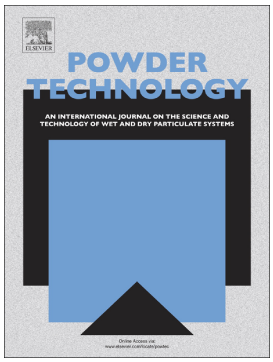

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Investigation of erosion behaviors of sulfur-particle-laden gas flow in an elbow via a CFD-DEM coupling method

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Abstract:

In the production and gathering process of natural gas with the high sulfur content, due to the variations in temperature, pressure, and other factors, sulfur dissolved in the gas may be precipitated as a solid particle in the gathering pipeline. Sulfur particles carried by high-speed flow impact elbow of pipelines, thus causing equipment malfunctions and even failures. In this study, a CFD-DEM-based erosion prediction model for gas-particle two-phase flow was proposed based on the consideration of the gas-particle, particle-particle and particle-wall interactions. The effects of secondary flow, vortices and particle trajectories on rare erosion scars were investigated. In addition, four kinds of polyhedral particles were modelled based on DEM framework to simulate erosion behaviors based on the consideration of particle shapes. The results indicate the V-shaped erosion scar is caused by the secondary collision. Two adjacent obvious erosion scars on the upper part of V-shaped scar are caused by direct collisions and sliding collisions. From the inlet to the outlet of the elbow, the turbulence intensity near the two sides of the wall increases and the secondary flows and vortices appear. Particle trajectories are affected by complex flow fluid, which causes rare erosion scars on the side walls of the downstream straight pipe near the elbow outlet. With the increase in the particle sphericity, the erosion rate decreases firstly and then increases. When the sphericity is less than 0.77, the erosion rate is mainly affected by the impact velocity and impact angle; when the sphericity is larger than 0.77, the influence of impact concentration on the erosion rate is more obvious.

Keywords:

Sulfur particle; Elbow erosion; Gas-solid flow; CFD-DEM; Particle shape; Numerical simulation

1 Introduction

Erosion corrosion, also named wear corrosion, refers the phenomenon of serious damage caused by solid particles carried by high-speed flow. In the process of production and gathering of natural gas with the high sulfur content, hydrogen sulfide is converted into sulfur atoms, which are condensed to form sulfur particles due to the changes in temperature, pressure, and other factors. Hyne [1] suggested that there