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Design and fabricate of tiny wind turbine in Tikrit - Iraq

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Abstract

The DC electric Power system depending on Horizontal-Axis Wind Turbine (HAWT), designed and manufactured by using and assembling an available low cost materials several primary and secondary parts of the system are modified to gam a good result's on producing electric power, we are capable to get 15 V (DC) . It is as found that when wind speed is of 6.2 m/sec ,route per minute is 100 rpm, power coefficient C_P **is** 0.5 and the gain power is 20 W.

1- Introduction

Renewable energies can be defined as sustainable energy, it can be continuous to the farthest extent of fossil production, which is in a close relationship with the environment because it does not cause side effects, many countries used it to reduce pollution like using Solar energy, hydroelectric power, tidal energy, waste energy [1-5] The source of wind energy from vital and modern sources has a large and effective role in the production of electric power, this type of energy can produce a large amount of energy ,the solar radiation has a Great role in determining the amount of wind and the wind directions, Air is not equal in region it varies from region to another and the advantages of this that energy can be generated any time [6]. There have been several previous studies on power wind production including Trftdy L, Forsyth. this paper covers the US National Energy Project for the small wind turbines of the laboratory project, its specifications, applications, and concepts of small wind turbines. [7], Alexander Bolonkin 2004 also proposed a revolutionary innovation that produces a huge increase for each unit and is independent of the prevailing weather in older studies and at a lower cost per unit of extracted energy. The main innovation consists of large free air rotations positioned at high altitudes to stabilize the air current, and the cable power transmission system between the air rotor system and the ground-based generator [8]. Mustafa Kamel Abdul-Janabi presented a study in the areas where wind can be used to produce electric power in Iraq, it was found that there was a difference in wind speed which leads to increase or decrease the production of electric power according to wind type, this shows that the central and southern regions are better Places to generate electricity to the wind, which gives impetus to the establishment of power stations, namely, the neighborhood and Nasiriyah [9]. Bedri Kekezoğlu 2015 has made a new model wind conversion system suiTable for urban use, the proposed design is modular and has a flexible structure, an external loop attached to the turbine blades is used in the design phase, both the number of blades and the number of external rings are varied to analyze their impact on turbine performance. Performance analysis of wind turbine model is completed under real life conditions, result of this study, increased gears and code numbers have increased turbo output capacity. The most efficient structure identified during field analysis [10].Kishor Chandak 2016 tested unconventional energy systems in many countries. One of the unconventional energies is wind power, can be used to run windmills to produce electricity. The latest technology windmills have high offshore output and barrier-free nonstop if the wind speed is high, the capacity of windmills depends on the air speed cube. [11] Ali M. Rasham 2016 analyzed wind speed data and selected areas were evaluated for potential energy production. The Matlab program was developed in the calculator to solve the mathematical model, the results were in the form of monthly and annual power measurements, average wind speed (wind cut, wind speed, maximum wind tolerance) and the most likely wind velocity, and at altitude stations had the best wind power in Basrah, Amarah and Nasiriyah respectively and the selected sites are suiTable for applications (60,90,120 m) and Nasiriyah at (120m) were accep Table to connect to the electricity grid. [12]. Presented by Shafiqur Rehman, Md. Mahbub Alam and others 2018, in this paper an overview of commonly used models, techniques, tools and experimental approaches used to increase the efficiency of wind turbines. In the current review work, particular emphasis is placed on the approaches used to design both experimental and numerical wind turbine blades, and the methodologies used to study the performance of wind turbines both empirically and analytically, and active and inefficient techniques used to enhance the power output of wind turbines, To improve turbine wind performance, and finally R & D related work to new and efficient materials for wind turbines[13]. The work of the wind energy system requires the design and modification of several mechanical parts to build the system and therefore not available all the parts in the local markets, so require new transformations to obtain outstanding result.

2 -Theoretical part

A- **Wind turbine power:** The main characteristic of the wind power production is wind power, wind speed without bumps and power output from turbines. Energy curve is the main way to describe turbine performance. The cutting speed starts from the lowest wind speed and the cutting speed starts gradually, Fig.1. shows the wind speed with the power output. The curve shows the relation between the speed of the wind and the output of the turbine the minimum speed where the turbine start working is the cut speed and the maximum is the cut out. The output capacity can be calculated from the below equation[14]

$$P = 1/2\, \rho\, AU^3\, \eta C_P \qquad (1)$$

P = power , ρ = Air density , A = diameter area of blade , U =, wind speed ,η = efficiency
C_p = power coefficient

