A flat shield plate effect on Savonius hydraulic turbine performance

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Research and development of various renewable energies have been promoted after Fukushima nuclear power plant accident. Hydropower is the most promising energy source from geographical conditions in Japan. Especially, the small scale hydroelectric plant applicable extremely low head hydropower has much attention.

The authors investigated the effects of a shield plate on the Savonius hydraulic turbine performance, and clarified the favourable conditions\textsuperscript{1}. The power coefficient was improved up to 80\% by using the shield plate. It was because why the shield plate blocked the stagnation flow toward the convex side of returning blade, and enhanced the flow velocity toward concave side of advancing blade. When we expand additional possibility to achieve better performance, it must be more increased the block effect for impinging flow toward the returning blade.

For that reason, we focused on distance, $G$, between the shield plate and the runner. A model of a Savonius turbine was tested in the water circuit tunnel. The diameter and the width of the runner is $D_R=142$ mm and $L_R=210$ mm, respectively. CFD simulation was also conducted to grasp the detail of velocity and pressure fields for some of relation between the setting distance and the power coefficient. Figure 1 shows example result of flow visualization by black ink. As the result, the setting distance ($G/D_R$) is strongly important factor which affects the impinging flow into the returning blade. When $G/D_R=1.0$ (left image), a standing vortex is observed at wake region of the plate, although main flow is blocked. The vortex induces flow (yellow arrow) toward the returning blade. Meanwhile, the standing vortex is disappeared when $G/D_R=0.7$ (right image). The flow toward the returning blade was not observed. A part of the main flow impinges the plate, and separates at the upper side, and then goes into the advancing blade. Then $C_{P_{max}}=0.49$ was obtained when $G/D_R=0.7$.

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Figure 1: Visualization of flow pattern (a) $G/D_R=1.0$ (b) $G/D_R=0.7$