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Application of dynamic mesh to model surface evolution under solid particles erosion in positive choke geometries

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Abstract

Positive choke valves provide great control for regulating the flow in oil and gas operations. They are easy to maintain and replace. However, their sharp-edged geometry can cause high erosion under high-velocity slurry flows. This study employs dynamic mesh capabilities in Computational Fluid Dynamics (CFD) codes to predict geometry changes during erosion and evaluate their impact on erosion rate and profile. The effect of shape change on erosion rate was predicted using CFD modeling. First, a dynamic

mesh UDF (User Defined Function) was created specifically for positive choke geometry; second, a CFD model was calibrated against published LDV (Laser Doppler Velocimeter) data for velocity profiles at various locations; third, a parametric study was conducted to predict the impact of various parameters on erosion rate and profile; and finally, by integrating the dynamic mesh UDF with various erosion models, the sharp edge rounding and its impact on erosion rate were simulated. The novel dynamic mesh algorithm has preserved high mesh quality and ensured convergence during geometry deformation, regardless of time step size or deformation magnitude. It has accurately predicted the impact of geometry changes on erosion rates and helped in visualizing the progressive rounding of the choke edge. Results show that erosion rates peak at the sharp edge before rounding begins. Most geometric changes take place early in the process, a finding not widely reported. These findings contribute to the development of transient erosion models, addressing the limitations of steady-state models in capturing the dynamic evolution of choke geometry under erosion. © 2025 Elsevier B.V.

Author keywords

Contraction expansion; Dynamic mesh; Erosion; Particulate flow; Positive chokes

Indexed keywords

Engineering controlled terms

Computational fluid dynamics; Doppler effect; Laser Doppler velocimeters; Mesh generation; Microstrip devices; Two phase flow

Engineering uncontrolled terms

Computational fluid dynamics modeling; Contraction expansion; Dynamic mesh; Erosion modeling; Erosion profiles; Erosion rates; Geometry change; Particulate flows; Positive choke; User Defined Functions

EMTREE medical terms

algorithm; application; Article; computational fluid dynamics; erosion; erosion rate; evolution; geometry; numerical setting; particle number; particle tracking; simulation; solid; steady state; surface roughness; velocity; wall movement

Engineering main heading

Erosion

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