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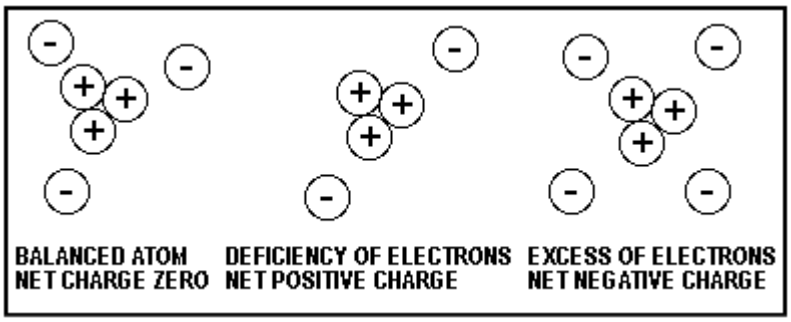
Static Electricity

STATIC ELECTRICITY: Denoting or pertaining to electricity at rest. How simple and inadequate this definition is of a phenomenon that creates problems which cost industry millions of dollars per year. A clearer understanding can be gained by explaining lightning. Static electricity in the atmosphere remains at rest until the potential gradient, between clouds, reaches a level that causes the insulator between clouds, in this case air, to break down or fail, and lightning is created to equalize the potential gradient. For the brief instant the lightning flashes, the static electricity is no longer at rest.

What do we know about this phenomenon called "static electricity"? What is it and how do we get rid of it or at least control it? Well, let's examine it.

CAUSE

Static electricity is generated by unbalancing the molecular construction of relatively non-conductive insulators such as plastics and paper. All matter is composed of atoms. A balanced atom contains positive charges that are present in the nucleus of the atom. An equal amount of negative charges orbits this nucleus in the form of electrons. Both charges are equal and, therefore, the overall charge of a balanced atom is zero. However, should this configuration be disturbed and several electrons removed from this atom, we end up with a greater positive charge in the nucleus and a deficiency of electrons, which gives you an overall charge in the positive direction. Conversely, should we add a few extra electrons, we have an overall charge of negative, due to the fact that we now have an excess of electrons and the net charge is now in the negative direction. See figure below.



CONDUCTIVITY

The ability of material to surrender its electrons or absorb excess electrons is purely a function of the conductivity of the material with which you are working. For example, a pure conductor, such as copper, has a rigid molecular construction that will not permit its electrons to be moved about freely. However, as you approach the semi-conductor range, such as some bond papers, the ability of this material to surrender its electrons is relatively easy and can be accomplished by friction, heat or pressure. As you approach the purely non-conductive materials, such as plastics, it is extremely easy to disrupt the molecular construction and cause the material to charge with the slightest friction, heat or pressure. If the conductivity of your processed material can be controlled, then, preventing static electricity becomes relatively easy.

For example, adding surface conductivity to plastics will move them up into the higher conductivity range and prevent the build up of static electricity that is caused by friction. This is normally accomplished by use of additives such as moisture and anti-static sprays. The average anti-static spray is made up from a soap based material that's been diluted in a solvent, such as mild alcohol.

A fire retardant is added to combat flammability of the solvent, then pressure and Freon ® are added, and you have your aerosol can of anti-static spray. As this spray leaves the nozzle of the aerosol can, the two Freons normally used evaporate immediately. A short time after con- tact with your material, the fire retardant and solvents evaporate leaving you with a conductive coating on the surface of the material. The plastic has now become conductive and as long as this coating is not disturbed, it will be difficult to generate static electricity in this material.

INDUCTION

Removing or neutralizing static electricity by induction is the simplest and oldest method. Tinsel is the most common tool for this application. However, tinsel is oftentimes misused and, therefore, oftentimes not successful. The first thing that must be recognized is the fact that any induction device, such as tinsel, will never reduce or neutralize static electricity to the zero potential level. This is due to the fact that a threshold or beginning voltage is required to "start" the process.

First, the correct induction equipment must be utilized. If you are using tinsel, it must have a metal core. We have seen tinsel with a string (non-conductive) core being utilized. This type of tinsel will not function properly. Second, the tinsel must be well grounded electrically. Third, the tinsel must be stretched tight and placed 1/4 of an inch from the material to be neutralized. Fourth, there must be "free air space" under the material to be neutralized directly under or over the spot where you place the tinsel. In this fashion the tinsel will reduce static electricity on both sides of the static laden material.

Actually, if the above steps are utilized, the sharp ends or points of the grounded induction device will ionize the air over the surface being neutralized, because the grounded sharp ends are placed within the electrostatic field that is present due to static electricity. If the static charge is negative in polarity, the electrostatic field is negative and positive ions are generated via the grounded sharp ends of the induction device and the positive ions are attracted back to the static laden surface. Conversely, if the static charge is positive in polarity, negative ions will be generated by the grounding induction device and attracted back to the charged area.

GROUNDING

It is also possible to disturb the molecular construction of your operator. As ridiculous as this sounds, if an operator is isolated by standing on a wooden floor or wearing crepe rubber soles, he will soon pick up a voltage gradient. For example, it is possible for an operator to charge to several hundred volts each time he handles a piece of charged plastic. As he handles many different pieces, he will become charged to a higher voltage gradient until a flash-over will occur and the operator receives a shock, or damages a static sensitive device. This can be prevented by having your operator stand on a grounded conductive mat or by the use of personnel grounding equipment that is commercially available and by ionization.

