Investigation of Electrostatic Charging Phenomenon in Multiphase Flows Using the Ecvt System

Qussai Marashdeh, Fei Wang, Ah-Hyung Alissa Park and Liang-Shih Fan

Abstract (Summary)

Among tomography techniques for process control and visualization, electrical based tomography systems are the most prominent due to their low construction cost, high speed, and safety. The development of electrical tomography has been mainly focused on permittivity, conductivity, or permeability imaging. Successful implementation of tomography systems depends on the sensor configuration, the data acquisition hardware, and the algorithm used for reconstruction. In addition, electrical tomography results can be challenged by electrostatic charges present in the imaging domain. Electrostatic charges are common in multi-phase flows and they affect both process control and measurements.

Electrodynamic sensors are generally used for measuring the level of electrostatic charges in a flow system. Measurements obtained from electrodynamic sensors are based on detection of varying electric fields from moving particles. Application of this technique has been focused on measurements of flow rates in multiphase flow systems. A modification of the system has been recently introduced for measuring concentration profiles of dry powders. In this case, the measured signal represents the accumulated charges on sensor plates resulting from static charges in the imaging domain. Although electrodynamic sensors have been applied for flow rate measurements, this technique is not suitable to fully explore the effect of the electrostatic charges in various tomography applications. Thus, an electrostatic tomography (EST) technique is developed to provide 3D real time information regarding the charging phenomenon in multiphase flow systems.

Similar to other electrical tomography systems, an EST system is composed of three main parts: (1) sensor, (2) data acquisition hardware, and (3) reconstruction algorithm. In an EST system, a set of sensors is mounted around the boundary of the process vessel. The sensor plates are designed to measure voltages due to static charges introduced through process dynamics. The

acquisition hardware is designed to measure the voltage difference (resulting from static charges in measurement domain) between each pair of sensors in the passive mode. The passive mode refers to the state in which the sensor is independent of any voltage or current source.

In this work, the electrostatic charging phenomenon of poppy seeds in a fluidized bed system is investigated with emphasis on the investigation of the effect of static charges on the capacitance measurements of the electrical capacitance volume tomography (ECVT). Moreover, boundary treatment of electrostatic charges is applied on the results for the ECVT system.