Performa turbin air turgo skala piko akibat besarnya sudut masuk dan keluar sudu batok kelapa = Performance of pico scale turgo water turbine due to entry and exit angles of coconut shell blades

Shafa Zahira Malik, author

Abstrak

Studi ini mengevaluasi performa turbin air Turgo skala piko dengan memanfaatkan batok kelapa sebagai sudu, khususnya meneliti pengaruh sudut masuk dan keluar sudu terhadap efisiensi turbin. Latar belakang studi ini adalah kebutuhan mendesak untuk sumber energi terbarukan yang ramah lingkungan di daerah terpencil dan tidak terjangkau listrik di Indonesia. Pemanfaatan potensi hydropower dengan instalasi pembangkit listrik tenaga air skala piko (< 5 kW) di daerah 3T (Tertinggal, Terdepan, Terluar) menjadi solusi potensial. Penggunaan bahan alami seperti batok kelapa sebagai sudu turbin Turgo menawarkan keunggulan ekonomi dan keberlanjutan, mengatasi masalah material dan pemeliharaan di daerah sulit akses. Turbin Turgo yang dirancang dalam studi ini diuji pada ketinggian jatuh air 4 meter dengan variasi sudut serang nosel. Pengujian d ilakukan melalui perhit ungan analit ik d an simulasi numerik unt uk menentukan sudut masuk nosel relatif, kecepatan relatif aliran air, sudut keluar relatif, kecepatan fluida keluar, dan efisiensi hidrolik teoritis. Tiga jenis turbin dengan sudut serang nosel berbed a d iuji: Turbin A (48.28°), Turbin B (19.03°), d an Turbin C (26.28°). Hasil studi menunjukkan bahwa sudut serang nosel optimal berada dalam kisaran 10°- 30°, dimana hasil perhitungan teoritis Turbin C menghasilkan efisiensi hidrolik tertinggi sebesar 74%, diikuti oleh Turbin B sebesar 52%, dan Turbin A sebesar 50%. Hal ini menunjukkan bahwa sudut serang nosel yang tepat dapat meningkatkan efisiensi turbin dengan mengoptimalkan perpindahan momentum aliran air. Penggunaan batok kelapa sebagai sudu turbin menunjukkan potensi besar dalam pengembangan pembangkit listrik tenaga air yang ramah lingkungan dan berbiaya rendah di daerah terpencil. Dengan demikian, inovasi ini dapat berkontribusi pada peningkatan rasio elektrifikasi nasional dan pengurangan emisi gas rumah kaca, sejalan dengan komitmen Indonesia terhadap Perjanjian Paris.
......The rapid growth of the global population and advancements in civilization have led to an exponential increase in energy demand. Despite the unsustainable nature of fossil fuels and their severe environmental and health issues, fossil fuels, particularly petroleum, remain the primary energy source. Greenhouse gases (GHGs) such as methane, carbon dioxide, and nitrous oxide are released in large quantities during the combustion of fossil fuels, contributing to climate crises, rising sea levels, and extreme weather conditions threatening coastal communities. According to the IPCC's Sixth Assessment Report (2023), the world is on a path to dangerous climate risks by the end of the 21st century, even under 1.5°C or 2°C warming scenarios. Indonesia's commitment to the Paris Agreement requires a 29% reduction in GHG emissions by 2030. However, strategies to decarbonize effectively need reevaluation, as the current deforestation emission reduction schemes only prevent 3% of the required total. With an increase in global surface temperature and a rapid rise since 1970, Indonesia is focusing on increasing its renewable energy share. Hydropower, with a potential of 94.6 GW and an installed capacity of only 6.1 GW, presents a significant opportunity, especially for electrifying remote areas through small-scale solutions like pico hydropower systems. This study aims to investigate the performance of a pico-scale Turgo water turbine using coconut shell spoon blades, focusing on the effects of the inlet and outlet blade angles. Analytical calculations were based on conditions at the

fluid mechanics laboratory of the Mechanical Engineering Department, using a head of 4 meters, 8 blades, and a nozzle- to-turbine distance of 100 mm. The water speed calculated was 8.59 m/s, with runner speed at 4.03 m/s, resulting in a water power of 16.9 W. Three turbine types (A, B, and C) with different attack angles were tested analytically for relative velocity, fluid exit speed, and hydraulic efficiency. Analytical results showed that Turbine C had the highest efficiency at 74%, followed by Turbine B at 52% and Turbine A at 50%. Turbines B and C fell within the optimal jet angle range for Turgo and Pelton turbines. Turbine C's superior performance was attributed to a better alignment of water momentum transfer due to its blade angles, minimizing flow separation and stall.