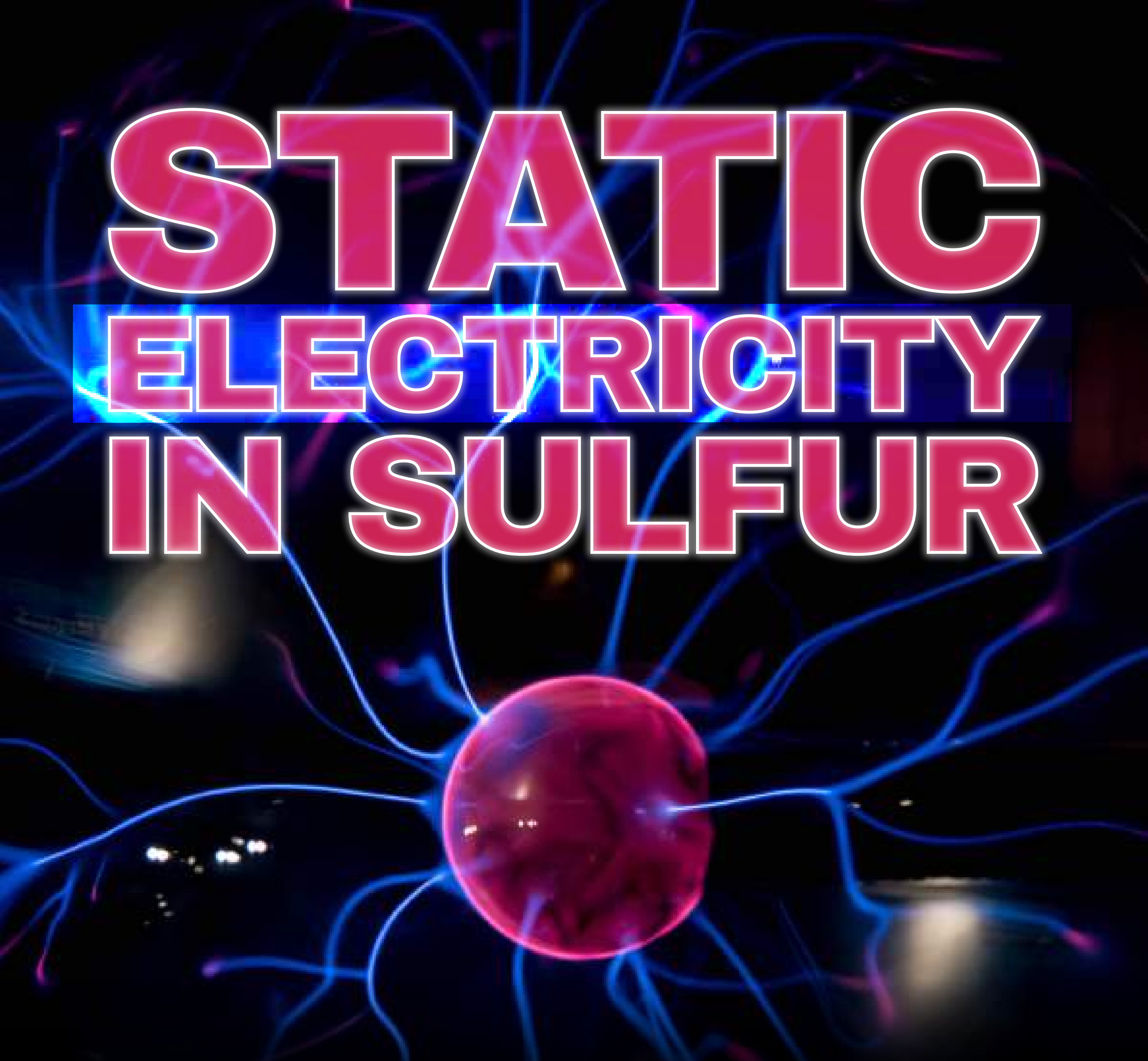
STATIC ELECTRICITY IN SULFUR



Edina Avdic, Enersul, Canada, discusses the nature of static electricity in sulfur, its effects on material handling and how to mitigate the hazards.

