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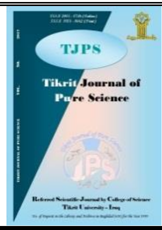

Fabrication of small size wind turbine and studying its characterization

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ABSTRACT

Wind energy is one of the renewable energies. the horizontal axis wind turbine (HAWT) fabricated in Iraq Tikrit, the system operating at low speeds. The characteristics of the two and three blade turbine are comparing. the results for best performance, We found that when used three-blade increasing the output power of the system, so when using two blades, the power (314.1 W) and the number of cycles (62.1) at wind speed (6.6 m/s), and also when using three blades, the power (354.40 W) and the number of cycles (67.9) at the same Wind speed.

I. Introduction

Renewable energy is important for solving many issues such as raising oil prices, environmental pollution and economic growth, thereby increasing the demand for renewable energy sources in developing countries to address these issues [1,2]. In order to take advantage of wind energy and make it economically viable, maximum wind power must be obtained to convert it into mechanical energy. Of all the different points of view, the optimum design of the rotor is the main determinant of achieving this goal [3]. Mostly small wind turbines operate in location with low wind speed, and moderate [4]. Stepper motor used to auto adjustable the wind turbine blades. This design is increasing the power and efficiency to 30%[5]. The horizontal axis wind turbine blade is designed to maintain turbine efficiency by redesigning and modifying the design of the blades [6]. The horizontal axis wind turbine blades, have been studied to obtain the maximum energy by (MW) [7]. A comparison was made between horizontal and vertical wind turbines , for best design and concluded that VAWT is efficient in building them when used in high stormy and tropical areas [8]. Previous studies on the interaction between the turbine blade and the tower showed that the dynamic interaction of the turbine tower with the blades was suddenly dropped n torque at 2.3% [9]. An analysis of the vibrations of wind turbines with a rotary axis (2m) to produce energy (3KW) was carried out and concluded that the use of the numerical and digital model is important for measuring the vibrations of the turbine resulting from the imbalance between feathers and secondary elements such as weight and tail fin vibrations [10]. The rotor size of vertical-axis wind turbines was studied to maintain operating efficiency at low winds and concluded that the energy obtained depended on the size of the turbine and efficiency as well and should be reduced the size of the turbine in high wind areas [11]. Performance was compared to horizontal and vertical axis wind turbines and the differences and similarities between these two different types of turbines were assessed when operating under the same weather conditions as the results obtained showed that HAWT was better performing and less impressive compared to VAWT [12]. Blade was designed and analyzed by using MATLAB 2018 for (2MW) power and concluded that the program is very useful for designing the turbine blade and getting the best power extraction design [13].

Use symbols:

Symbols	
(HAWT)	Horizontal axis wind turbine
(VAWT)	Vertical axis wind turbine
P_T	Actual power extracted by rotor w
P_W	Total power available in the wind w
V	wind speed in(m/s)
ρ	Air density in (Kg/m^3)
A	Swept area in (m^2)
D	diameter of turbine (m)
C_P	power coefficient
T	*Torque N .m*
Λ	*Tip speed ratio*
N	number of blade
R	Rotor radius in meter *m*
$\nu_\circ$	undisturbed wind speed m/s
ω	rotational speed of the turbine

II. Theoretical part

wind power and power turbine are given in the following equations.

$$P_w = \frac{1}{2}\,\rho A_T V^3 - - - - (1)$$

$$P_T = \frac{1}{2}\rho A_T V^3 C_P - - - - (2)$$

There is a limit of energy produced from the wind turbine, this resulting by wind flow during the rotor decrease , and convert to kinetic energy the energy produced cannot exceed Cp = 59.3% and this coefficient is expressed by the power factor (CP) and called the value (59.3%) By The Beatles , The power coefficient is the ratio between the mechanical energy of the wind turbine to the power of wind and is given in the following equation(3) [14,15,16] :

$$C_P = \frac{P_T}{P_w} - - - - (3)$$

And the area of turbine is given by equation (4):

$$A = \frac{\pi D^2}{4} - - - - - - (4)$$

The tip speed ratio is given by equation (5):

$$\lambda = \frac{\omega\, R}{\nu_\circ} - - - - - - (5)$$

Torque is given in the following equation[17]:

T= ω×R ----------(6)

III. Experimental work

Most parts of the system are made using cheap materials and manual manufacturing system consisting of many parts Figure (1) show the mechanic and electrical part

.

