Static Electrification - Problems and Solutions
The Application of Ionising Sources.

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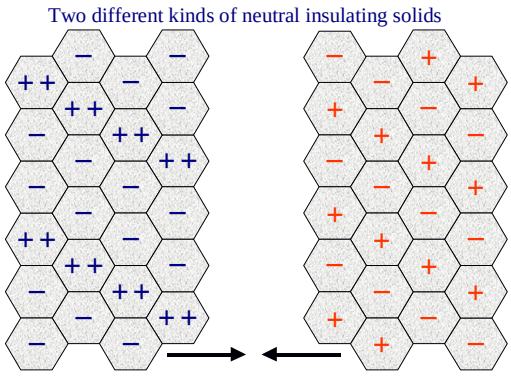
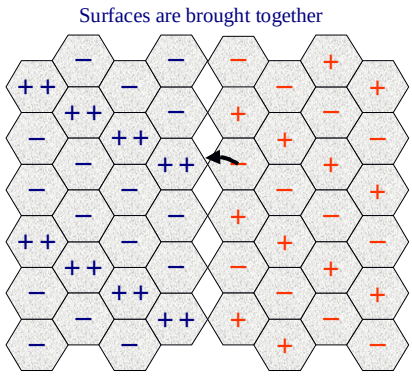
CAUSES

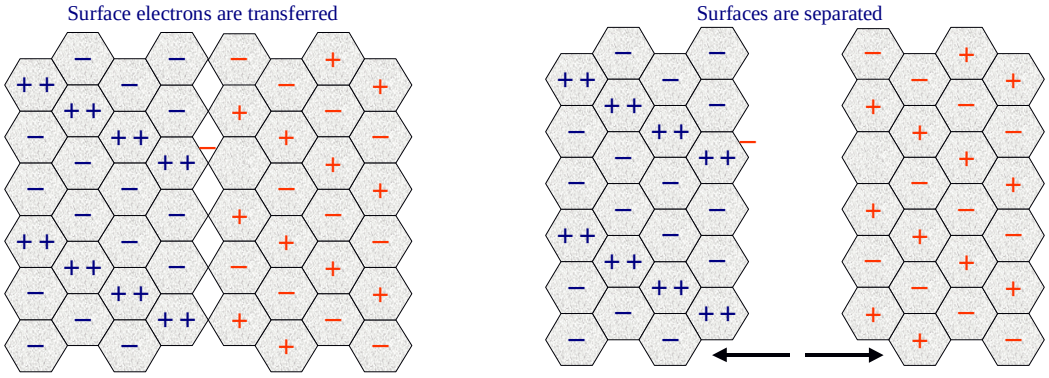
Static electrification occurs whenever electrically insulating materials move, rub against or separate from one another. This occurs particularly in dry conditions when charges, which have accumulated cannot easily find a conducting path to ground. Any surfaces can be involved such as solid/gas, solid/liquid, solid/solid and liquid/gas. Static electrification happens everywhere, all the time. It occurs in the home, at work and in the environment. The most well-known example in the environment is lightning, caused by ice and water particles becoming charged as they jostle and move through the air. At home common examples arise as a result of combing dry hair, removing nylon clothing or touching a grounded metal object like a car door handle on a dry day. These are little more than nuisances in everyday life, but in industrial environments electrostatic discharges can be severely damaging. Anything, which moves (and also many things, which don't) can pick up very large amounts of static charge. The clean and dry conditions, the high speed of modern industrial processes and the prevalence of insulating materials throughout industry provide perfect conditions for static electrification to occur.

All materials contain positive and negative charges. In electrical insulators these are in the form of positive ions, negative ions and neutral molecules. In the diagram below the atoms and electrical charges of two imaginary solids are represented. They have different types of surface. The surface forces and surface energies are also very different. When they are brought together, surface electrons are shared. In this imaginary example, an electron on the right-hand surface is attracted towards the other by stronger surface forces, in this case from a "++" ion. (In real life materials, there are several mechanisms and driving forces for transferring electric charges at surfaces).





When surfaces are separated, some of the shared electrons are left behind on whichever surface had the strongest local bonding forces. When this happens both solids become electrically charged, one material being positive and the other negative.



The above diagrams represent the process of static electrification at surfaces, but only in the simplest of terms. It should be noted that many insulating materials in everyday use are continually coming into contact and separating again. Electric charges are therefore always being exchanged and static electricity is continually being generated around us.

