

Cause & Effects of Static Electricity in Paper

Problem

The paper has developed a static electrical charge causing an abnormal sheet-to-sheet or sheet-to-material attraction which is difficult to separate. This condition may result in feeder trip-offs, print voids from surface contamination, ink offset, or poor sheet jog in the delivery.

Description

Static electricity is defined as a non-moving, non-flowing electrical charge or in simple terms, electricity at rest. Static electricity becomes visible and dynamic during the brief moment it sparks a discharge and for that instant it's no longer at rest. Lightning is the result of static discharge as is the shock you receive just before contacting a grounded object during unusually dry weather.

Matter is composed of atoms, which in turn are composed of protons, neutrons, and electrons. The number of protons and neutrons, which make up the atoms nucleus, determine the type of material. Electrons orbit the nucleus and balance the electrical charge of the protons. When both negative and positive are equal, the charge of the balanced atom is neutral. If electrons are removed or added to this configuration, the overall charge becomes either negative or positive resulting in an unbalanced atom.

Materials with high conductivity, such as steel, are called **conductors** and maintain neutrality because their electrons can move freely from atom to atom to balance any applied charges. Therefore, conductors can dissipate static when properly grounded.

Non-conductive materials, or **insulators** such as plastic and wood, have the opposite property as their electrons can not move freely to maintain balance. When two insulators contact each other, electrons may build up on one surface creating a negative charge, while the other surface loses electrons and becomes positively charged. Since these insulators do not conduct electricity, the charges will not dissipate until the material contacts a conductor. When this happens we see a static discharge in the form of a spark.

With all other variables equal, coated paper can create higher static charge as compared to uncoated paper because the coating further insulates the low conductivity of the raw cellulose paper fiber while increasing potential surface contact. Therefore, lightweight, large-format, gloss-coated papers can be of particular challenge because the ultra-smooth surface offers a high contact area with less weight and body. Since coated paper is only semi-conductive at best, accumulated charges will not dissipate until the material approaches contact with a conductor and sparks a discharge.

Cause & Effects of Static Electricity in Paper (continued)

If paper develops a static electrical charge, feeding problems can result when individual sheets resist separation at the feeder head causing double-sheeting, forwarding interference, and/or off-timing into the head-stops. This charge may also attract airborne contaminants to the paper which can result in hiccups or print voids. If exceptionally high, the static charge can disrupt the dispersion of spray powder in the delivery, and in conjunction with the sheet-to-sheet attraction, cause poor sheet jog and ink offset.

If the conductivity of the paper and ambient environment can be properly maintained and controlled, the problem of static becomes easier to manage.

Causes

- **Improper Grounding** – This results in the inability of the metal parts of the printing or converting equipment to effectively neutralize charges. It will not eliminate static electricity, but properly grounded machinery will help drain-off and dissipate large charges, making the problem much more manageable.
- **Low Humidity** – Exceptionally dry ambient and/or material moisture levels can aggravate static build. Adequate moisture is necessary to help dissipate static by raising conductivity. Without moisture, air and coated paper are basically non-conductive. Low moisture paper, either by design or due to adverse exposure to a dry environment, can be especially problematic. For example, coated web papers, manufactured to lower moisture content, may be more susceptible to static charge when converted to run sheetfed.
- **Pressure and Contact** – The greater the contact area between paper and other surfaces, the higher the potential for electron exchange and static build. Friction, itself, does not create a charge, but processes that increase friction also increase contact. Thus, large format, lightweight, lower stiffness coated papers are more susceptible to static charge. Exceptionally smooth, gloss-coated papers with greater contact area may be especially difficult to separate, not only when a static charge is present, but also when tightly pressed together.
- **Temperature** – Winter months and colder temperatures bring dryer climates and higher potential for static build. Thinner air at higher elevations also tends to be dry and does not consistently hold temperature resulting in humidity fluctuations. In addition, colder paper tends to be less conductive and more prone to static build than warmer paper properly acclimated to recommended pressroom temperature.
- **Combination Effect** – When combined, different materials or objects with variable levels of static charge can create a cumulative effect causing very high static charge.

