

Investigation of Electrostatic Charge Distribution of Particles Adhered to the Wall of a Gas-Solid Fluidized Bed

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Abstract—Gas-solid fluidization is a common process used in a variety of applications such as, but not limited to, gas-solid reactions, drying, and coating. Within a gas-solid fluidized bed, particles continuously come into contact with each other, as well as the fluidization column wall. Over time, such contacts result in electrostatic charge build up, causing some of the particles to adhere to the column wall. In the polymer industry, this particle wall adhesion is extremely problematic specifically in polyethylene gas-solid fluidized bed reactors leading to process downtime and ultimately large financial losses [1]. The exact nature of the reactor wall fouling is not well understood. Thus, the main focus of this work was to investigate the particles electrostatic charge distribution within the wall fouling region of a fluidized bed reactor.

Experiments were conducted in a 0.1 m in diameter carbon steel fluidization column under atmospheric conditions. Polyethylene particles (approximately 50 to 1500 micron) were fluidized with extra dry air at 1.5 the minimum fluidization velocity (bubbling flow regime) for a period of 60 min. Using an online Faraday cup measurement technique [2], the net charge-to-mass ratio (q/m), as well as the size distribution of all particles adhered to the column wall was determined. Furthermore, the particles charge distribution was investigated by a custom made apparatus (charged particle separator) that was able to separate the particles based on their charge magnitude and polarity. The particles separation also allowed the measurement of their size distribution. This measurement was also conducted on particle layers removed from the adhered particles which determined the radial charge distribution. It was found that the q/m of the particles became predominantly more negative as more particles were removed from the column wall; however, the particle size did not vary suggesting different surface charges for similarly sized particles. In order to determine if these samples were in fact completely negatively charged, the charged particle separator was used under the same conditions. It was determined that although the net charge of the majority of the particles was negative, there still existed positively charged particles within each sample and therefore the entire wall particle layer. This suggests that the wall layer was formed through some layering between positively and negatively charged particles.

REFERENCES

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