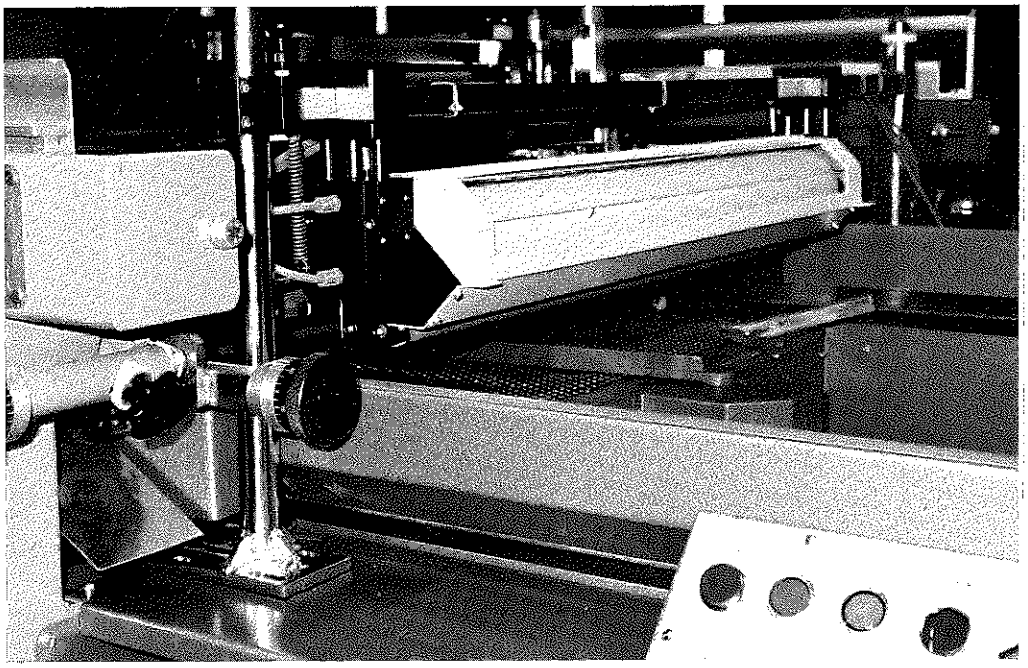
# Controlling Static Electricity During Production

*By Sheila Hamilton*

*This is the first of a two-part article on static electricity as it affects screen printers. Part one will cover the theory of static electricity and equipment used to combat it. Part two, next month, will cover the causes and solutions of static electricity during screen printing production.*



In the screen printing industry, static electricity is one of the major contributors to reduced yields through lower throughput, increased reject levels, and low personnel effectiveness. Careful control of static will show immediate benefits in profitability. This article will highlight the problems caused by static, while providing a basic understanding of the theory behind the generation and neutralization of the static charge. In addition, an outline of practical measures which can be used to control static in the screen printing facility will be given.

## Static Theory

All matter is composed of atoms. A balanced atom contains positive charges that are present in the nucleus of the atom and an equal amount of negative charges which orbit this nucleus in the form of electrons. Both charges are equal, and therefore, the overall charge of the balanced atom is zero. However, should this configuration be disturbed and electrons removed from the atom, the result is a greater positive charge in the nucleus and a deficiency of electrons, which gives an overall positive charge. Conversely, if a few extra electrons are added, there is an overall negative charge. In either case, when electrons are added or subtracted from the atom, it becomes an ion with an electrical charge, with the potential to cause static electricity.

