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SCIENCE DIRECT
Journal of Electrostatics 63 (2005) 815–821
Journal of ELECTROSTATICS
www.elsevier.com/locate/elstat

Positive vs. negative electrostatic coating using food powders

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Available online 26 March 2005

Abstract

Previous studies on electrostatic coating of food powders using negative corona have showed benefits such as an increase in coating deposition and a more even coating. However, no work has been done on the advantages of positive corona. Thus, this study was aimed to determine whether positive or negative corona produced better coating for different food powders. Twenty-three powders were coated onto five aluminum strips using an electrostatic powder applicator. Transfer efficiency (TE), adhesion and dustiness were measured and correlated to particle size, flowability and tribocharging value. The polarity of the tribocharging value for each powder determined whether positive or negative corona produced higher TE. For most proteins, positive corona produced higher TE than negative corona since proteins tribocharge positive. Most carbohydrates tribocharge negative; thus negative corona produced higher TE than positive corona. Salts had relatively small tribocharge values; thus there was no difference between TE of positive and negative corona. No significant difference was observed between positive and negative corona for adhesion and dustiness, though electrostatic coating produced higher TE and adhesion and less dust than nonelectrostatic coating.

Keywords: Powder coating; Electrostatics; Positive corona; Negative corona; Tribocharging

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0304-3886/$ - see front matter
doi:10.1016/j.elstat.2005.03.077

1. Introduction

The appearance of food is as important as its taste. Powders are often added for taste and to enhance food appearance. However, most manufacturers over-apply coating powders to overcome unequal distribution of the coating powders. Conventional coating processes, such as a tumble drum or roll salter, create a dusty environment and increase powder waste [1]. Electrostatic coating offers answers to this problem by utilizing the principle of attraction between the charged powder and the nearest grounded object [2].

Electrostatic coating studies on food powders have shown better coating utilizing negative corona than utilizing the traditional method where coating depends mostly on gravity and the shaking action of the machine [3–5]. When positive corona was used, a thicker layer of epoxy/polyester hybrid [6] and greater improvement in adhesion for epoxy, nylon and diacon were observed [7]. However, no work has been done on food powders on the advantages of positive corona. Thus, the purpose of this study is to identify which food powders are better with positive corona versus negative corona.

2. Materials and methods

Twenty three powders were coated onto five grounded $4.5 \times 5.1.5\,\text{cm}^2$ aluminum strips horizontally placed on top of the conveyor belt of an electrostatic powder applicator (Terronics Development Corporation, Elwood, IN, USA). The strips were coated stationary by feeding 3 g of powder through a corona zone at 0, $+25$ and -25 kV. Transfer efficiency (TE) was calculated using TE = (g of coating)/(g applied). Adhesion was determined by dividing the retained coating on strips after shaking by the amount of coating before shaking. Dust samples were collected with a polyvinyl chloride filter (5.0 μm, 37 mm) placed on top of a cellulose pad inside a cassette attached to a Sensidyne air pump set to 4 l/min. The cassette was placed at the outlet of the coating chamber 3 cm above the stationary conveyer belt for 3 min.

Tribocharging values of powders were determined by measuring the amount of charge accumulated when 5 g of powder were passed through the electrostatic powder applicator system at 0 kV. Powder was collected on $30 \times 52\,\text{cm}^2$ aluminum placed on top of the stationary conveyor belt separated by a plastic sheet. An electrometer was attached to the aluminum to record the charge on the powder and the reading was taken 3 min after the powder was charged, when the reading was stable. Tribocharging value is obtained by dividing the charge generated by the powder mass. The tribocharging value generated for each powder in this study was relative to polycarbonate, which is the material of the powder applicator.

Particle size was determined utilizing the Malvern mastersizer X with a powder dispenser. The median value (v, 0.5) is reported. Flowability was measured by angle of repose (AR) determined by the fixed-based method. The range for powder particle