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Modeling Flow and Deposition Characteristics of Solid CO2 during Choked Flow of CO2 Pipeline in CCS

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Abstract : With the development of carbon capture and storage (CCS), the flow assurance of CO2 transportation becomes more important, particularly for supercritical CO2 pipelines. The relieving system using the choke valve is applied to control the pressure in CO2 pipeline. However, the temperature of fluid would drop rapidly because of Joule-Thomson cooling (JTC), which may cause solid CO2 form and block the pipe. In this paper, a Computational Fluid Dynamic (CFD) model, using the modified Lagrangian method, Reynold's Stress Transport model (RSM) for turbulence and stochastic tracking model (STM) for particle trajectory, was developed to predict the deposition characteristic of solid carbon dioxide. The model predictions were in good agreement with the experiment data published in the literature. It can be observed that the particle distribution affected the deposition behavior. In the region of the sudden expansion, the smaller particles accumulated tightly on the wall were dominant for pipe blockage. On the contrary, the size of solid CO2 particles deposited near the outlet usually was bigger and the stacked structure was looser. According to the calculation results, the movement of the particles can be regarded as the main four types: turbulent motion close to the sudden expansion structure, balanced motion at sudden expansion-middle region, inertial motion near the outlet and the escape. Furthermore the particle deposits accumulated primarily in the sudden expansion region, reattachment region and outlet region because of the four type of motion. Also the Stokes number had an effect on the deposition ratio and it is recommended for Stokes number to avoid 3-8St.

Keywords : carbon capture and storage, carbon dioxide pipeline, gas-particle flow, deposition
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