World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:9, No:12, 2015

Movable Airfoil Arm (MAA) and Ducting Effect to Increase the Efficiency of a Helical Turbine

Authors : Abdi Ismail, Zain Amarta, Riza Rifaldy Argaputra

Abstract : The Helical Turbine has the highest efficiency in comparison with the other hydrokinetic turbines. However, the potential of the Helical Turbine efficiency can be further improved so that the kinetic energy of a water current can be converted into mechanical energy as much as possible. This paper explains the effects by adding a Movable Airfoil Arm (MAA) and ducting on a Helical Turbine. The first research conducted an analysis of the efficiency comparison between a Plate Arm Helical Turbine (PAHT) versus a Movable Arm Helical Turbine Airfoil (MAAHT) at various water current velocities. The first step is manufacturing a PAHT and MAAHT. The PAHT and MAAHT has these specifications (as a fixed variable): 80 cm in diameter, a height of 88 cm, 3 blades, NACA 0018 blade profile, a 10 cm blade chord and a 60o inclination angle. The MAAHT uses a NACA 0012 airfoil arm that can move downward 20o, the PAHT uses a 5 mm plate arm. At the current velocity of 0.8, 0.85 and 0.9 m/s, the PAHT respectively generates a mechanical power of 92, 117 and 91 watts (a consecutive efficiency of 16%, 17% and 11%). At the same current velocity variation, the MAAHT respectively generates 74, 60 and 43 watts (a consecutive efficiency of 13%, 9% and 5%). Therefore, PAHT has a better performance than the MAAHT. Using analysis from CFD (Computational Fluid Dynamics), the drag force of MAA is greater than the one generated by the plate arm. By using CFD analysis, the drag force that occurs on the MAA is more dominant than the lift force, therefore the MAA can be called a drag device, whereas the lift force that occurs on the helical blade is more dominant than the drag force, therefore it can be called a lift device. Thus, the lift device cannot be combined with the drag device, because the drag device will become a hindrance to the lift device rotation. The second research conducted an analysis of the efficiency comparison between a Ducted Helical Turbine (DHT) versus a Helical Turbine (HT) through experimental studies. The first step is manufacturing the DHT and HT. The Helical turbine specifications (as a fixed variable) are: 40 cm in diameter, a height of 88 cm, 3 blades, NACA 0018 blade profile, 10 cm blade chord and a 60o inclination angle. At the current speed of 0.7, 0.8, 0.9 and 1.1 m/s, the HT respectively generates a mechanical power of 72, 85, 93 and 98 watts (a consecutive efficiency of 38%, 30%, 23% and 13%). At the same current speed variation, the DHT generates a mechanical power of 82, 98, 110 and 134 watts (a consecutive efficiency of 43%, 34%, 27% and 18%), respectively. The usage of ducting causes the water current speed around the turbine to increase.

Keywords : hydrokinetic turbine, helical turbine, movable airfoil arm, ducting
Conference Title : ICRERA 2015 : International Conference on Renewable Energy Resources and Applications
Conference Location : Istanbul, Türkiye
Conference Dates : December 21-22, 2015