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Improving the Uniformity of Electrostatic Meter's Spatial Sensitivity

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Abstract : In pneumatic conveying, the solids are mixed with air or gas. In industries such as coal fired power stations, blast furnaces for iron making, cement and flour processing, the mass flow rate of solids needs to be monitored or controlled. However the current gas-solids two-phase flow measurement techniques are not as accurate as the flow meters available for the single phase flow. One of the problems that the multi-phase flow meters to face is that the flow profiles vary with measurement locations and conditions of pipe routing, bends, elbows and other restriction devices in conveying system as well as conveying velocity and concentration. To measure solids flow rate or concentration with non-even distribution of solids in gas, a uniform spatial sensitivity is required for a multi-phase flow meter. However, there are not many meters inherently have such property. The circular electrostatic meter is a popular choice for gas-solids flow measurement with its high sensitivity to flow, robust construction, low cost for installation and non-intrusive nature. However such meters have the inherent non-uniform spatial sensitivity. This paper first analyses the spatial sensitivity of circular electrostatic meter in general and then by combining the effect of the sensitivity to a single particle and the sensing volume for a given electrode geometry, the paper reveals first time how a circular electrostatic meter responds to a roping flow stream, which is much more complex than what is believed at present. The paper will provide the recent research findings on spatial sensitivity investigation at the University of Tees side based on Finite element analysis using Ansys Fluent software, including time and frequency domain characteristics and the effect of electrode geometry. The simulation results will be compared tothe experimental results obtained on a large scale (14" diameter) rig. The purpose of this research is paving a way to achieve a uniform spatial sensitivity for the circular electrostatic sensor by mean of compensation so as to improve overall accuracy of gas-solids flow measurement.

Keywords : spatial sensitivity, electrostatic sensor, pneumatic conveying, Ansys Fluent software
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