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Analysis of silt abrasion and impeller shape optimization in a centrifugal pump

Zhongdong Qian
Wuhan University, P R China

Centrifugal pumps are widely used in irrigation pumping stations along the Yellow River. Because of high silt content in the Yellow River, the pump impeller is usually severely abraded by silt, resulting in decreases in pump head and pump efficiency. The water flow and movement of silt in a prototype double suction centrifugal pump was simulated using an Euler–Lagrange multiphase flow model. Back-blade and J-groove configurations were adopted to protect the impeller ring from silt abrasion. Four back-blades and four J-grooves were considered. A bionic blade with convex domes was also applied to improve erosion resistance of the blade surfaces in this study. The results show that the relative velocity of water around the impeller ring is too low to move silt out of the spacing between the impeller and the casing, which results in a high silt concentration around the impeller ring. Back-blade and J-groove configurations are effective in reducing the silt concentration around the ring but extra friction loss is also introduced and the pump efficiency is decreased. The bionic blades exhibited much better erosion resistance than the smooth surface ones. The high erosion-rate area was reduced remarkably and the erosion region became more dispersed on the whole bionic blade surface. The pump with bionic blades had a higher head and a lower efficiency than those of the pump with smooth blades.

zdqian@whu.edu.cn