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Study Variation of Blade Angle on the Performance of the Undershot Waterwheel on the Pico Scale

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Abstract : According to data from 2021, the number of households in Indonesia that have access to on-grid electricity is claimed to have reached 99.28%, which means that around 0.7% of Indonesia's population (1.95 million people) still have no proper access to electricity and 38.1% of it comes from remote areas in Nusa Tenggara Timur. Remote areas are classified as areas with a small population of 30 to 60 families, have limited infrastructure, have scarce access to electricity and clean water, have a relatively weak economy, are behind in access to technological innovation, and earn a living mostly as farmers or fishermen. These people still need electricity but can't afford the high cost of electricity from national on-grid sources. To overcome this, it is proposed that a hydroelectric power plant driven by a pico-hydro turbine with an undershot water wheel will be a suitable pico-hydro turbine technology because of the design, materials and installation of the turbine that is believed to be easier (i.e., operational and maintenance) and cheaper (i.e., investment and operating costs) than any other type. The comparative study of the angle of the undershot water wheel blades will be discussed comprehensively. This study will look into the best variation of curved blades on an undershot water wheel that produces maximum hydraulic efficiency. In this study, the blade angles were varied by 180˚, 160˚, and 140˚. Two methods of analysis will be used, which are analytical and numerical methods. The analytical method will be based on calculations of the amount of torque and rotational speed of the turbine, which is used to obtain the input and output power of the turbine. Whereas the numerical method will use the ANSYS application to simulate the flow during the collision with the designed turbine blades. It can be concluded, based on the analytical and numerical methods, that the best angle for the blade is 140˚, with an efficiency of 43.52% for the analytical method and 37.15% for the numerical method.

Keywords : pico hydro, undershot waterwheel, blade angle, computational fluid dynamics
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