Investigation of Newly Developed Rim-Drive Micro and Pico Kaplan Hydro-Turbine Performance
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OBJECTIVES
• Investigate a power-efficient very-small hydro turbines at very-low water heights with a new concept of electric generators, specifically, at water heights of less than 3 meters.
• Increase the efficiency of hydropower generation in general, and the efficiency of low-head turbines in specific

METHODOLOGY
First, a conventional Kaplan hydro turbine is studied and optimized for the maximum possible power output and efficiency. Then, a Rim-Drive Turbine (RDT) is introduced and compared with the conventional turbine.

Optimization of the Conventional Turbine:
The design parameters of the rotor (runner) of the turbine were optimized to obtain the maximum power outlet of the turbine. So then when the RDT is introduced, it is compared with the optimum design possible of the conventional turbine.

The conventional turbine was optimized for:
1. Number of Blades of the Rotor
2. Blade’s Angle of the rotor
3. Intake and Draft Tubes
4. Operational Rotational Speed

The optimization is conducted by using a Computational Tool (Computational Fluid Dynamics, CFD) through a software called Star-CCM+ to simulate the flow and predict the turbine power output. Considering this procedure for the optimization can save the time and cost of experimental testing.

Optimization & Evaluation of the Conventional Hydro Turbine Performance:
• The conventional Kaplan hydro turbine is evaluated at 2.6 m (8.5 ft) of water head (water height).
• A 3-inch diameter Kaplan turbine is selected based on the operation conditions of the system. The system is a closed water loop with two tanks (low and high levels), pump, and a valve to control the flow.
• The setup is located in the Hydro Turbines Lab of UW-Milwaukee.

Introducing the Rim-Drive Turbine (RDT):
Based on the available literature pertaining to the shaftless rim-driven ship propellers (RDPs), further in the rim-driven electric generator with a shaftless turbine design is investigated.

The concept here is to have a ring of magnets all over the perimeter of the turbine and right above that an electric stator is attached. When the turbine rotates by the force of the water, a magnetic field is generated and then electricity.

RESULTS
➢ The optimum range of rotational speeds is between 1000 rpm to 1500 rpm, while the peak power output recorded was 8.6 W at 1480 rpm with a double-row of N52 magnets’ arrangement.

CONCLUSION
➢ The RDT shows a higher capability of theoretical power generation with up to 460 W. On the other hand, the conventional turbine has a theoretical power output of up to 390 W only. Hence, the RDT has 18% more power output than the conventional turbine.
➢ Besides the higher efficiency of the generation of the RDT, this approach has some other advantages such as reducing the vibration and noise, considered a compact design with less weight, more flexible in installations, cost-effective, and less maintenance.

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