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Experimental study of self-starting torque required to operate Darriues the vertical axis wind turbine

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Abstract (Times New Roman - 10)
The wind turbine converts the kinetic energy of the wind current into the rotational energy of the rotor shaft. The use of vertical axis wind turbines as a source of clean energy production is of great importance. Among the advantages of vertical axis wind turbine over horizontal axis wind turbine are low production cost, lightweight, the efficiency of the installation, and use in residential zones. The darriues blades of vertical axis wind turbines are more in the kind of straight or helical blades. The central difficulty of Darius vertical axis wind turbines is their primary self-starting, which is the basis of this study. They increase self-initiation at low speeds. For this purpose, Darius vertical axis wind turbine was designed and built-in CATIA software. NACA0015 is made for airfoils and the material used for straight and porous blades is plain aluminum sheet and porcelain embossed sheet, both of which are series alloys of aluminum and the equipment used in manufactured and calibrated Manufacturing and calibrating. The result showed that the Ambas blade wind turbine needs less torque to start up to a speed of 9m/s than the vertical blade axis wind turbine.

Keywords: Lift Coefficient, NACA0015 Airfoil, Porous Blade, Self-Starting Torque, Darriues

1. INTRODUCTION

The device that is used to extract energy from the wind is called a wind turbine. A wind turbine is a device that converts the kinetic energy of the wind current into the rotational energy of the rotor shaft [4]. There are delinquent models for Darius wind turbine blades, which are mostly straight and spiral blades. Darius wind turbine blades depend on the economic cost of one to five blades. The advantage of Darius wind turbine over other vertical axis turbines is that it has the highest efficiency, but its main problem is the low torque at the moment of start and start of rotation [1]. In recent decades, several studies have been conducted to optimize various parameters affecting the performance of Darius vertical axis wind turbines with straight blades. Islam studied the suitable material for straight blades of Darius vertical axis wind turbine and in his study concluded that polymer fiber is suitable for this type of turbines [2]. Wang et al. [8] identified the increase in airfoil thickness as a factor in improving turbine performance at low tip speeds. Domini et al. [3] proved that a three-bladed vertical-axis wind turbine has a better potential for self-starting than a two-blade because the two-blade automatic start-up is highly dependent on the initial blade placement angle. Edwards [4] studied numerical and experimental studies on small-scale vertical axis turbines and the effect of blade surface roughness on the performance of these turbines. Wang [5] studied the aerodynamic performance of the Darius Vertical Axis Vertical Axis Wind Turbine at different wind speeds. Hayashi et al. [6] compared the results of aerodynamic analysis of a conventional single-stage Savinius wind turbine with a two-stage turbine and showed that adding a floor reduced torque fluctuations, but with the addition of a floor, the inertia of the turbine increased and structural problems could occur. has it. Koravand et al. [7] studied the design and analysis of small wind turbines. For this purpose, Marvast region in Yazd province was selected as a test and their goal was to increase energy production at lower speeds by combining airfoil rotors with high production torque (Savinius) with airfoil rotors with higher efficiency (Darius). Give. Duak et al. [8] studied the physical analysis of the starting point of the Darius vertical axis wind turbine. They used an angle monitoring system to start the Darius vertical axis wind turbine spontaneously, and the turbine self-start was improved at low speeds. Pagnini et al. [9] studied the power generation evaluation and structural behavior of Darius vertical axis wind turbines and concluded that the two issues are related and the results can be good signs for improving turbine performance. The pneumatic axes are vertical.

Sun et al. [10] investigated the effects of the blade on the performance of a straight vertical axis wind turbine. They examined three parameters of starting time, mean power factor and standard aerodynamic force deflection using different blade shapes. The results showed that the S-1046 blade performed better than the NACA0018 airfoil.

In their study, Sagrichi et al. [11] examined step-by-step variable approaches that are one of the best strategies for improving the self-starting performance of Darius vertical axis wind turbines and the relationship between attack angle and self-starting performance of rotor H wind turbines. Analyzed. They selected four step functions with four amplitudes and concluded that the best variable step performance could reduce the angle of the attack blade in the upstream stage while increasing the angle of attack in the downstream stage.

Su et al. [12] proposed a new type of direct-axis wind turbine using three pairs of blades, each with a fixed blade and a rotating auxiliary blade. The experimental results showed that the static torque coefficient of the proposed rotor was positive in all angles and showed better self-starting performance than the H-type rotor.

Zhao et al. [13] used three new flow deflector blades, or FDGs, to improve the rotation of the vertical axis wind turbine. They first examined the aerodynamics of the blades and concluded that the designed blade increased the stopping angle by up to 2 degrees relative to the airfoil used.

In their study, Stearo et al. [14] investigated and improved the automatic start capability of a vertical axis turbine, and it was performed experimentally using a towing tank in Indonesia and using an inclined blade for a vertical axis wind turbine to increase the capability. The drive was used and it was concluded that a vertical axis wind turbine with sloping blades has better self-start capability, which is suitable for operation in areas with low tidal velocity.

2. Design and Fabrication

Schematic of wind turbine in Katia software, design of shape and in 5: 1 scale, the main sample made and the height of the blade designed and built equal to 35 cm, blade radius 18.5 cm and the length of the airfoil is equal to 6.4 cm. To make the blade from NACA0015 airfoil and the material used to cover the blades is to use plain aluminum sheet for the straight blade and for the porous blade of the embossed sheet cover which is in the form of pores, and aluminum sheets using The rivets and bolts of the car are connected and controlled by the indicator clock, the looseness and depression of the straight and porous blades are controlled so that no protrusions and depressions are created in the blades, and the blades are controlled accurately and in any case of comparison, each The blades have the same conditions and precise control so that there is no errorin calculations and construction.

