Static Grounding Clamps & Cables, Key Factors Too Often Overlooked

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According to reports from NFPA in the Unites States and from HSE in the UK and continental Europe, reports of static electricity incidents are much more common that one would expect, given that simple and reliable means of prevention is readily at hand.

In the US an average of 280 incidents are reported each year while the UK reports an average of 50. And in Europe the total is even more notable at 350 incidents. In instances where the electrostatic charge build-ups exist in a flammable or explosive ambient an obviously hazardous situation is created. (Copies of source data are available from the author upon request.)

Yet a great number of these incidents could have been prevented by the use of a reliable low-resistance electrical connection between the equipment involved and an identified grounding point. Many static elimination systems include valuable features such as connectivity monitors and provisions for protection in hostile applications, but the essence of a static protection system remains simple: a powerful clamp or some other reliable connection to the equipment to be protected, attached to an appropriate cable able to conduct the electric charge to a known grounding point.

Especially with batch processes that can require many hundreds or even thousands of earth connections to be made and broken every day, it is essential that good ground contact is made each and every time. The effectiveness, reliability and durability of any grounding clamp and associated cabling is therefore key to keeping process operations safe from the dangers of a static discharge.

Prime cases in point: Static electricity is a ubiquitous hazard in the production of coatings, resins, adhesives, paints, solvents, explosive or combustible powders and many other related processes. The common problem in these applications is that the processing equipment, as well as associated containers, drums and IBC's can build up layers of product or rust, or they have surface coatings. These layers can form an unpredictable insulating barrier that can easily defeat certain designs of clamps and other "in-house, jury-rigged" methods of making earth connections.

Regulatory Constraints

The importance of effective clamp design and its suitability for use in flammable atmospheres has not gone unnoticed by regulatory and approval bodies around the globe. Under ATEX, grounding clamps must meet specific criteria to be certified as suitable for use in hazardous areas. For example, a grounding clamp made of aluminum for use in Zone 0 or 20 must be coated with material that will not contribute to mechanical sparking under normal operating conditions.

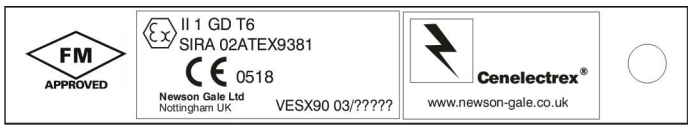
There are also limitations placed on the amount of plastic that may be used in the clamp body since this may allow surface-accumulation of static charge. The use of plastic also can introduce problems in terms of durability, resistance to chemical attack, and thermal stability.

Clamps are also assessed for sources of potentially stored energy and their ability to cause a spark if the energy is released in the hazardous area. One major energy source in grounding clamps is the spring. The spring has the potential to generate a mechanical spark through contact with other objects if its escapes the body of the clamp. Therefore clamps are tested for their structural robustness to ensure any stored energy is reliably contained within the clamp.

Combined with structural robustness testing, US approval bodies such as FM Global assess several other design criteria regarded as being essential for static grounding clamps. For use in hazardous locations, the electrical resistance across the clamp, including contacts and clamp body must not exceed 1 Ohm when attached to plant equipment. Additional tests ensure that the clamp is suitable for use in normal industrial conditions. The clamp must pass separation force testing, minimum-clamping force testing and vibration testing at varying frequencies to ensure that approved clamps guarantee positive and stable contact with mobile or portable plant equipment.

Clamp Approvals

These are typical markings to be found on an ATEX and/or FM approved clamps.



Newson Gale Studies

Engineers at Newson Gale have studied the effect of product accumulation, rust build up and protective coatings on the ability of grounding clamps to dissipate static effectively. Lab tests, designed to reflect real world operating conditions, have been conducted to investigate the impact layers of protective coatings and adhesives can have on the ability of clamps to establish positive contact with strips of conductive metal. Based on grounding clamp approval requirements, the benchmark clamp resistance test was set at 1 Ohm.

The tests showed some surprising results. Most notably, in the 'Coatings Test' even the thinnest layers (400 µm) provided a wide range of clamp resistance readings that varied based on clamp design. The test indicated the highest levels of clamp resistance (upwards of $1x10^6$ Ohm) were exhibited in clamps with varying combinations of high surface area contact with poor to good spring pressure. The clamps that exhibited consistent positive values (less than 1 Ohm) combined low surface area contact with good spring pressure. Low surface area contact, achieved via sharpened tips (typically manufactured from Tungsten Carbide or Stainless Steel) supported by good spring pressure, enabled penetration of the entire range of test coatings.