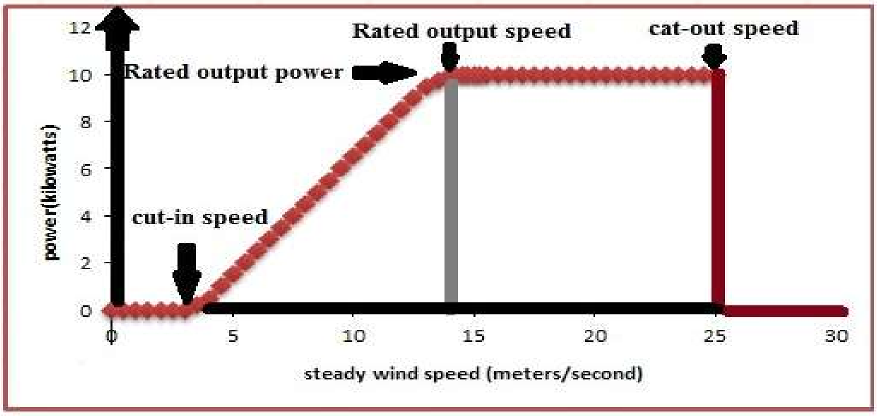

Fig. 1. wind speed with power output [14].

B / Momentum theory

Bates Limit

Bates model of the performance for ship turbine, where this system was later widely used to demonstrate the principle of wind turbines, where it was assumed that the air was one in dimension, the time was constant and simulated with momentum, the force T was on wind turbines through sections (1) and (4) as shown in Fig. 2.[14].

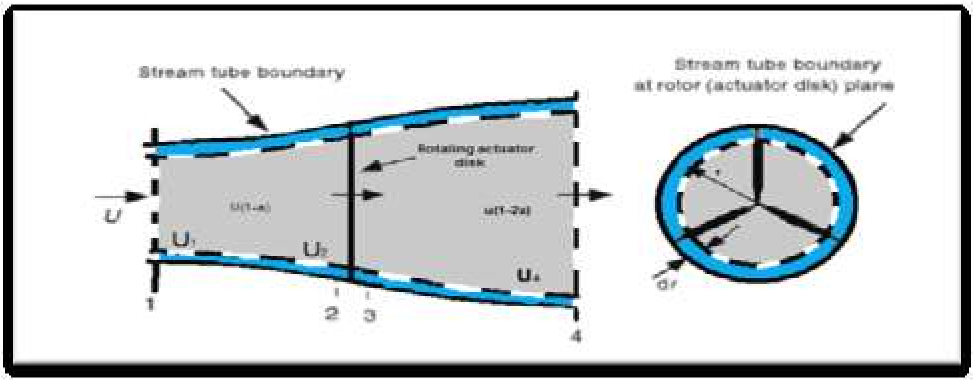

Fig. 2. Shows wind power on wind turbines [14].

The axial force acting on the control volume is equal and opposite to the rate of change of momentum of the stream – tube, thus [14]

$$\sum F_X = T = m(u_1 - u_4) = u_1(\rho Au)_1 - u_4(\rho Au)_4 \quad (2)$$

Where T is the force of wind on wind turbines , $\dot{m}$ mass flow rate of air per unit time .

u_1, u_2, u_3, u_4= is the air velocity

The Bernoulli equation can be apply on section 1,2,3,4 we find that :-

$$p_1 + \frac{1}{2}\rho U_1^2 = p_2 + \frac{1}{2}\rho U_2^2 \quad (3)$$

$$p_3 + \frac{1}{2}\rho U_2^2 = p_2 + \frac{1}{2}\rho U_4^2 \quad (4)$$

where p1, p2, p3 and p4 is the air pressure at profile 1-4 respectively $u_3 = u_2$ can be extracted and $p_1 = p_4$

They can be found on T the disc

ρ = Air density.

$$a = \frac{u_1 - u_2}{u_1} \quad (5)$$

a=Bates Limit

Then of energy P

$$P = T.U_2 = \frac{1}{2}\rho A_2 U_1^3 4a(1-a)^2 \quad (6)$$

Then of P power A_2 is typically replaced with A and U_1 is replaced with U

Wind turbine performance is representative of theC_P power coefficient

$$C_P = \frac{P}{\frac{1}{2}\rho AU^3} = 4a(1-a)^2 \quad (7)$$

the maximum value of $c_{p_{max}} = 0.5926$

Where a = 1/3, which represents the Bates limit

The practical wind turbines do not reach that limit because the maximum power factor of freshness [15,16] has a value of just over 0.51 for the global power factor and local power plants. The global power factor is slightly higher than the bits in the interior of the three-dimensional rotor and the dynamics method Using the same methods, the T axis can be extracted on the disk on position (2) and the C_T orientation coefficient is defined as the direction signal coefficient and can be obtained from equation (1) and (2), equation (6)and (7) can be written as follows [14]:

$$T_p = \frac{1}{2}\rho AU^2 4a(1-a)^2 \quad (8)$$

$$C_T = \frac{T}{\frac{1}{2}\rho AU^3} = 4a(1-a) \quad (9)$$

3- Experimental part

The most important practical aspects of the design and manufacture of the wind energy system to obtain electricity, the system consists of several parts.Fig. 3.show component of wind turbine which is consisting of:-

