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CFD Investigation of Empty Flanged Diffuser Augmented Wind Turbine

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Abstract: Enclosing a wind turbine within a flanged diffuser is an innovative mean to increase the powerharvested by turbine blades and it is among the most effective devices for increasing wind turbine energy. The geometric parameters of the empty flanged diffuser contribute efficiently to increase mass flow in the diffuser, hence improve the turbine performance. The study presents developed models of the geometrical parameters of an empty flanged diffuser that suitable for a scaled-down (1-6.5) horizontal axis wind turbine, the geometry parameters were involved the diffuser length, diffuser angle, flange height and flange angle. The geometrical models were verified and CFD investigated in 2-D and 3-D domains. Results obtained from CFD simulations show that, using a compact size of flanged diffuser within optimum geometrical parameters can give well acceptable for flow velocity increase at suggested place for the turbine rotor install. The increase in flow velocity is due to lower pressure at the outlet of the diffuser. As there is also a significant effect of the flange angle on increasing the flow velocity inside the diffuser where the rate of increase in wind velocity at turbine position was calculated for two flange angles (0 ° and 5 °). In another hand, the results also provided information on the velocity contours and velocity streamlines around diffuser geometry.

Keywords: Wind energy harvesting, DAWT, flanged diffuser.

1. Introduction

The need for energy to consume society increases as technology advances in certain areas, so the capability to produce energy must keep pace with increasing demands. Due to the rapid depletion of fossil energy sources, there is a necessary need to seek alternative and sustainable sources of energy. However, wind energy as a renewable and inexhaustible source of energy is now the fastest-growing energy technology worldwide (T. Wei, 2010). Wind power systems, represented by wind turbines have been the focus of interest of scientists and researchers in the past decades. Flowing of wind through the turbine rotor leads to the production of mechanical energy that can be used in many applications especially to produce electricity.

However, power produced by the wind turbine is dependent on the Betz limit; an ideal type can extract only 59.3% of incoming energy in stream-tube by turbine blades (Libii & Drahozal, 2012), (IGRA, 1981). As the energy extracted

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