Experimental Analysis of Vertical Wind Turbine in Baghdad

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Abstract
The vertical axis wind turbine rotor rotates around vertical axis (VAWT). Its fundamental benefit is to achieve the ability of receiving the wind from any direction, which is in case of wind changes. This type of wind turbine does not require the initiation of steering device for deviating rotor to face the wind. The advantage of the use of upstream deflector for the improvement of the efficiency of a vertical axis wind turbine has been presented in this paper. A wind turbine scale model has been constructed and tested experimentally. VAWT design had operated at a reasonably sufficient degree throughout experimental .tests, even under the sub-optimal conditions
Energy of 1.4 watts was obtained at an air velocity of 3.5 meters / second, this result is acceptable for an experimental device with dimensions of 50 cm high and 11 cm diameter .of feather convex and a turbine diameter of 56 cm

Introduction
There is a wide range of the renewable energy forms. The majority of them are dependent on the sun-light in one way or another. Hydroelectric and wind power are direct results of the differential heating of the surface of the earth that causes in air movement (i.e. the wind) and the precipitation that forms as air is lifted. The energy of the sun represents the direct sun-light conversion with the use of the collectors or the panels. The bio-mass energy represents the stored sun-light that is contained in the plants. Other renewable energy sources that are not dependent upon the geothermal energy or sunlight that results from

the radioactive decays of the crust, in combination with original heat of creating the earth, and tidal energy that represents a conversion of the gravitational energy by Boerema et al [1] (2013). The investment technology of the wind is utilized the energy (movements of air masses at the surface of the earth) to rotate shaft power. This direct mechanical energy converts to electric power in the generator. During the past 30 years, considerable advances in the designs of the wind turbine were accomplished along with the modern technological development by Hall, D.O., et al. [2] (1993). It was estimated that the advances in the structural dynamics, aerodynamics, and the micro-meteorology can play a role in a 5% yearly increasing in wind turbine energy yield by Shikha, et al [3] (2014). A variety of the concepts of the wind turbine were advanced and built for the maximization of wind energy output, minimization of turbine cost, and the increase in the reliability and efficiency of the turbine. First experimental measures on a Vertical Axis Wind Turbine (VAWT) model tested in wind tunnel studied by B. Fortunato, et al [4] (2010) the new wind tunnel that is located at Fluid-dynamic Lab of Dept. of the Mechanical and Management Engineering (DIMeG) of Polytechnic Univ. of Bari. The wind tunnel was designed by research group on Department's wind energy. It's a sub-sonic, closed loop, wind tunnel with transparent testing section, in which small scale models may be analyzed. It should be noted that results that have been obtained in closed loop wind tunnel are influenced by the walls of the test section, confining turbine wake, the suggested method may be one of the highly beneficial test rigs for the innovation in the turbines of the wind. A wind turbine that is identified by the twisted blades was tested in open field facility by Gabriele Bedon, Marco Raciti Castelli, and Ernesto BeniniIn [5] (2013) The turbine has been identified by twisted bladed design, every one of the blades is placed at a specific distance to rotational shaft. Experimental setup for performing acquisitions has been explained. Results have .been lower than expected, as a result of high impact of wind shear

A strong wind shear has been registered, heavily affecting the overall aerodynamic performance. Vertical Axis wind turbine development has been performed by Samir J. Deshmukh and Sagar M.Charthal [6] (2017) an attempt has been made for the utilization at wind of low velocity, lower than 4 m/sec for the generation of the useful power with the use of the magnetic levitation for the VAWT termed as Maglev turbine. One large Maglev turbine may give output more than conventional horizontal axis wind turbine (HAWT). The effectiveness of the turbine has been increased through the replacement of traditional bearings by the magnets in the repulsion; the magnetic levitation is helpful for turbine to spin at considerably faster rates as it eliminates stresses on turbine shaft. The utilization of the energy of the wind from the wind prototype install in highway for taking advantage of moving cars on both road sides have been performed by Saurabh A. Kulkarni and Prof. M.R. Birajdar [7] (2016) in the most effective way, for getting maximal electric output .with the minimal cost indulges

