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Numerical Investigation of the Operating Parameters of the Vertical Axis Wind Turbine

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Abstract : This paper describes the geometrical model, algorithm and CFD simulation of an airflow around a Vertical Axis Wind Turbine rotor. A solver, ANSYS Fluent, was applied for the numerical simulation. Numerical simulation, unlike experiments, enables us to validate project assumptions when it is designed to avoid a costly preparation of a model or a prototype for a bench test. This research focuses on the rotor designed according to patent no PL 219985 with its blades capable of modifying their working surfaces, i.e. absorbing wind kinetic energy. The operation of this rotor is based on a regulation of blade angle α between the top and bottom parts of blades mounted on an axis. If angle α increases, the working surface which absorbs wind kinetic energy also increases. CFD calculations enable us to compare aerodynamic characteristics of forces acting on rotor working surfaces and specify rotor operation parameters like torque or turbine assembly power output. This paper is part of the research to improve an efficiency of a rotor assembly and it contains investigation of the impact of a blade angle of wind turbine working blades on the power output as a function of rotor torque, specific rotational speed and wind speed. The simulation was made for wind speeds ranging from 3.4 m/s to 6.2 m/s and blade angles of 30°, 60°, 90°. The simulation enables us to create a mathematical model to describe how aerodynamic forces acting each of the blade of the studied rotor are generated. Also, the simulation results are compared with the wind tunnel ones. This investigation enables us to estimate the growth in turbine power output if a blade angle changes. The regulation of blade angle α enables a smooth change in turbine rotor power, which is a kind of safety measures if the wind is strong. Decreasing blade angle α reduces the risk of damaging or destroying a turbine that is still in operation and there is no complete rotor braking as it is in other Horizontal Axis Wind Turbines. This work has been financed by the Polish Ministry of Science and Higher Education.
Keywords : computational fluid dynamics, mathematical model, numerical analysis, power, renewable energy, wind turbine
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