World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:13, No:10, 2019

# Numerical Investigation on the Influence of Incoming Flow Conditions on the Rotating Stall in Centrifugal Pump

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**Abstract :** Rotating stall in centrifugal pump is an unsteady flow phenomenon that causes instabilities and high hydraulic losses. It typically occurs at low flow rates due to large flow separation in impeller blade passage. In order to reveal the influence of incoming flow conditions on rotating stall in centrifugal pump, a numerical method for investigating rotating stall was established. This method is based on a modified SST k-ω turbulence model and a fine mesh model was adopted. The calculated flow velocity in impeller by this method was in good agreement with PIV results. The effects of flow rate and sealing-ring leakage on stall characteristics of centrifugal pump were studied by using the proposed numerical approach. The flow structures in impeller under typical flow rates and typical sealing-ring leakages were analyzed. It is found that the stall vortex frequency and circumferential propagation velocity increase as flow rate decreases. With the flow rate decreases from 0.40Qd to 0.30Qd, the stall vortex frequency increases from 1.50Hz to 2.34Hz, the circumferential propagation velocity of the stall vortex increases from 3.14rad/s to 4.90rad/s. Under almost all flow rate conditions where rotating stall is present, there is low frequency of pressure pulsation between 0Hz-5Hz. The corresponding pressure pulsation amplitude increases with flow rate decreases. Taking the measuring point at the leading edge of the blade pressure surface as an example, the flow rate decreases from 0.40Qd to 0.30Qd, the pressure fluctuation amplitude increases by 86.9%. With the increase of leakage, the flow structure in the impeller becomes more complex, and the 8-shaped stall vortex is no longer stable. On the basis of the 8-shaped stall vortex, new vortex nuclei are constantly generated and fused with the original vortex nuclei under large leakage. The upstream and downstream vortex structures of the 8-shaped stall vortex have different degrees of swimming in the flow passage, and the downstream vortex swimming is more obvious. The results show that the proposed numerical approach could capture the detail vortex characteristics, and the incoming flow conditions have significant effects on the stall vortex in centrifugal pumps.

**Keywords :** centrifugal pump, rotating stall, numerical simulation, flow condition, vortex frequency
**Conference Title :** ICCFD 2019 : International Conference on Computational Fluid Dynamics
**Conference Location :** London, United Kingdom
**Conference Dates :** October 23-24, 2019