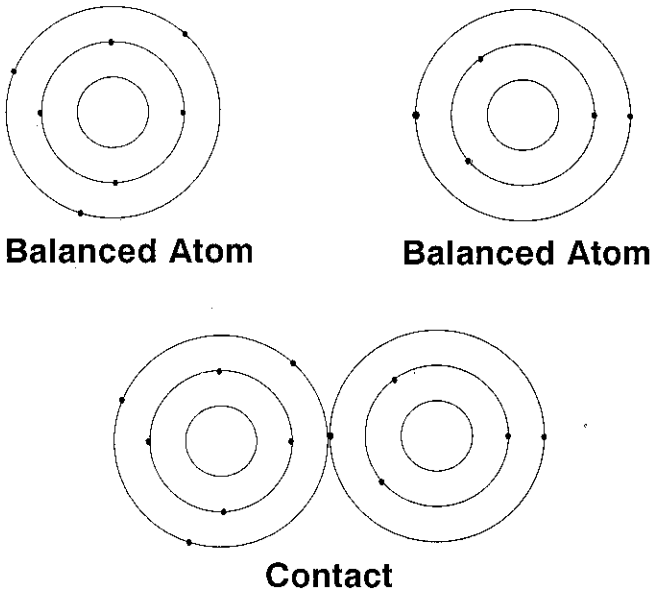
An insulator such as plastic can be affected by certain physical forces which contain sufficient energy to add or subtract electrons from their orbits by breaking weak atomic bonds (See Figure 1). These physical forces include pressure, friction, heat and separation.

Static electricity occurs as surface charges on materials and equipment through a process called triboelectric charging, during which electron transfer takes place. Some materials resist this electron transfer process more than others, while those that readily share electrons will charge the highest and potentially cause static difficulties. Some substrates which exhibit this electron freedom include polyesters, polycarbonates, vinyl and paper. The precise quantity of charge generated when two materials are separated is complex and depends on variables such as speed of separation, intimacy of contact, contact pressure temperature, humidity and the ability of the material to accept or donate electrons. This ability has been scientifically determined and the results tabulated in the triboelectric series (See Figure 2) such that the materials at the top of the table take on a positive charge and those at the bottom a negative charge. The greater the distance between the two materials in the table the greater the charge which will be generated.

Static electricity cannot exist on the surface of any material without there being an electrostatic field present. This field is formed of energy which can charge dust particles. The charged dust particles are then attracted to the surface which has the opposite polarity of charge. Static electricity can only be neutralized when in free space. This is because the electrostatic field is necessary to establish the electrostatic forces which in turn attract the ions from the neutralizing equipment. If the static-laden material comes in contact with any surface, the electrostatic field will collapse and no attraction of ions will take place, rendering the static control system useless.

While the human body and other conductors can be grounded to dissipate static charge, insulators such as

## FIGURE 1




## FIGURE 2

### TRIBOELECTRIC SERIES

The farther apart two materials on this list, the greater the potential to generate static electricity.

AIR
HUMAN HANDS
GLASS
MICA
NYLON
WOOL
ALUMINIUM
PAPER
COTTON
STEEL
HARD RUBBER
NICKEL
COPPER
SILVER
ACETATE
POLYESTER
ACRYLICS
POLYURETHANE
POLYETHYLENE
POLYPROPYLENE
PVC
SILICON
PTFE

plastic cannot. They require air ions to become neutralized. Air ions exist in great quantities in outdoor fresh air environments. However, the modern print shop is practically devoid of this natural ion supply. Ion depletion is the single biggest cause of static problems.