Fig 1: Homemade wind turbine when use two and three blades

1-**Base:**

The base is a square shaped made of iron ,the dimension of the square is 120 cm ,we added a cross shaped iron piece to strengthen the square ,and in the center we added a column with screw with dimension (6 *35cm) to fix the column that carries the system. figure (2).

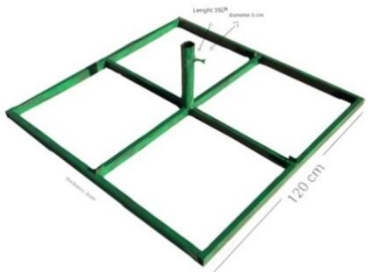

Fig 2: Base for wind turbine

2-Tower: The tower is made of iron ,the diameter of it is 5 cm and thickness 3 mm with length 2.25 m , at the top we fixed a rotatable square piece of iron called yaw drive to Carries the generator, rotor and other equipment including electrical wiring Figure (3).

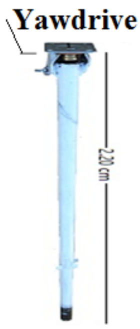

Fig 3: Tower for wind turbine

3-Tail: The length of the base is 167 cm we fixed a fish tail shaped piece of iron with thickness 1 mm Figure (4).

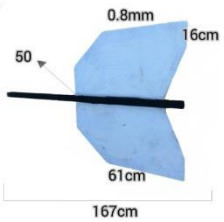

Fig 4: Tail of wind turbine

4- Gear box : Is made of two disks the first is a 35 cm diameter disk shaped piece of iron surrounded by 164 spicules and it contain several holes to fix the blades ,and the second is the same shape as the first but the diameter is 5 cm and the spicules are 9 Figure (5).

Fig 5: Gearbox assemble

5-Blades: It's a conical shape with length 120 cm the end that is attached to the disk is 10 cm and the other side is 17.5 cm, 4 mm thickness shown in Figure 6.

Fig 6: The blade of rotor

6- Generator : A 15 files installed on the disk have been used so that they have Indium magnets in front of them .Figure 7.

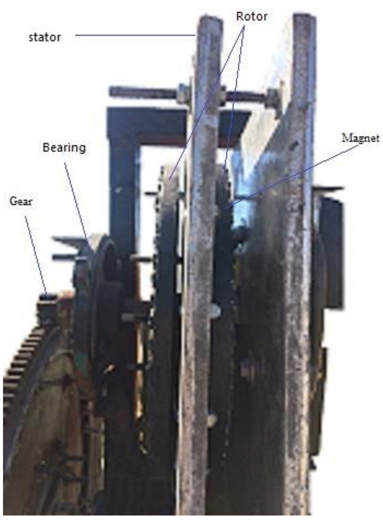

Fig 7: wind turbine generator

IV. Results and discussion

The wind turbine rotates when the wind speed exceeds the 1.8m/s. The relation between wind speed and the power of wind turbine with variation the number of blades we see increasing the power with increase the wind speed this is because it depended on equation (1) the power proportional to the third power of speed, In addition, it can be observed that, when three blades are used, the turbine's power will increase relative to the turbine when two blades are used because of the increased effective area of turbine that is affected by the speed of the incoming wind this show in Figure (8),

We also note that the torque increases when using three blades and decreases when using two blades, this is because the effective area affected by wind has increased to a certain point, resulting in increased torque this agreement with [18] .

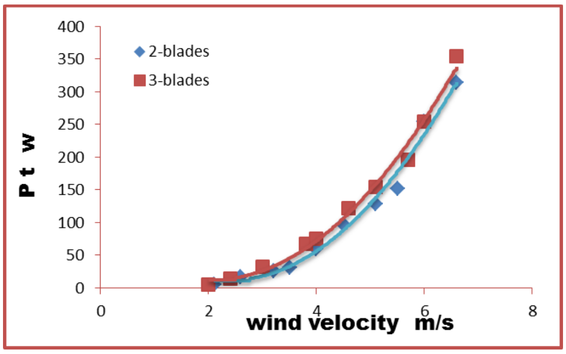

Fig 8: Relation between wind velocity and power turbine

also, we study the power coefficient with the tip speed ratio, between the turbine with two and three-blade by using equation (3,5), from figure (9) experimental the maximum coefficient of power 0.3 at two-blade and 0.37 at three-blade. The wind passing through the two-blade turbine is easily relative to the three-blade turbine, so power and torque increase, followed by the tip speed of the three-blade turbine relative to the two-blade turbine this agree with [19].

