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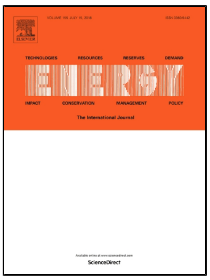

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Numerical study on the impact of runner inlet arc angle on the performance of inline cross-flow turbine used in urban water mains

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Abstract

The inline cross-flow turbine is a promising and reliable device to harvest hydropower in an urban water supply pipeline for power supply to its water supply monitoring system. However, investigations about the influencing factors on the performance of inline cross-flow turbines are still rare and this paper focuses on the effect of their runner inlet arc angle for improving the device's performance. Firstly, a mathematical design method for the turbine's blocks is developed. With the proposed method, four models with different runner inlet arc angles are developed. The turbine's performance, function of conversion block, flow velocity characteristics, pressure distribution and blades torque output of the models are then analyzed. Results indicate that a smaller runner inlet arc can increase the flow velocity at runner inlet and pressure difference between the upstream and downstream of the runner, resulting in a higher output power but also a higher overall water head reduction through the turbine. Besides, it is found that the runner inlet arc angle has a significant influence on the power output of runner second stage. With the increase of runner inlet arc angle, the torque output at the second stage encounters a gradual decrease. To achieve a good balance between turbine efficiency and water head reduction, the suggested runner inlet arc angle is 105°. Numerical results showed that the model with 105° runner inlet arc angle could produce a maximum power generation efficiency of 42.6% with about 1.6kW power output.

Keywords: Runner inlet arc angle; urban water mains; micro hydropower; inline cross-