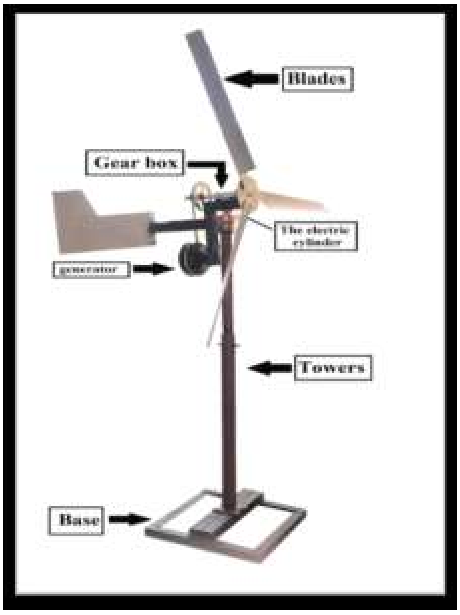

Fig. 3. Assembly wind turbine component.

A- Mechanical parts

The mechanical parts consist of several parts to sustain the operation of the system

1. **Base** : An iron base on which the main parts of the system are built is constructed with 40 × 40 × 3 cm dimensions.
2. **Towers**: is the column that holds the main system and is in the form of a metal tube diameter (5 cm) and length (1 m) and moves inside another tube in the form of slit diameter (4cm) and length (1.25m).
3. **Gear box**: It made of iron pipe with diameter (3 cm) and length(12 cm) and connected to the front part of rotated disc used to installed the blade ,and connected from other side by the serrated disc.
4. **Blades**: A resistive plastic piece whose dimensions are invariable , These blade convert wind energy into mechanical movement, which is then converted into electricity by the force of the wind pressure by the Rotated disk and confirmed by screws (3) for each blade, the force of rotation according to the wind speed and wind direction. Fig. 4. represents the blade.

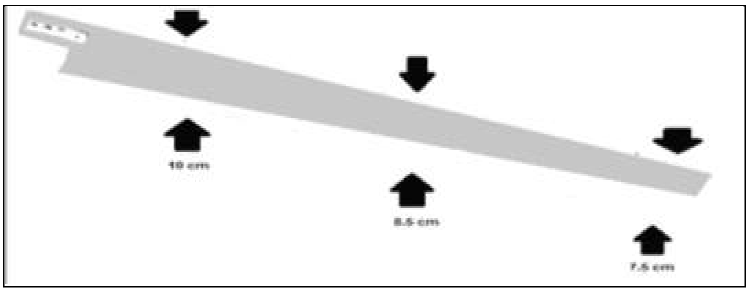

Fig. 4. Shows the wind turbine blade.

B- Electrical parts

The electrical part is the resulting part due to mechanical movement and consists of several parts.

1– **generator :** This part is the main part connected in front of the small gear wheel and is connected from the sides by bolts in the main hull We have modified the generator no to obtain AC alternating current and therefore to obtain variable current and variable voltages, there are three conversions take place to get output electricity, the first processes is the process of converting mechanical movement to the magnetic field and from the magnetic field to electric field this can thus invest the electric energy produced from these transformations .

2-**The electric cylinder:** It is a plastic disc with an outer diameter of 5cm and an inner diameter of 3cm. The outer strap holds two strips of copper used to transfer the electric power from the dynamo to the consumption and the Fig. 5. represents the electric cylinder.

Fig. 5. The electric cylinder.

4- Result and discussion:

we find wind power, Torque T_P turbine power P, the power coefficient C_p, thrust coefficient C_T for wind turbines by using equation (2 ,5,6,7,8,9) , Table (1) show the geometrical parameter .

Table (1) Turbine Parameters

Blade Length	0.8 m
Number Of Blade	3
Swept Area	2.2m
wind power T	73.0835
Torque T_P	36.54 J
turbine power P	233.86 w
power coefficient C_p	0.5925
thrust coefficient C_T	0.8888

In the laboratory we test the system with varies velocity of wind speed, the wind speed is measured by using Anemometer, the generator is connected with the Multi meter, current and voltage is recording with the corresponding wind speed, and the power calculated also, Table 2 show the electrical parameter.