VAWT has been modeled and fabricated such that it has the ability of capturing the wind from all directions, the power that has been developed from this project has been 28 W for a 6.1 m/sec speed, VAWT efficiency may be increased through changing the blade size and shape, the experimental and theoretical results vary due to the fact that in the

theoretical computation, it is considered that wind hitting all 8 turbine blades, practically it's not. VAWT over HAWT have been designed and concentrated by P. Gulve and Dr. S.B.Barve[8] (2014) The turbine of the wind has been designed for generating the electricity which is efficient for the domestic uses. Benefits of VAWT compared with the HAWT are compact for same generation of electricity, less noise, easy maintenance and installation and reacts to the wind from every direction. The obtained results have been up to the expectations. Whereas in the theoretical design the turbine efficiency has been considered 25%, but the efficiency that has been actually obtained has been 23.30%. The efficiency has been reduced as a result of a variety of the friction losses and manufactur-.ing errors

Design of Components

Design calculations of VAWT that has been illustrated in figure (1), they performed through the consideration of air impacting blade speed of turbine. When it starts rotating, blades through one axis with the electrical generator transfer the mechanical energy to .electrical power

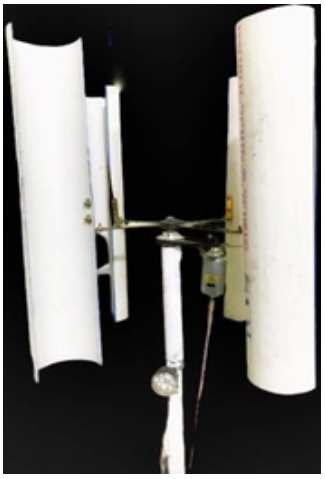

Figure (1): Vertical axial wind turbine VAWT

The blade is designed in semicircular shape. Four blades were used in this project as (shown in figure (2

In this study four vertical shaft blades have been utilized, it has a height and width of (50) cm & (16) cm respectively. The material used for the blade is PVC pipe. This material has been taken due to its low-cost and those pipes' weight is less too, which is why, the weight of the device has been decreased as well and therefore, the rotational speed too. Also PVC material has a high resistance corrosion, shock and abrasion, in addition to a .good strength

Figure (2): Blades manufacturing

While designing shaft it has to be fitted properly to the blade. The shaft has a (40) mm .diameter so as to easily fixed in disc, the pulley fixed on it

A belt and pulley system shows in figure (3). They are designed by two pulleys in common to a belt. The number of teeth for small and large puelly (driver &driven)(12 &26) respectively. This allows the mechanical power, (speed and torque) to be transmitted over the axles. And the pulleys are in different diameters to give a mechanical advantage has :been realized. Speed ratio (SR) was calculated by formulation

$$SR = \frac{no.of\ teeth\ (driver)}{no.of\ teeth\ (driven)} = 0.46 \quad \ldots 1$$

Figure (3): Pulley and belt

Four motors were experimented (6, 12, 24 &220 -volt) respectively. And a 220-volt motor as shown in figure (4) was used, because of the 220-volt motor with the smallest rotation .of the blades; the voltage is generated, while the other motors needed faster rotation

Figure (4): DC motor 220V

The base design by welding four (L) clamps on the plate washer as shown in figure (5), .this base rotates and the four blades are fixed on it

Figure (5): The base of prototype

The battery used for charging by generating energy from axial wind turbine
In this project wind speed was measured using an anemometer and shaft rotation using a tachometer, the voltage measure by Avo-meter device. The output data were taken from roof of high building at a height of 47 meters at (15 June-22 July) 2020. The test and results are shown in appendix 1

Experimental results & Discussion

The figure (6-7) was plotted between velocity of wind turbine and Power generating for various days in June and July using a scale model (VAWT) in Baghdad. Figure (6) shows good power generation depending on wind speed at (June –July) months in Baghdad, competing with the wind speed the power output were sufficient and shows good behavior (acceptable results according to standard specifications). Figure (7) illustrate wind effect on shaft speed which was very good and result shows 8500 R.P.Y at 3.5 m/s which is over normal result at similar wind speed depending on literature study

