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Numerical Erosion Investigation of Standalone Screen (Wire-Wrapped) Due to the Impact of Sand Particles Entrained in a Single-Phase Flow (Water Flow)

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Abstract : Erosion modeling equations were typically acquired from regulated experimental trials for solid particles entrained in single-phase or multi-phase flows. Evidently, those equations were later employed to predict the erosion damage caused by the continuous impacts of solid particles entrained in streamflow. It is also well-known that the particle impact angle and velocity do not change drastically in gas-sand flow erosion prediction; hence an accurate prediction of erosion can be projected. On the contrary, high-density fluid flows, such as water flow, through complex geometries, such as sand screens, greatly affect the sand particles' trajectories/tracks and consequently impact the erosion rate predictions. Particle tracking models and erosion equations are frequently applied simultaneously as a method to improve erosion visualization and estimation. In the present work, computational fluid dynamic (CFD)-based erosion modeling was performed using a commercially available software; ANSYS Fluent. The continuous phase (water flow) behavior was simulated using the realizable K-epsilon model, and the secondary phase (solid particles), having a 5% flow concentration, was tracked with the help of the discrete phase model (DPM). To accomplish a successful erosion modeling, three erosion equations from the literature were utilized and introduced to the ANSYS Fluent software to predict the screen wire-slot velocity surge and estimate the maximum erosion rates on the screen surface. Results of turbulent kinetic energy, turbulence intensity, dissipation rate, the total pressure on the screen, screen wall shear stress, and flow velocity vectors were presented and discussed. Moreover, the particle tracks and path-lines were also demonstrated based on their residence time, velocity magnitude, and flow turbulence. On one hand, results from the utilized erosion equations have shown similarities in screen erosion patterns, locations, and DPM concentrations. On the other hand, the model equations estimated slightly different values of maximum erosion rates of the wire-wrapped screen. This is solely based on the fact that the utilized erosion equations were developed with some assumptions that are controlled by the experimental lab conditions.

Keywords : CFD simulation, erosion rate prediction, material loss due to erosion, water-sand flow
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