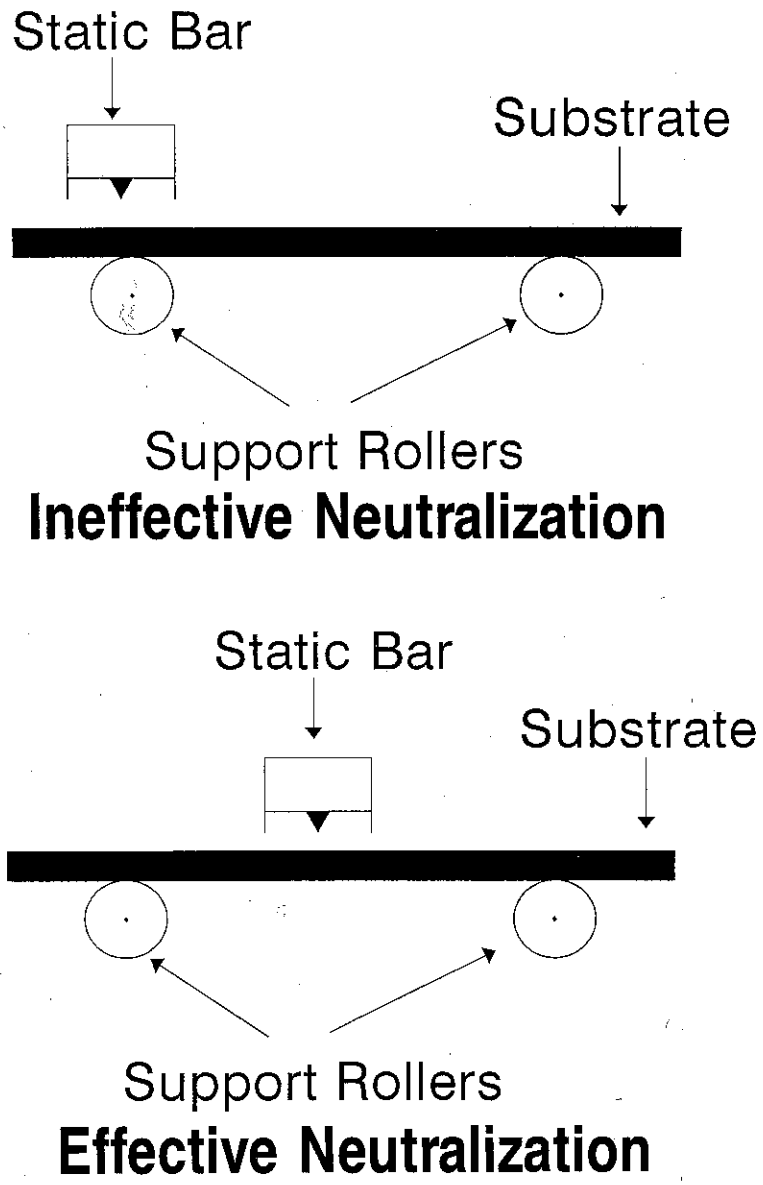
Equipment used to control static must generate these ions to neutralize the common non-conductive substrates used in the screen printing process. Most static eliminators utilize the principle of high voltage corona discharge from a sharp point which is placed in close proximity to a grounded outside case. The high voltage generated between these conductors in the static eliminator breaks down the air into positive and negative ions. If the material to be neutralized is charged positive, it will attract negative ions from the static bar and repel the positive ions. Conversely, if the material to be neutralized is charged negative, it will attract positive ions from the static bar and repel negative ions. The most effective approach toward elimination of the static charge involves the ionization of the ambient air around the charged parts.

## Basic Static Control

Most static eliminators use an AC high voltage source at a frequency of 60 hertz. The ionized corona created with AC is compact and powerful. The output of positive and negative ions is equal with positive ions being generated during one-half of the AC cycle and negative ions generated for the other half.

With pulsed DC, both the frequency and the polarity of the high voltage supply can be varied giving longer range performance and an electrical balance which can be altered for faster neutralization of specific substrates. If the frequency of the pulse is high, DC units will generate a compact, intense corona similar to AC units. If the pulse frequency is reduced to 4 hertz, ion emission is followed by a substantial time during which there is no emission. The adjacent emitters are normally of different polarity and the brands of ionized air are propelled away from the emitters on the basis that like poles repel. As they travel, the ions mix with the oppositely charged ions from the adjacent emitter and create the desired electrical balance in the air. In this way, a slow pulse gives a long range and wide area coverage.

**FIGURE 3**




Corona discharge emitter points form the ion generation mechanism of many types of equipment supplied for static control. Static bars contain a line of emitter points and are designed to be placed in close proximity to the part to be neutralized using electrostatic forces to attract the ions to the part. Blowers incorporate emitters in front of a fan which blows the ions toward the charged material. Air knives blow air across a static bar and static hoods generate ions from an array of static bars but use gravity to propel them toward the part.

Static emitters can cause induced charges on non-conductive parts which sit in an unbalanced ion stream. The parts will accumulate the net charge and the potential of the object will increase.

An understanding of the basic theory governing static generation and neutralization is vital in selecting and implementing effective static control measures. There are three main areas in a screen printing shop where static is a major problem, namely on substrates, equipment and people. Each of these areas is dealt with individually together with the appropriate static control measures. ■

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