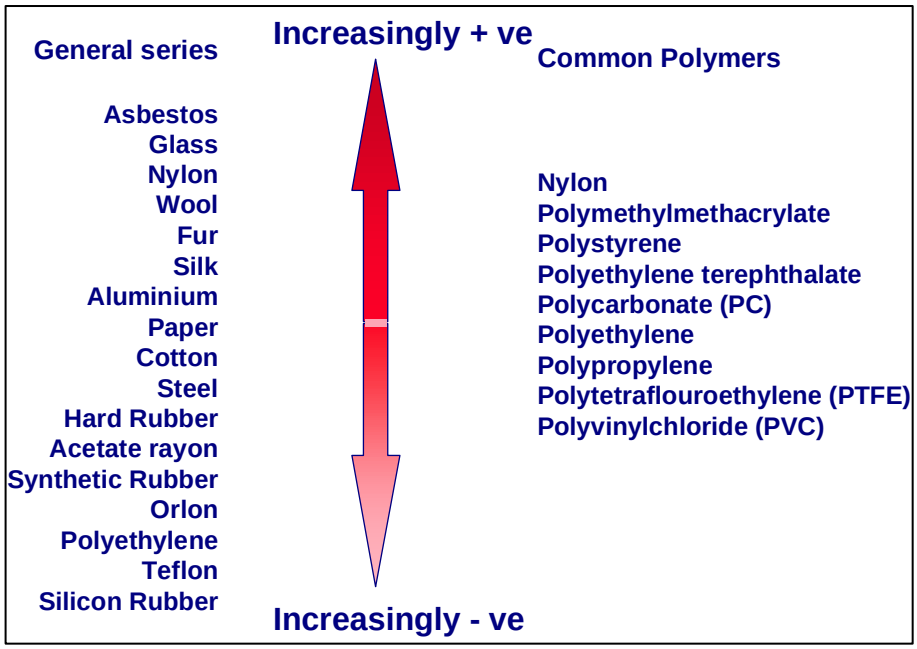
Static charge on insulators leaks away very slowly in dry conditions because conduction of charge over insulating surfaces to ground is especially slow when it is dry. In rapid industrial processes there is often insufficient time after materials separate for charge to dissipate, so charge progressively builds up and can easily reach dangerous levels. In rapid processes involving highly insulating materials static charge can build up very quickly to exceed several thousands of volts. When this occurs in the presence of a flammable material a catastrophic fire or explosion can occur if this causes a spark of sufficiently high energy. The most serious risks occur when flammable material is present as a mixture with air in the form of a vapor, an aerosol or as a dust cloud. There are special problems in industry involving food processing, milling and grinding operations and in handling and packaging powders. 30% of all dust explosions occur in the food industry.

Some materials may be damaged by exposure to quite low levels of static electrification, where no spark is needed to cause damage. Just the proximity to an electrostatic field is sufficient. Materials undergoing coating processes may also be affected in subtle ways by electrostatic fields. In the automotive industry for example, millions are lost each year due to faulty paint-work, caused by dust inclusions arising from paint dust, which may be attracted to surfaces by strong electrostatic forces from charged body panels. Or non-random orientation of metallic particles in paint can result from electrostatic fields, which causes poor and variable surface quality. This is a common problem and one, which is very difficult to solve safely. The paint-spraying environment is extremely hazardous, involving toxic and highly flammable solvent vapors, aerosols and dusts. These problems and some of their solutions are highlighted later in this paper.

STATIC PREVENTION AND ELIMINATION

Static charge cannot be seen or heard so it is not always obvious or apparent that a static problem exists. There may be no awareness of the risks and hazards and therefore no preventative measures put in place.

Some materials are prone to become more electrified than others, depending on what they may come into contact with. Some become positively charged and others become negatively charged. The tribo-electric series for some common materials is shown in the diagram below. It is usual in processes, which involve materials coming into contact with each other and with rollers and conveyors for example, such as in plastic film, fabric and paper production to ensure that roller materials are compatible with the film being processed. This can minimize the amount of charge produced during processing.



Compressed air driven guns are used to deliver high velocity ionized air to surfaces, which require dust particles to be removed prior to painting. An important application is in the preparation and cleaning of car body parts. Dust is a notorious problem in the automotive industry and in paint spray booths in general. It is difficult to remove dust and dirt because strong electrostatic fields attract and hold fine suspended dust particles onto car body panels. This cannot be removed by compressed air alone. The solution is to use an ionising gun. Devices of this kind blow compressed, ionized air onto the surface which eliminates the surface static charge, enabling the compressed air to blow the dust and dirt away. Once the body panel is clean, suspended dust in the air does not resettle on the car once the static charge has been removed. Thousands of devices such as this are now used in this application throughout Europe and the USA. It is estimated that the costs of reworking and refinishing car body panels in the European automotive industry amounts to over £300 million per year.