عنوان مقاله:

Numerical Analysis on the Unsteady Radial Load on the Shaft of a Large-Scale Dredge Pump Unit

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خلاصه مقاله:

Vibration and fatigue damage of pump shafts has become a prominent engineering problem, indicating the need for higher-quality reliability analysis of the pump unit in the design stage. In this study, the unsteady flow field in a large centrifugal dredge pump was numerically simulated via the unsteady Reynolds-averaged Navier-Stokes (URANS) method with the SST k-ω model. An experiment was carried out to verify the numerical method. The hydraulic radial force on the impeller and the total radial load were calculated based on computational fluid dynamics. The flow field with a double volute was simulated, analyzed, and compared to the flow field with a single volute. The stress of the pump shaft caused by the radial load was also calculated and discussed. The results show that the impeller gravity determines the time-averaged value and fluctuation frequency of the total radial load on the shaft, which must be considered in the shaft stability analysis. The total radial load fluctuating in asymmetric cycle results in stress cycles with different features at different circumferential locations. The application of a double volute effectively reduces the radial load on the pump shaft, which decreases the time-averaged hydraulic radial force by ۳۸% and its fluctuation amplitude by ۳%, decreases the time-averaged total radial load by ۲۰% and its fluctuation amplitude by ۲۸% in the design condition, and decreases the local stress at the narrowest shaft section by ۴۴%. A double volute can be applied to weaken vibration and fatigue damage for a pump shaft if it is acceptable for the pump efficiency to be lowered.

کلمات کلیدی:

Centrifugal dredge pump, Radial force, Gravity, shaft, Dynamic stress, Double volute