Date of presentation: 27 Nov 2021

STEP-V#8

Influence of Temperature on Electrostatic Charging of Polyethylene

Mohsen Isaac Nimvari, Andrew Sowinski, Poupak Mehrani*

Department of Chemical and Biological Engineering, University of Ottawa, 161 Louis-Pasteur, K1N 6N5 Ottawa, Ontario, Canada

*E-mail: poupak.mehrani@uottawa.ca

In this work, the influence of temperature on electrostatic charging behaviour of polyethylene (PE) particles was investigated in two experiments: a pilot-scale pressurized gas-solid fluidization, and a bench-scale shake test. The fluidized bed was a stainless-steel column with an inner diameter of 0.15 m. The PE resin received from commercial reactors was fluidized with air from a cylinder (relative humidity close to zero) for 60 min at two pressures of 101 and 2600 kPa while the operating temperatures was varied in the range of 24 to 58ºC. The amount of wall fouling as well as charge distribution of particles in various regions of the fluidized bed (i.e., particles in the bulk of the bed, particles fouled on the column wall, and entrained) were measured by two inline Faraday cages: one at the exit and another at the bottom of fluidization column below the distributor plate. For all temperatures tested, column wall fouling was observed, with majority being within the static bed height. Increase in temperature resulted in a substantial decline in the extent of wall fouling at both operating pressures. At atmospheric pressure, when the average bed temperature was doubled from 24ºC, the average amount of fouling declined by approximately 30%. A similar trend was observed at 2600 kPa; however, the influence of temperature was significantly greater, with 72.5% decline at the highest temperature tested. Another significant finding from all conditions tested was that particles within the bulk of the bed acquired less net specific charge (Q/m) at higher temperatures. Detailed evaluation of the results including the occurrence of bipolar charging within the bed led to the conclusion of a lower electrostatic charge generation within the bed with the increase of the bed operating temperature. To better understand the reason for a lower charge generation at higher temperatures, bench-scale shake tests were conducted. In this experiment, an orbital shaker with a built-in heater with adjustable temperature was used along with a Faraday cup to measure the particles charge before and after shaking. All equipment were placed in a glove box (i.e., in a controlled environment with relative humidity-RH of approximately 5% and temperature of 24°C). Cups made of variety of materials ranging from a conductor to an insulator were used. For each trial 0.1 g of PE particles, neutralized prior to shaking, were used. After shaking at a desired temperature (i.e., ambient and 60°C), the Q/m of particles was measured. Results showed that temperature had no influence on the particles Q/m when particles were shaken in the conductive container. However, Q/m of particles decreased in the insulator containers at 60°C comparing to that at ambient temperature. One of the parameters that suspected to influence the charging behaviour of particles is materials volume resistivity. Therefore, a cell was fabricated in-house and used to measure the volume resistivity of small sheets made of the same material as the cups tested. It was found that volume resistivity declined in 2 orders of magnitudes when temperature increased from ambient to 60°C. Hence, our preliminary results imply that the changes in material volume resistivity could influence their charging behavior at various temperatures. This finding is under further investigation.