Sulfur is transported either in liquid or solid form. Each method has its benefits and drawbacks, and both require special considerations to ensure safe transportation. Liquid sulfur is transported either via the use of heated pipeline, specialised trucks or rail. Transport over short distances can be achieved by the use of well-insulated containers or rail cars as the low thermal conductivity of sulfur enables it to trap in the heat and remain mostly in a molten state. However, over longer distances, a heating system is required to keep the liquid from solidifying, and generally this is not an economical option. Also, if the sulfur is not used immediately, storage becomes a matter of concern.

Storage of liquid sulfur entails keeping it at a temperature above 120˚C to ensure that it remains liquid. This results in high utility costs. When transporting liquid sulfur, safety hazards such as pipeline leaks, de-railings and accidents involving sulfur trucks can occur. Due to the aforementioned hazards and the expense of storing the liquid sulfur for extended periods of time, if the technology is available, the liquid sulfur is shipped to the nearest forming facility and formed into solid granules, which are then shipped to their respective destinations. Sulfur destined for offshore markets is generally formed into granules to enable efficient transportation and storage.

Figure 1. Antistatic rubber conveyor belt.

One of the issues with shipping sulfur in solid form is that there is a possibility of dusting because extensive material handling can cause product degradation and breakage. Dusting is an issue as sulfur is a hazardous material and any release into the environment must be closely monitored and controlled. Another issue with sulfur dust is that at a certain concentration, and with the presence of an ignition source such as a static discharge, a fire or explosion can potentially occur. Due to the severe potential hazards of handling both liquid and solid sulfur, proper procedures must be followed. This article reviews the nature of static electricity in sulfur, its effects on material handling, and how to mitigate the hazards.

Static electric ignitions

Static electricity results from an imbalance of electric charge within or on the surface of a material. The ability of the material to surrender its electrons or absorb excess electrons, which causes the imbalance of electrical charge to form, is purely a function of the conductivity of the material. If the processed material is a conductive material, preventing considerable static electrical build up is relatively easy as it has a rigid molecular construction that will not permit its electrons to be moved about freely. The best way to remove any built up electrical charge from a conductive material is by grounding. However, if the material is non-conductive (also referred to as an insulator), minimal amounts of friction, heat or pressure can move around the electrons within the material and cause static electricity to build up, which is not easily dissipated. Sulfur is classified as a non-conductive material. Therefore, static electricity is likely to build up during handling operations.

Static electric ignitions result from transferring accumulated charges to another surface through a discharge. If the energy of this discharge exceeds the minimum ignition energy of the fuel, an explosion or fire may result. There are several types of discharges; the most energetic type is called an ‘arc’ or ‘spark’ discharge and occurs when an ungrounded charged conductor gets near another ungrounded or grounded conductor. This discharge is the most energetic and, therefore, also the most dangerous. Another type of discharge is called a ‘brush’ discharge, which occurs when a conductor gets near or is in contact with a charged non-conductive material. This discharge is lower in energy than the arc or spark type discharge, but it still holds enough energy to pose a hazard. A third type of discharge is called a ‘propagating brush’ discharge and occurs on the surface of a non-conductive material that is backed by a conductor, such as a painted metal object or a liner inside a metal drum. This arrangement grants electrical energy to build up similarly to in a capacitator, which can, therefore, result in a very high energy discharge. Another type of discharge that can occur in sulfur handling operations is called bulking brush or cone discharge and arises during the filling of a vessel or silo. The charge is built up in the non-conductive material and then transfers from the surface of the non-conductive material pile to the vessel walls or silo; this can also result in a high-energy discharge.