Electro-static locator meters can measure the amount of static electricity present and identify the polarity as either positive or negative. Without a meter, the presence of static within a load of paper can be determined by removing approximately 30 sheets from the top of the pile and then slowly

Cause & Effects of Static Electricity in Paper (continued)

sliding the next sheet across the surface without lifting it. If significant resistance is felt, the presence of a static charge is causing a material attraction. The potential for static charge can be determined by rubbing the top sheet against the pile surface. This increase in surface contact can simulate the potential for building a static charge during the paper converting or feeding process.

Options and Solutions

Both the presence and potential for static electricity in paper can be effectively managed by a combination of effective grounding, ionization, and proper humidity/temperature control.

Grounding

- Plant machinery should be grounded to a steel rod driven into the ground, ultimately as deep as 8 feet, depending upon voltage currents, local electrical codes, and manufacturer specifications. A properly grounded machine will help dissipate high charges of static electricity from semi-conductors such as coated paper.
- When properly grounded, metal core tinsel can dissipate static by induction. The tinsel must be tightly stretched approximately 1/8" from the paper surface without contact. It is best placed across the pile at the feeder head at the point of sheet separation and across the feedboard where adequate air space exists under the sheet. The tinsel should then be attached to a properly grounded press or other conductive object.

Ionization

- Electronic static eliminators, or neutralizers, use a high-voltage discharge to ionize the surrounding air; the ionized air acts as an electron source which, in turn, neutralizes the static charge on the paper.
- In-line air ionizers are simple to install in the feeder blower line and very effective if installed properly. As the air blows between the sheets, the paper surfaces build up similar, or like, charges that now repel each other, enabling sheet separation. It is recommended that these in-line ionizers be replaced annually. Be sure that air blower filters and blower heads are clean with adequate air pressure and distribution to insure optimum sheet separation.
- Ionizing string and/or elastic cord dissipates static electricity with tiny conductive micro-fibers that cause the static charge to ionize and flow to the ground. It is easily placed in multiple locations both over and under the sheet, but is most effective in removing static as it emerges from the stack or roll.
- Anti-static or silicone sprays increase conductivity and minimize excessive contact from friction by applying a thin silicone or soap-based coating to the machine components that transport the material. Application to contact points such as the feedboard, transport tapes, and wheels can be helpful.

Cause & Effects of Static Electricity in Paper (continued)

Humidity / Temperature

- Adequate moisture in a conditioned pressroom increases conductivity and helps dissipate static charge. A properly climate-controlled facility includes humidification that maintains 45% (+/-5%) Rh @ 72° (+/-5°) F. for North America and 52% (+/-5%) Rh @ 21° C. for Europe. Ambient relative humidity below 35% Rh can adversely affect paper and decrease conductivity, which results in greater potential for static.
- Paper, properly acclimated to recommended pressroom temperature, has a better chance of running static-free as compared to cold paper. To maintain the relative humidity of paper consistent with original moisture content, do not unwrap paper any sooner than necessary before going to press. Paper can be properly acclimated to pressroom temperature without unwrapping. (See Sappi technical tip sheet on *Paper Conditioning & Characteristics*).
- Avoid storing paper in proximity to extreme hot or cold sources and minimize exposure to high heat in the drying process which may adversely decrease moisture content. Keep press IR dryers to a minimum with pile temperatures not to exceed 95° F. / 35° C.
- If static and smooth-surfaced sheet cling make feeding difficult in a properly controlled pressroom environment of 40% Rh or greater, it might be helpful to gently hand-wind the paper and rebuild feeder loads just prior to running on press. This consideration may improve sheet acclimation and separation but be sure to minimize any potential for surface friction during the process.
- Static is a common problem in web heatset sheeting and post-press converting due to the extremely low moisture content of the paper after drying at high temperatures. Remoisturizing the web after the chill rolls with a mix of water, silicone, and liquid fabric softener can increase conductivity and reduce surface contact from friction, ultimately minimizing static while helping the paper re-acclimate to ambient environment.

There are numerous websites available offering anti-static products and solutions which effectively neutralize the presence of static electricity. It is important to note, however, that static electricity is only managed and not entirely eliminated. Semi-conductive materials such as coated paper will always be susceptible to static if once again subjected to the adversities of high contact through pressure and friction, and/or low humidity.