Test Data

- Paint coating thickness 300µm - 675µm
- Ohm meter range 0 - 1000 Ohms
- From the range of purpose designed static grounding clamps tested 64% failed
- 100% failure rate for standard welding clips

The 'Adhesive Test' proved the most challenging for all the clamps tested. A 1mm layer of adhesive was applied to metal conductive strips and all clamps failed at initial clamping. When the clamps were then permitted some "jigging" by hand to dislodge the adhesive, the clamps that passed the coatings test, subsequently passed the adhesive test. Rusted and corroded clamps were also tested for values of resistance. These test results were alarmingly high, even on clean surface tests.

The tests effectively demonstrate that product deposits can severely compromise accepted good grounding methods. Of particular cautionary note; welding clamps, alligator clips and copper cables wound around plant equipment showed values of electrical resistance that exceeded generally accepted safe test levels for static electricity.

Grounding and Bonding Cables

Effective Clamps need cables and connections that can stand up to the rigors of industrial use. Due to their mechanical strength multi-stranded steel cables provide much longer lifetime use than copper braids or cables which can easily work harden with constant movement. In manufacturing areas where corrosion is a problem multi-stranded stainless steel cabling is available.

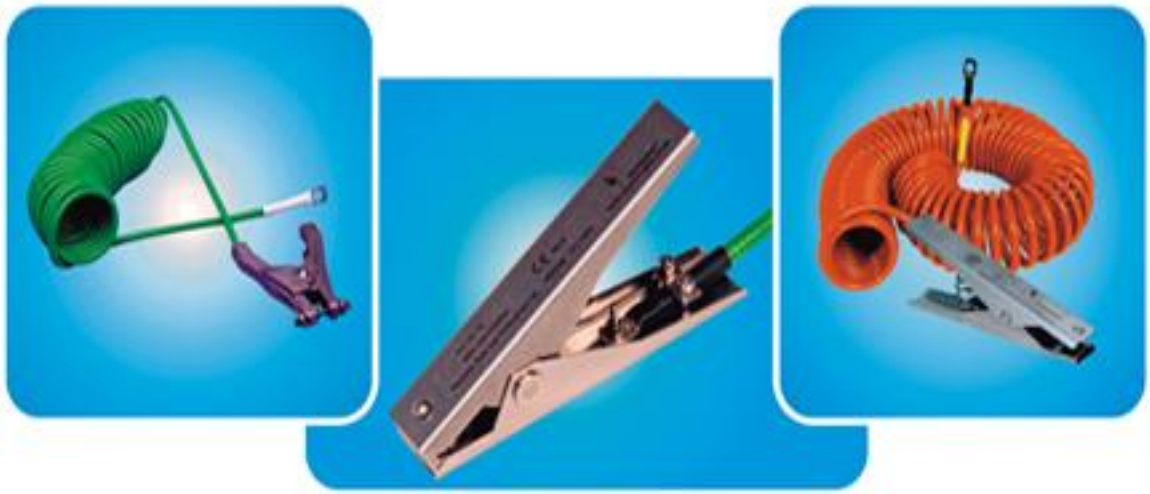
Trailing or taut grounding wires and cables can be a major trip hazard in the work place. Use of brightly colored highly visible sheathed cable (in accordance with IEC 60446) clearly identifies the cable is for static grounding as opposed to electrical earth use. Hytrel® covered cable with proven resistance to abrasion, mechanical wear and most types of chemical corrosion when used in a retractable spiral, keeps earth cable handling simple, and options are available with a special anti-static treatment to even prevent a surface charge accumulating on the cable coating.

Maintenance

Regularly inspecting and recording the integrity of bonds to designated earth points is essential. The integrity of bonds can be tested in hazardous areas with Intrinsically Safe portable instruments, which provide a simple reading to ensure the clamp is making effective and positive contact with the plant equipment, and that the bonding cable is properly attached to the local earth point.

Cable Colors

There are no mandated identifying colors for sheathed static grounding cables, however due attention should be paid to IEC60446, and the importance of selecting colors which cannot be confused with electrical "fault current" or circuit protective conductors. In Europe the Cen-Stat™ single conductor cable is GREEN in order to distinguish it from the banded green/yellow used for electrical grounding. Cen-Stat™ ORANGE cable is used to denote single conductor static grounding cables in North America.



Conclusion

It is easy to assume that the use of simple clamps will automatically eliminate the risk posed by static electricity. However, the complexity of dissipating static effectively requires careful planning and a sound approach to risk management.

Regulatory & Approval bodies in Europe and in North America emphasize the importance of using specially designed grounding clamps that are both fit for the purposes of dissipating static safely and for use in industrial environments. For ultra-critical applications with extremely sensitive flammable/explosive atmospheres, where a low resistance bond to ground is absolutely vital, self-testing clamps and indicating/interlock systems are recommended. Working to these standards and guidelines is the way to ensure plant and plant personnel are protected from the ever-present and hidden dangers of static electricity.

For additional information on static electric protection technology please visit the Newson Gale On-Line Knowledge Center at www.newson-gale.com.