It is critical to understand the importance of static electricity in sulfur material handling operations as the flow of product against other materials and surfaces can easily generate friction and consequently lead to the generation of static electric charge. The following elements must be present for static electricity to be a threat for a potential fire or explosion; a fuel source such as a dust cloud with a certain particulate distribution, low moisture, oxygen and an ignition source that exceeds the fuel’s minimum ignition energy. In order for the sulfur dust particles to be explosive, the dust loading must be fairly uniform and the particles must be suspended at a minimum concentration of 35 g/m^3. Sulfur dust clouds have a relatively low minimum ignition energy (of 15 mJ) compared to other bulk materials and, therefore, most of the static discharges mentioned above can be considered as ignition sources. When watching sulfur fall onto a stockpile or a silo, it is possible to see the small sparks that are created between the particles while in motion. These sparks are very low in energy as they are occurring in between two non-conductive materials and do not pose a threat of explosion. However, if the charge is built up on a metal surface, this can result in higher energy discharges that can pose a safety hazard. Such a scenario may arise when the sulfur drops off the end of a conveyor onto a stockpile, or as it is transported along a belt conveyor. Another major potential for a static electrical charge to form is during the loading of a silo where the electrical charge can transfer from the product to the silo itself.

Mitigation

Static discharge has been documented to be the fourth largest ignition source in dust explosions and any material that has a minimum ignition energy (MIE) less than 30 mJ is classified to be susceptible to static discharges. Proper design guidelines need to be followed to ensure safety while handling materials with low MIEs. Mitigation includes proper equipment design with adequate bonding and grounding, proper material handling procedures, use of static resistant coatings, and the application of dust control techniques, such as dust suppression systems. Bonding consists of connecting materials together in order to establish the same electrical potential. When materials have the same electrical potential, they will not build a charge in relation to each other. Therefore, no electric discharge will occur. Grounding consists of connecting the material to an earth ground so that any built up charge is transferred to the earth. Both bonding and grounding are required in order to dissipate any built up electrical charge and to prevent the possible discharge of static electricity. As a measure, it should be ensured that the electrical resistance between any point in the system and earth should not exceed 10^6 ohms. All bonded and grounded equipment should also be inspected on a regular basis to warrant that the bonding and grounding connections are in good condition. Static electricity hazards can also be mitigated by ensuring proper material handling procedures are in place. Speed is a major factor when it comes to static electricity build-up during filling or emptying operations. Operating at reduced speeds essentially takes care of two problems; the slower the speed, the less static build-up and dust there is. Using antistatic materials and increasing the humidity in a process above 60% are other good mitigation measures to put in place. Since the build-up of static electricity cannot be completely eliminated, it is important to ensure that all electrical equipment is rated as explosion proof and that explosion mitigation techniques, such as explosion venting, are used.

Conclusion

Enersul has been operating and supplying sulfur forming and handing equipment for the last 60 years and has experience incorporating these design considerations into its process and equipment design. The process in the granulation drum is kept at close to 100% humidity to prevent static discharges in the drum, all equipment is properly bonded and grounded, and all electrical and instrumentation items have proper certifications. In material handling operations, conveying speeds are kept low, antistatic rubber belts (Figure 1) are used, and the number of transfer points and drop heights are minimised to reduce dusting as well as any static discharge potential. To reduce drop heights and drop impact, spiralling chutes and telescoping spouts are used where required, and the equipment is grounded to remove any potential static hazard. The use of diesel or propane powered equipment while handling sulfur is avoided as this can be a source of ignition. Front end loaders are commonly used to move piles of sulfur. However, the movement of equipment on stored sulfur causes breakage and results in dust formation. In order to avoid this, operations should be done very gently and slowly to minimise the dusting. Furthermore, care must be taken not to scrape the equipment against any concrete as this can cause sparks to form, which can cause ignition of a sulfur dust cloud. If all proper measures are taken and equipment and processes are adequately designed, the potential for safety incidents can be eliminated.