One of the problems of Darius vertical axis wind turbines is their low ability to start up, which is the basis of this research. Therefore, it is necessary to first measure the force required to start the turbine. Figure 15 shows how to use a dynamometer to generate the initial starting force. To do this, first at the wind speed at which the turbine can start, the dynamometer was connected to the turbine blade and then the force required to measure the straight and porous blade at a height of 35 cm was determined. It should be noted that the vibrations of the whole device are allowed in the dynamic state of the range and have been calibrated with an accuracy of 0.2 for more accurate measurement of the dynamometer.

3. Results and Discussion

Experimental study of the torque required to start the Darius vertical axis wind turbine the Darius Vane Vertical Axis Wind Turbine requires less start-up torque than the Darius Vertical Axis Vane Turbine to start rotating at speeds of one, two and three meters per second. The torque required for start-up is 0.00925 Nm, but in the Darius vertical blade vertical axis wind turbine at speeds of one and two meters per second, the amount of torque required to start is 0.0185 Nm, which is twice the amount of torque. Required for the turbine blade turbine period and at a speed of three meters per second the amount of torque required to move in a direct blade wind turbine is equal to three times the same amount for a darius vertical axis wind turbine porous blade. At a speed of four and five meters per second, the amount of torque required for the porous blade is 0.0185 Nm, which for a straight blade at the mentioned speeds is equal to 0.037 Nm, which for starting it in The speeds mentioned must be twice the torque of the porous blade to start the rotation.

At a speed of seven meters per second, 0.2775 Nm of torque is required to operate a porous vane wind turbine, while to operate a direct vane wind turbine at the same speed, 0.0466 Nm of torque is required to start the turbine. To rotate. At a speed of 7.45 m / s, the torque required to start rotating a porous vane wind turbine is 0.037 Nm, while for a direct vane wind turbine it is 0.06475 Nm. At the mentioned speed, more force must be applied to the wind turbine of the vertical axis of the straight blade so that it can start rotating.

At 8.25 m / s, the amount of torque required to start a porous vane wind turbine is 0.04625 Nm, while at the same speed for a direct vane wind turbine is 0.08325 Nm. Which requires approximately twice the torque of a porous vane wind turbine to be able to rotate a straight vane wind turbine at the same speed. At 8.5 m / s, the amount of torque required to start a porous vane wind turbine is 0.055 Nm, and for a direct vane wind turbine, the amount of torque that the turbine can start is 0.111 Nm. Which is twice the torque required for a porous vane wind turbine.

At a speed of nine meters per second, the amount of torque required to start rotating a porous vane wind turbine is 0.13875 Nm, while for a direct vane wind turbine it is 0.1295 Nm. At the mentioned speeds, in contrast to the speeds before nine meters per second, more torque is required for a porous vane wind turbine than for a direct vane. At a speed of 9.5 m / s the torque required to start a porous vane wind turbine is 0.665 Nm, while for a direct vane wind turbine the starting torque is 0.13875 Nm, which in The mentioned speed, like the speed of nine meters per second, the starting torque of the porous vane wind turbine is higher than that of the direct vane.

At a speed of 10 meters per second, the torque required to operate a porous vane wind turbine is 0.17205 Nm and the torque required to operate a direct vane wind turbine is 0.148 Nm. At the mentioned speed, the torque required to start the porous vane wind turbine is more than the flat vane wind turbine, and at this speed, the porous vane rotation will direct a lot of energy towards the straight vane to start rotating. However, for speeds of one to nine meters per second, the torque required to operate a porous vane wind turbine is less than that of a straight vane, and at speeds of nine to 10 meters per second, the torque required for a porous vane wind turbine cycle It is more than a direct blade wind turbine.

4. Conclusions

NACA0015 airfoil was selected using Q-blade software and the effect of pressure distribution on different angles of Naca0015 airfoil in Ensys Fluent and Q-blade software was investigated. For numerical analysis, the K-ω SST model was used and finally the lift and drag coefficient was obtained at different angles in Ensys Fluent software, which was in good agreement with the Q-blade software data and laboratory results. Using Q-blade software and aerodynamic analysis, it was concluded that by increasing the Reynolds number, the turbine performance coefficient increases and the turbine efficiency improves.

To operate a porous vane turbine at speeds of one and two meters per second, 50% less torque is required than a flat vane turbine to start the turbine. To operate a porous vane turbine at a speed of three meters per second, 33% of the torque of a flat vane wind turbine is required to start the cycle, and to operate a porous vane turbine at a speed of four and five meters per second, 50% and at 7 m / s, 60% of the blade turbine is smooth, and at 7.45 m / s, 57% of the torque is smooth, and at 8.25 m / s, 55% of the torque is smooth, and at Speed ¬ 8.5 m / s 50% torque of flat blade wind turbine is required to start the cycle. To operate a smooth-bore wind turbine at a speed of nine meters per second, 93% of the torque of the porous blade wind turbine and at a speed of 10 meters per second, 86% of the instantaneous torque of the porous blade turbine is required to start the cycle.

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