Performance analysis of a crossflow vortex turbine for a gravitational Water vortex power plant

ABSTRACT

The micro hydro system is the most favorable renewable energy source to supply electricity for rural areas. The Gravitational Water Vortex Power Plant (GWVPP) is one of the micro hydro systems that is suitable for very low-head hydropower sites. GWVPP consists of three major parts: electromechanical components, civil structures, and electric distribution. The micro hydro turbine in GWVPP is called a vortex hydro turbine and is used to convert induced vortex flow to mechanical energy coupled with a generator to produce electricity. This paper investigates crossflow vortex turbine performance using Computational Fluid Dynamics (CFD) software and experimental work. The CFD results provide qualitative and quantitative comprising velocity distribution, water vortex profile, and water vortex height. The optimum hydraulic performance in the water vortex was observed and determined for different turbine positions. The vortex crossflow turbine was placed 0.05 m from the bottom surface of the basin at the highest vortex tangential velocity. A 0.05 m turbine position was chosen for the turbine installations as it creates a high-velocity profile. The comparative performance was conducted on the vortex crossflow blade with different inlet blade angle designs at a range of 400 – 700 . The experimental analysis was conducted at rotational speeds of 30 rpm – 70 rpm to determine its efficiency performance. The optimum design for the crossflow blade was at 500 with an operational speed of 50 rpm, which exhibited torque and power output at 0.27±0.02 m and 1.49±0.08 m respectively with an efficiency recorded at 18.98%.