Table 2 Power calculation

Wind speed in m/s	Voltage (V)	Current(I) amps	Power P=VI (W
3	3	0.3	0.9
4	6	0.5	3
5	13	1.15	15
6	15	1.33	20

From the Fig. 6. we notice four periods of stability for the wind speed

from 9:00 - 9:15 o'clock increase from (3.5 - 5 m/s) , and from 9:15-11:00 o'clock, relative constants at(5m/s) ,

from 11:00- 1:30 o'clock increase from (5 – 5.7 m/s)

from 11:30 -14:00 o'clock relative increase.

Otherwise , we note that the number of cycles (rpm) varies according to the time due to wind speed during the time .so as when increasing the wind speed increasing the rpm and when constant wind speed constant rpm the behavior compatible with [14,15] .

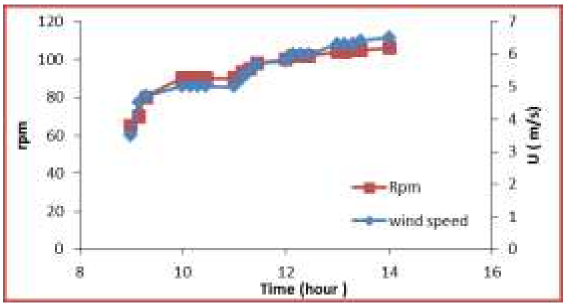

Fig. 6. Relation between time with wind speed and rpm.

Fig. 7. shows that the amount of energy varies with the wind speed, there is a change in the amount of power starts at the wind speed (4m/s) and The capacity is increased and the stability of the wind speed is observed, there is a slight change in capacity with a slightly higher wind speed ,The highest value is obtained when wind speed at this locally time is (6.3 m/s) [15].

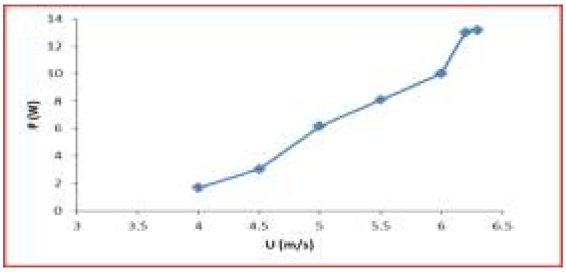

Fig. 7. Relation between wind speed and power.

Fig. 8. was plotted between the power and number of cycles , at certain circumstance and , we notice when increasing the amount of power it increasing rpm directly [15] .

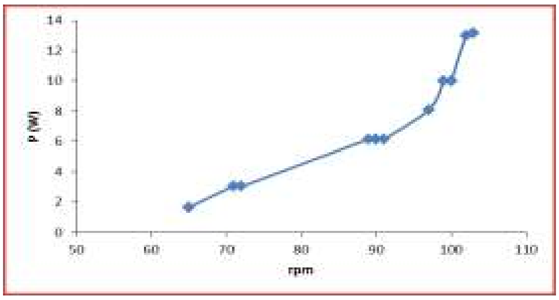

Fig. 8. Relation between power and rpm.

Conclusions

This Horizontal-Axis Wind Turbine (HAWT) is fabricated by low cost materials to achieve rpm at low wind speed . We can used low wind energy in Tikrit to drive small wind turbine, From experiment can be generated when the turbine is rotate at up to 60 rpm at the wind speed is up to 3.5 m/s, this type of renewable energy can therefore be used to generate clean energy in Tikrit and surrounding areas to reduce the pollution caused by fuel combustion, to solve problems of electricity production and to reduce the cost of production.

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تصميم وتصنيع منظومة صغيرة لتوليد الطاقة الكهربائية من الرياح في تكريت – العراق

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الملخص

تم تصميم وتصنيع نظام لتوليد كهرباء التيار المستمر من طاقة الرياح، وذلك باستخدام مواد منخفضة التكلفة متاحة في الأسواق حيث يتكون هذا النظام من عدة أجزاء، منها الأجزاء الأساسية، والأجزاء الثانوية حيث قمنا بتحوير العديد من الأجزاء. وتمكنا من الحصول على نتائج جيدة للنظام في إنتاج قدرة كهربائية وتمكنا من الحصول على جهد كهربائي قدره (15 V DC). وجدنا عندما تكون سرعة الرياح (6.2m/s)، فأن عدد الدورات في الدقيقة (100rpm)، ومعامل قدرة $C_p = (0.5)$ كسب قدرة (20 W).