PROTECTION AGAINST ELECTROSTATIC HAZARDS FOR TANK TRUCKS DURING LOADING PROCESS

How are the electrostatic hazards generated and how to prevent the danger effectively?

Background information

Varieties of ignition accidents were recorded during the loading of tank trucks. For instance, over 250 accidents were recorded between 1960 and 1981 in USA and Germany. The trend of accidents is going backwards.\(^1\) These accidents are all related to static electricity, more precisely, uncontrolled electrostatic discharge. In many accidents, although measures against electrostatics were established, uncontrolled discharge was still investigated as ignition source.

Generation of electrostatic charge

Two closely contacted surfaces (liquid/liquid or liquid/solid) will generate an electrical double layer (EDL), when they are moving relatively to each other. As a result of the physical separation of the surfaces, the electrical charge separation will lead to electrostatic charging. The static electric charging rate can be increased by increasing the speed of interface separation.

If the recombination of the electric charges is not possible, or when the charges cannot be dissipated, or when the charges dissipate too slowly, the charges generated during the process will remain and accumulate on the surface.

Typical forces in loading operations include flowing, mixing, pouring, pumping, filtering or agitating materials where there is the forceful separation.

The following mechanisms lead to the accumulation of electrostatics during truck loading:

1. product flow through filters and screens
2. product flow through pipe or hose
3. splash during loading
4. multiphase flow

The real danger arises through uncontrolled electrostatic discharge. After the potential difference between the two surfaces reaches 3 kV/mm, discharge in the form of spark with enormous energy can easily ignite hydrocarbon products.

What can we do to protect the loading process from the hazards of static electricity?

Prevention of electrostatic hazards during truck loading

The answer is simple: prevent the accumulation of electrostatic charges on the loading equipment and tank trucks during the process and dissipate the static charges in time before they reach the limit.

According to the German Technical Rules for Hazardous Substances\(^2\) practical and effective methods to prevent the accumulation of static electricity are:

1. limit the filling speed (decrease the speed of separation)
2. avoid splash of liquid
3. prevent gas bubbles
4. avoid a second, immiscible phase (water in the bottom of the container)

Increasing the dissipation of static charges can also be achieved by: \(^3\)

1. increase the conductivity of the liquids (with additives)
2. leave sufficient time for the relaxation of the electrostatic charge during the process
3. dissipation of static electricity by grounding all conductive components

Some of the methods can be applied forcibly in an organizational way, e.g. by limiting the filling speed, preventing to fill the different product in the same tank. There are still some more methods which are regarded as uneconomical or in-

\(^1\) cf.: Handbuch des Explosionsschutzes (2016), Henrikus Stehen, John Wiley & Sons, p. 155

\(^2\) cf.: TRGS 727 (2016), p. 23

\(^3\) cf.: Handbuch des Explosionsschutzes (2016), Henrikus Stehen, John Wiley & Sons, p. 155
efficient, like leaving enough time for the relaxation of static. Theoretically, spark discharge can be easily avoided by simply grounding all conductive parts. However, experience shows that the safe grounding of all conductive parts in practice is not always that easy to ensure. This applies in particular to mobile objects and have to be grounded again and again by the staff, such as tank trucks. How to ensure a reliable and effective grounding of the tank truck?

Reliable grounding monitoring system

According to the IEC TS 60079-32-1: a grounding cable should be connected to the truck before any operation is carried out. And to ensure the grounding of tank trucks, TRGS recommends ground monitoring system (interlock equipment) that blocks the loading or unloading process when the grounding cable is not connected or not working appropriate.  

Additional safety thanks to object recognition

A modern grounding system as TIMM’s Grounding Control Device EKX-4 provides an object recognition function to detect the tank truck. This function prevents manipulation by connecting the clamp to other metallic parts. To realize this recognition function, the impedance (resistance and capacitance) of the connected object is measured. Within the measurement, a significant source of capacitance is the cable capacitance itself. Cable capacitance is an electrical characteristic of cables. The value of the cable capacitance is intensively influenced by the length and size of the cable and even the environmental situation, e.g. the humidity of the air or the wet ground. The cable capacitance itself can easily reach the typical value of a tank truck in some situation. In such case, the grounding device will mistake the capacitance as truck and give the fake release. For the reliability of truck recognition function, the influence of the cable capacitance must be eliminated. EKX-4 has a built-in cable compensation function. The device will
measure the cable capacitance and compensate its influence to ensure the true truck recognition function. It enables also the possibility to use longer grounding cable (up to 30 m).

Summary
Grounding Control Devices are the necessary safety measure for every truck loading terminal for fuels and chemicals. It is the easiest and most effective way to protect the tank trucks against electrostatic hazards during the loading process. They must be interlocked with the process control system and give filling release only, when the grounding connection to the tank vehicle is established and its condition proved.

For further information
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About TIMM
H. Timm Elektronik GmbH (called TIMM), located in the Northern Part of Germany, is a specialized developer and producer of electronic measurement and control devices. Since 1963, TIMM’s monitored grounding solutions have been safeguarding operating facilities around the world. TIMM’s specially developed Intelligent Explosion Protection Concept (IEPC) enables you to put TIMM devices into operation and also maintain them very easily in hazardous areas.

Prevalent application areas of TIMM devices are the petrochemical and chemical industry. Our products provide safe loading and unloading of inflammable liquids and solids as well as qualified access control to hazardous areas.

Together with our global sales partners we supply our products around the world by taking the individual requirements of our customers to achieve a suitable application solution.