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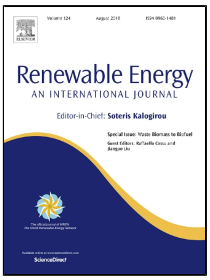

Symmetrical and unsymmetrical tip clearances on cavitation performance and radial force of a mixed flow pump as turbine at pump mode

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Symmetrical and unsymmetrical tip clearances on cavitation performance and radial force of a mixed flow pump as turbine at pump mode

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Abstract: Transient cavitating flows of a mixed-flow PAT (pump as turbine) at pump mode are investigated experimentally and numerically. Radial force on principal axis is recorded and compared between PAT with unsymmetrical and symmetrical tip clearance. Numerical simulation with improved cavitation model by modifying the vapour pressure is conducted, and the simulation results agree well with the experiments. Tip clearance has great influence on PAT cavitation performance. The pump energy performance will deteriorate with tip clearance increasing. In addition, in comparison with the symmetrical tip clearance, the unsymmetrical tip clearance makes the PAT cavitation performance worse. As the cavitation develops, the unsymmetrical tip clearance simultaneously influences the magnitude and direction of radial force, while the symmetrical tip clearance only influences the magnitude of radial force. The dominant frequencies of radial force of symmetrical and unsymmetrical tip clearances are related to the blade number and guide vane number, respectively. The maximum amplitude of force fluctuation for unsymmetrical tip clearance is 7 times that for symmetrical tip clearance.

Keywords: pump as turbine; symmetrical and unsymmetrical; tip clearance; radial force; cavitation

1. Introduction

Clean and cheap renewable energy sources are playing more and more important role nowadays. Hydropower is the most promising and high efficiency among all the renewable energy sources [1]. PAT (pump as turbine) is widely used as storage power plant [2-4], water distribution networks [5-6] and pressure reducing valves (PRVs) sites with small power output capacities [7] owing to their cost effectiveness, high efficiency, effective storage capability and high flexibility. Recently, the transient characteristic and operation stability of PAT have been heated topics. Li et al. [8-10] studied the hysteresis characteristic of turbine by Entropy production analysis, and he also investigated the transient