Influence of grain size distribution on synergistic cavitation–particle erosion

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Abstract Cavitation-particle erosion often occurs in high-velocity sediment-containing flows in hydraulic structures and machinery. However, accurate prediction of erosion behavior is difficult due to the unclear relation between the erosion and the sediment characteristics [1], particularly the grain size distribution (GSD). Herein, vibration erosion tests of carbon steel were carried out in suspensions of continuously graded sand and silt mixtures, and the effect of GSD properties such as the mode number and sand-to-silt ratio was investigated. The results show that total sediment content and GSD parameters have important effects on erosion. Even with fixed sand and silt concentrations, changes in GSD patterns can lead to different erosion behaviors. Based on the viscosity-increasing effect of silt particles and the impact effect of sand particles [2], a new theoretical model for determining particle impact energy was established by considering GSD. Erosion was closely correlated to the particle impact energy calculated using the GSD-based model. This means that GSD has a huge impact on erosion and that it is necessary to consider GSD effects in prediction. This new knowledge can help predict and prevent synergistic cavitation–particle erosion in solid-liquid systems. For example, the findings can be applied to damage predictions for dam spillways and tunnels that discharge high-velocity flows that entrain successively graded sediments. Refining the current model by incorporating the shielding effect of high concentrations of sand will be the subject of future work.

Keywords Cavitation, particle erosion, size distribution, impact energy, modelling

Reference

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