Personnel grounding equipment becomes important if your operators are sitting while working. This is the best means of isolating operators and, therefore, they become extremely vulnerable to static discharge due to charging. This phenomenon can be related to an individual dragging his feet on the living room rug and then discharging himself by touching a well grounded lamp.

In addition, grounding of all your plant machinery and related equipment is most important. It never ceases to amaze us that so many plants are operating machinery that is not grounded electrically. Besides the safety factor, a grounded machine will help drain off extremely high charges of static electricity from partial conductors. Remember, grounding is only an aid to reducing your problems with static electricity. It is not a solution.

For example, grounding your operators will not drain off static electricity from their clothing. Also, it will not drain off static electricity from a plastic container one maybe holding. The conductivity of some clothing and most plastics is so low that electricity cannot flow to a ground; hence, "static electricity." To solve this problem, ionization must be utilized.

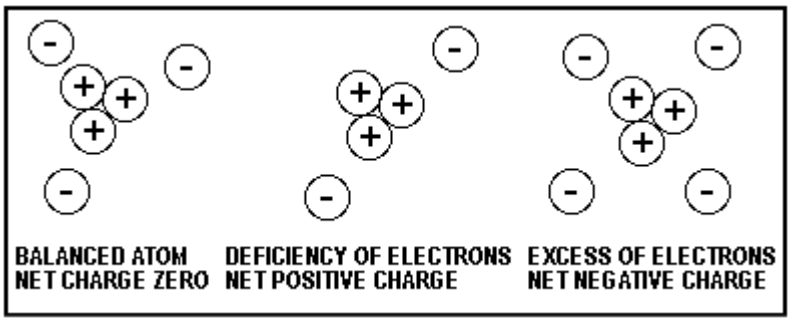
IONIZATION

By following the above steps, you can greatly reduce the hazards of building up high charges of static electricity. Another practical method of curing your static problems, however, is by neutralization. It is important to understand that static electricity cannot be entirely eliminated. In fact, the terminology, "static eliminators," is definitely misleading.

Static eliminators are really ionizing units that produce both positive and negative ions to be attracted by the unbalanced material so that neutralization does occur. For example, a charged piece of material can be neutralized by utilizing a static neutralizer. However, it does not eliminate the static electricity because, if the material is again frictioned after being neutralized, static electricity will be generated.

In order to gain the most benefit from your static neutralizing equipment, it is important that you understand how they operate and how they provide the means of neutralization. Most electronic static neutralizers are constructed by placing a high voltage on a sharp point in close proximity to a grounded shield or casing. As the high voltage alternating current pulses through the 60 cycle operation, the air between the sharp points and the grounded casing is actually broken down by ionization and therefore both positive and negative ions are being generated. Half of the cycle is utilized to generate negative ions and the other half is utilized to generate positive ions. Since we operate on 60 cycles per second, we are changing polarity on our ionization every 1/120 of a second.

If the material being neutralized is charged positive, it will immediately absorb negative ions from the static neutralizer and repel the positive ions into space. When the material becomes neutralized, there is no longer electrostatic attraction and the material will cease to absorb ions. Conversely, if the material being neutralized is charged negative, it will absorb the positive ions being generated by the neutralizer and repel the negative ions. Again, once neutralization is accomplished, the material will no longer attract ions. See figure below.



Nuclear-powered equipment may also be used to generate ionized air for static neutralization. These devices, powered by Polonium 210 isotopes which have a half-life of only 138 days, are continually losing their strength and must be replaced annually. They are more expensive and less effective than electrically powered devices. These nuclear devices cannot be purchased and are leased by users. One year lease costs are usually more than the purchase price of comparable electrically powered devices.

SOLUTION

In order to solve problems related to static electricity, certain basic steps must be taken. The logical approach should be:

A. Identify the problem.

B. Determine the solution.

C. Select the **proper equipment** to solve the problem.

To identify the problem, some sort of measuring equipment must be used. For example, an ElectroStatics, Incorporated **Model 9000** electrostatic locator meter will measure the amount of static electricity that is present and identify the polarity as either positive or negative. Measuring and locating static electricity will remove the mystery often associated with this phenomenon.

Once the problem is identified, the solution should be considered next. Can the static electricity be controlled by grounding, induction, ionization or a combination thereof?

In making this decision, keep in mind the facts mentioned, relative to conductivity. With pure conductors or partial conductors (such as the human body or some paper), grounding should be considered. However, if you are working with insulators, such as plastics, ionization must be added.

PROBLEM IDENTIFICATION

Before any problem can be solved it must be identified. Is your problem related to static electricity? An in-depth analysis should be made with the necessary equipment and experience to afford a definite identification of the problem.

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*Electro***Statics** products such as **Static Meters** are used to measure Static Electricity and can be reviewed here.

*Electro***Statics** **Ionization Products** can be reviewed here.

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*Electro***Statics** Incorporated is a leading manufacturer and marketer of systems to control static electricity and the related contamination. The products line includes but is not limited to Static Meters, Static Neutralizing, Static Bars and Blowers, Static Generating & Grounding systems, Web Cleaning, Sheet Cleaning, and Contamination Control devices for the complete control of Static Electricity.

Industry in general, and the plastics, paper, textiles, electronic industries in particular, have been plagued with static electricity and it's related particulate attraction. *Electro***Statics** Incorporated has extensive application experience in these industries and is dedicated to providing each industry with complete systems for the control of static electricity and web, sheet, and parts cleaning.

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