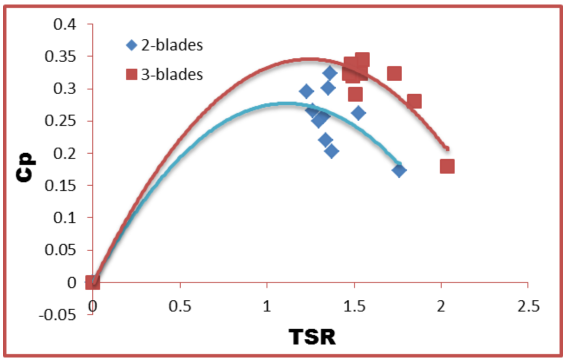

Fig 9: Power coefficient variation of the turbine at two and three blade.

Moreover, we study the wind speed with number of turbine cycle (Rpm) figure (10), we see the increasing the number of cycles of turbine with increasing wind speed and see the critical rotor at 1.8m/s after this velocity the rotor increasing the rpm with increasing wind speed depend to blade number increasing [20].

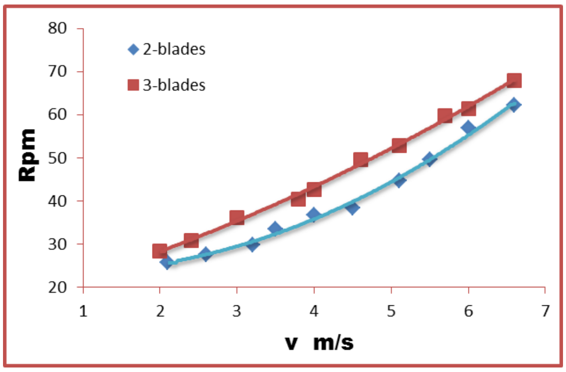

Fig 10: wind velocity with Rpm at two and three blade

Also we study the torque of wind turbine we found increasing with increasing wind speed, and we see increasing in three blade than two blade at low wind speed, meaning that increasing the number of blades at a low wind speed increases the process of capturing of wind energy more and thus increases the torque, figure(11) this agreement with [21].

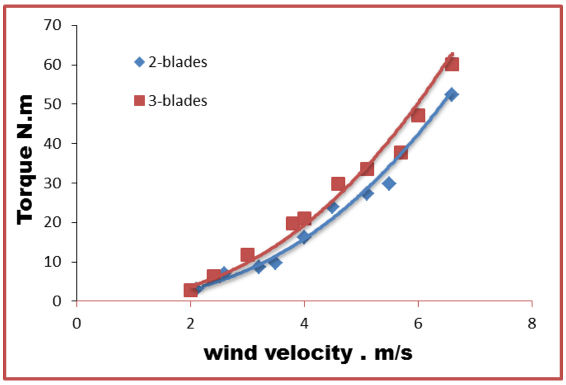

Fig. 11: torque with wind velocity at two and three blade.

V. Conclusion

The paper presents experimental though work on two and three blades small wind turbine we found that the power of wind turbine , power coefficient, torque and the Rpm were increased in case of three blades, compared with the use of two blades at the same low speed wind. The system more stable with three blades than two blades and more efficient for wind generator under Tikrit conditions (north central Iraq)

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تصنيع منظومة رياح صغيرة ودراسة خصائصها

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الملخص

ان طاقة الرياح واحدة من أنواع الطاقة المتجددة. تم تصنيع منظومه توربين رياح افقي (HAWT) في مدينة تكريت/شمال وسط العراق, تعمل عند سرعات رياح المنخفضة, مع دراسة بعض الخصائص الميكانيكية للتوربين الصغير ذي الشفرتين والثلاث شفرات ومقارنه نتائجهما للحصول على افضل أداء. ووجدنا ان زيادة عدد الشفرات عند السرع المنخفضة للرياح يكون افضل لتوليد الطاقة اذ عند استخدام شفرتين تم الحصول على طاقة مقدارها (314.1W) وعدد دورات (62.1) عند سرعة رياح (6.6m/s) عند استخدام ثلاث شفرات تم الحصول على طاقة مقدارها (354.40W) وعدد دورات (67.9) عند سرعة الرياح نفسها.