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Factors influencing tribo-electrification of granular polymers in a coaxial-counter-rotating-cylinders tribo-charger

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Abstract—Contact charging or tribocharging occurs when two different materials are brought into contact and separated, so that an electrical charge is transferred from one to the other; this phenomenon is widely used in industrial applications. The aim of the present study is to identify the optimal configuration of a novel tribocharging device by analyzing several factors that favor the transfer and the accumulation of the electric charge at the surface of plastic granules. The newly designed charger consists of two coaxial counter-rotating cylinders, the inner one being removable. Blades made of the same material can be placed on the inner wall of the external cylinder, to enhance the tribocharging efficiency. Furthermore, the rotating cylinder and the rest of the components of the tribocharger are available in two different materials: High-density Polyethylene (HDPE) and Polyvinyl Chloride (PVC). The triboelectric charge measurement was achieved by using a set up consisting of a Faraday cage associated with an electrometer and placed on an electronic balance. With the electrometer and the electronic balance connected to a computer, the data were recorded simultaneously in real time using a data acquisition program using National Instruments LabView software.

A multitude of factors may influence the efficiency of the triboelectric charging mechanisms, mainly: the number and the height of the blades, the presence of the inner cylinder, the rotation speed of the outer cylinder, as well as the inclination angle and the length of the two co-axial cylinders.

The experimental study revealed that the charge acquired by the particles is lower in the absence of the inner cylinder and increases with the length of the two-cylinder system, with the rotation speed of the outer cylinder, as well as with the number and the height of the blades. In fact, the blades and the inner cylinder insure more particle-wall impacts as compared with the smooth inner wall outer cylinder. The eight granular polymers that were studied (ABS, HDPE, PP, PVC, PC, crystalline PS, HIPS and crystalline PC) could be ordered in two distinct triboelectrical series depending on the material (HDPE- or PVC) of the counter-rotating cylinders of the tribocharger.