the "ground source" (or "grounding point") which is in contact with the earth, is a key performance indicator of the entire grounding circuit's capacity to provide a secure and safe product transfer operation. NFPA 77 and API RP 2003 state the resistance in a healthy metal circuit should never exceed 10 ohms, therefore the entire circuit between the truck and grounding point should be measured and be equal to, or less than, 10 ohms. If a resistance above 10 ohms is measured this will indicate problems with parts of the grounding circuit including the road tanker connection, the ground point connection or the condition of the conductor cable.

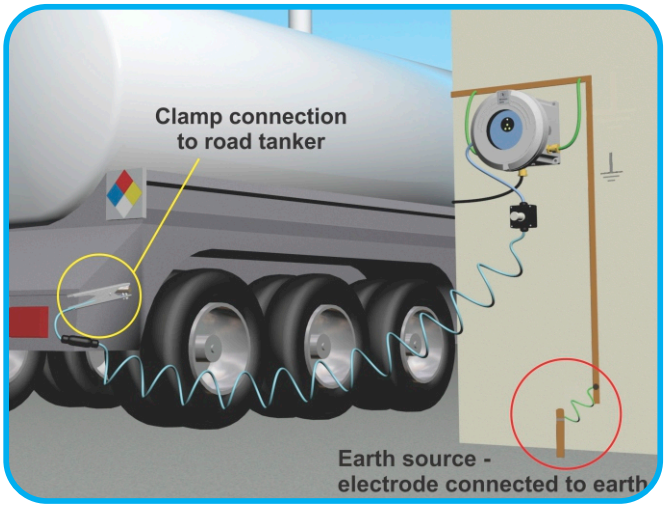
Road tanker grounding systems

The standards advise that a grounding system, which can measure and monitor resistance in the grounding circuit, can be utilised. The system should verify if the ground connection to the road tanker is complete before loading or unloading is initiated. The CLCTR: 50404 standard recommends 10 ohms or 100 ohms for "convenience" in monitoring.

An additional recommendation in NFPA 77 and API RP 2003 calls for interlocking the feed system (e.g. pump) with the grounding system so that if the grounding system is not connected to the road tanker, product cannot be transferred. This will ensure that electrostatically charged product cannot enter or leave the road tanker when the road tanker has no grounding protection in place. In general, interlocked grounding systems will complete the grounding circuit when the driver connects the clamp of the grounding system to the road tanker and the system sees a circuit resistance of 10 ohms or less.

Although the standards recommend a monitored resistance of 10 ohms, there are many grounding systems on the market today that monitor well in excess of this level. While it may be claimed that these systems are capable of dissipating static charges the capacity of a system to monitor at 10 ohms, not only provides an opportunity to demonstrate compliance with internationally recognised recommended practice, it also means that hazardous location operators know the system's grounding clamp is making a secure and reliable connection to the road tanker, every time a product transfer is carried out. Grounding clamps should be designed to penetrate paint coatings, rust and dirt build up as they are very effective at impeding secure electrical contact with the conductive metal of the road tanker.

Additionally, the grounding system must be capable of detecting minute changes in resistance when the transfer is underway and should not allow a high degree of change in resistance before shutting down the pump or alerting personnel. As soon as a resistance above 10 ohms is present in the grounding circuit, the grounding system should be capable of detecting this change and take control of the feed into the road tanker. Systems that permit resistances higher than 10 ohms have a greater degree of difficulty in detecting changes in the health and condition of the grounding circuit.



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Road Tanker Recognition

Because resistance monitoring systems operate when connected to conductive metal objects, additional features can enhance the protection of drivers, product and equipment. A "road tanker recognition" feature can be utilised to ensure that drivers can only operate the feed system when the grounding system detects it is connected to a road tanker. A system like the Earth-Rite RTR will analyse the capacitance of the road tanker as part of the grounding circuit. If the capacitance presented is in the normal range for road tankers (1 nano Farad or 1 x 10^{-9} farads), the grounding system will recognise that it has made a positive connection to a road tanker.

From the site operator's perspective, this eliminates the risk of drivers unknowingly connecting the grounding clamp to parts of the truck chassis that are electrically isolated from the truck's container. This isolation may be due to original design oversight like isolated mud guards or paint coatings insulating conductive parts like truck light enclosures from the chassis. In addition drivers have been known to attach the grounding system's clamp to the loading rack in order to obtain a permissive state for the feed system to "speed up" the transfer. So while a permissive state for the feed system can be obtained with a standard resistance based monitoring system it does not necessarily mean the grounding clamp is electrically connected to the road tanker's container.

Specifying a grounding system with a road tanker recognition feature ensures the road tanker is safely grounded before drivers are in a position to begin filling it with product. Once the system has verified it is connected to a road tanker it should then monitor the road tanker's connection to the grounding point to 10 ohms or less.

The Earth Source

When a road tanker grounding system is installed it is assumed that the earth source (e.g. buried ground electrode) to which the system is connected has been independently verified as having a low resistance connection to earth. This connection is the foundation for secure and safe transfers and it is incumbent on the site operator to conduct seasonal "Fall of Potential" tests to ensure these ground connections do not deteriorate due to changes in soil composition, soil resistivity or corrosion of the ground electrode. In winter, ground temperatures can reduce dramatically and cause an exponential increase in soil resistance levels. For the ground electrode these temperatures can have a significant impact on its contact resistance with the soil potentially impeding the transfer of static charging currents.

Summary

In accordance with the recommendations of industry groups and fire safety associations, the static grounding of road tankers is a key safety protocol in the loading or unloading of flammable and combustible products. Grounding ensures static charges are not permitted to accumulate on the road tanker eliminating the risk of the container becoming an ignition source. Additionally, national and international recommended practice advocates the adoption of static grounding parameters that will enhance the safety of the product transfer process including monitoring the grounding circuit to 10 ohms or less and interlocking the product feed system with a dedicated grounding system. When selecting road tanker grounding systems, specifiers should also consider additional functions that can enhance the safety of the transfer process. Grounding systems which include road tanker recognition and static ground connection verification functions provide additional guarantees that a transfer process cannot take place unless the road tanker is connected to the grounding system and the grounding system itself is connected to a verified ground source. These features enhance the secure grounding of the road tanker and enable hazardous area operators demonstrate the highest levels of compliance with NFPA 77, API RP 2003 and CLCTR: 50404.

More Information: If you have any queries related to the earthing of road tankers at risk of static charge accumulation contact:

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