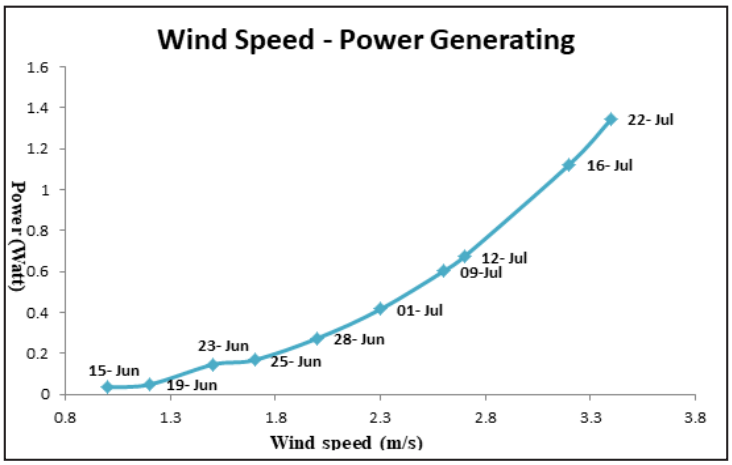

Figure (6): Power generation at a different wind speed in June-July 2020 Baghdad

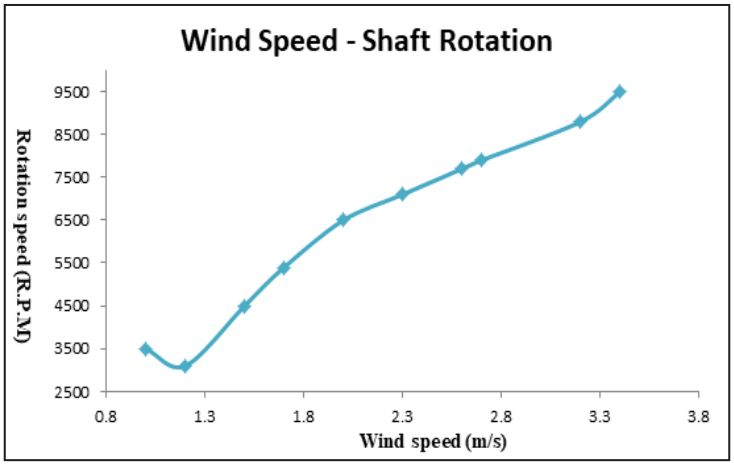

Figure (7): Wind effect on shaft speed rotation at a different wind speed

Conclusion

1-A wind turbine scale model has been constructed and experimentally tested has shown good behavior. VAWT design operated at a reasonably sufficient level throughout the ex-.perimental test, even in the case of the sub-optimal conditions

2-More than 1.5 watts were produce form 500 cm high, 11 cm diameter and with 56cm (manufacturer turbine) libertarian wind prototype which is consider good results comper-.ing with the work condition and effected parameters

3-The results and comparison with literature work of other countries shows that the vertical wind turbine in Baghdad can work effectively at high building and side the roads

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Appendix

Table (1): testing experimental results

Date	Wind Speed m/s	Rotation shaft r.p.m	Voltage Volts	Current Ampere	Power Watts
15-Jun	1	3500	2.1	0.016	0.034
19-Jun	1.2	3100	2.7	0.02	0.048
23-Jun	1.5	4500	3.3	0.034	0.145
25-Jun	1.7	5400	3.7	0.045	0.168
28-Jun	2.0	6500	4	0.068	0.274
01-Jul	2.3	7100	4.2	0.099	0.416
09-Jul	2.6	7700	4.8	0.125	0.602
12-Jul	2.7	7900	5.2	0.129	0.674
16-Jul	3.2	8800	6.5	0.172	1.125
22-Jul	3.4	9500	7.2	0.187	1.347