

Electrostatic Issues in Roll-to-Roll Manufacturing Operations

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Abstract—Presented here is a survey of electrostatic issues in Roll-to-Roll (RtR) manufacturing operations, use of electrostatic fieldmeters to diagnose static problems, and effective methods to dissipate charge. Electrostatic issues are usually caused by tribocharging between two chemically dissimilar materials but rarely arise from static charge separated during a single contact. Rather, charge accumulates from multiple contacts until there is enough to cause problems. Eliminating static charge at the source is the most cost effective solution to static problems. Materials of construction of the manufacturing equipment, equipment design and product formulation should be selected to minimize static charge separation. The electrical conductivity of rubber or polymer-covered rollers should be made sufficiently high so that it dissipates static charge in one roller revolution. Electrically conductive antistatic coatings may be included in products to reduce static problems. Because manufacturing operations can be quite complex, having a model or framework in which to organize information is most valuable. An existing model for charge separation and accumulation is extended to include common issues in RtR manufacturing operations. From this model, it is apparent that static monitors are valuable tools to track the charge present in a manufacturing process. High static levels resulting from assignable causes can be identified by control charting the readings from permanently mounted electrostatic fieldmeters. Areas of high electrostatic field may be identified by using appropriate portable electrostatic fieldmeter measurements to identify where to install charge dissipation technology to make it most effective.

Keywords: charge, conductivity, dissipation, electrostatic, fieldmeter, monitoring, resistivity, static, tribocharging

I. INTRODUCTION

In roll-to-roll (RtR) manufacturing operations, electrostatic issues are caused by electrostatic charge that separates when two chemically dissimilar surfaces touch and separate as illustrated in Fig. 1. Rarely does sufficient charge separate in a single contact to cause problems. Rather, charge accumulates from multiple contacts until there is enough to cause problems. In this work, Glor's model [1] for charge separation and accumulation is extended to include common issues in RtR manufacturing operations. From this extended model, it is apparent that static monitors can measure the charge present in

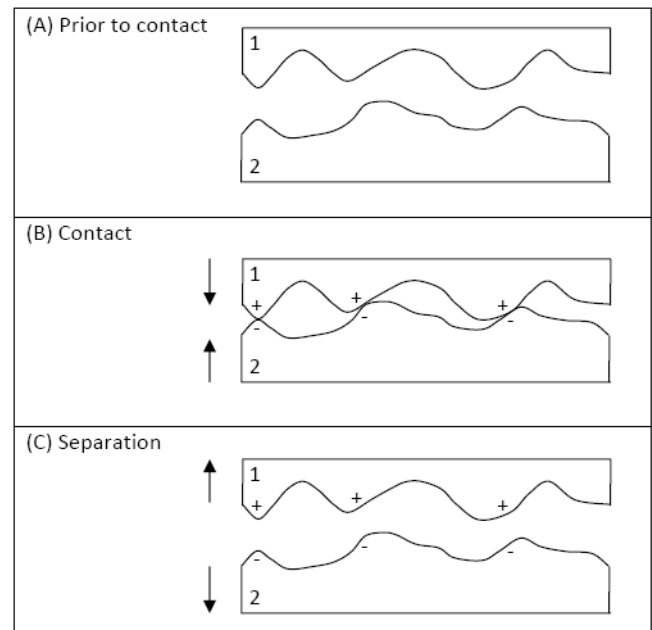


Figure 1. Electrostatic charge is separated whenever two chemically dissimilar surfaces touch and separate. Here, material 1 is more positive on the triboelectric series than material 2. Prior to contact in (A), both surfaces are neutral. Upon contact in (B), charge separation occurs at the points of contact. At a microscopic scale, only a small amount of surface area actually touches. Upon separation in (C), the surfaces are charged.

a manufacturing process and that charge dissipation technology will be most effective at locations where charge accumulates.

A. Advantages of Roll-to-Roll Manufacturing

“Roll-to-Roll” or “RtR” manufacturing is a production process where the end product is built on a thin flexible web such as in printed electronics or RFID tags, or the end product is a thin flexible web such as packaging materials. In RtR manufacturing, using a long, continuous web to transport the end product through the manufacturing process provides important advantages including high processing speeds, high production volume, precise control during the production process, and fast change-over between production runs [2].