European Journal of Mechanical Engineering Research
Vol. 9, Issue 1, pp.1-11, 2022
Print ISSN: ISSN 2055-6551(Print)
Online ISSN: ISSN 2055-656X(Online)

MODELING AND SIMULATION OF SHROUD ED WIND TURBINES TO WORK IN IRAQI WEATHER CONDITIONS

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Rajaa Jarallah Abdul Rahman, and Ahmed Khalid Ibrahim (2022) Modeling and Simulation of shroud Ed Wind Turbines to work in Iraqi weather conditions*, European Journal of, Mechanical Engineering Research* , Vol. 9, Issue 1, pp.1-11,

ABSTRACT: *This study provides an overview of renewable wind energy in Iraq and the possibility of deploying concentrated wind energy technologies to support power generation in agricultural fields. On horizontal wind turbines. The results showed that with the addition of the diffuser, the energy produced shows an increase, and the study also showed that the wind speed in Iraq reaches 8 m per second in the center and south of the country. The study presents wind energy activities in Iraq, and the Iraqi government's attempts to use wind energy. Renewable energy in general, and wind energy in particular*.

KEYWORDS: modeling, simulation, Ed wind turbines, Iraqi, weather, conditions

INTRODUCTION

The continuous depletion of fossil fuel sources in addition to the increasing demand for energy due to the growing world population makes the transition to renewable and environmentally friendly alternatives such as solar and wind energy very urgent. Also, this step can significantly mitigate the consequences of polluting gas emissions and global warming. In this regard, wind energy harvesting is a reliable technology to reduce harmful carbon pollution due to consumption of fossil fuels besides reducing the high costs of electric power generation. In Iraq, the current reliance on conventional power plants to meet the increasing demand for electrical energy is not considered a reliable solution. Thus, the move to increase the share of electricity began energy field. Globally, several studies have been conducted to evaluate and analyze the potential of wind energy to help find suitable wind sites for wind energy projects. The early use of wind as a source of energy dates back to the seventeenth century BC. The Babylonian Emperor Hammurabi planned to use wind energy for irrigation in Mesopotamia (Iraq) Nowadays, wind energy is usually used to generate electricity (wind turbines), or to pump water (windmills) [1]. Wind power generation is directly proportional to the cubic wind speed. Thus, any increase in wind speed will cause a significant increase in production. If we can increase wind speed by taking advantage of the fluid dynamics of nature, that is, if we can concentrate wind energy, then the energy production can be increased from wind turbines. It can effectively generate power from the wind [2]. It's worth looking at some of the history of wind energy. The history serves to illustrate the problems that wind power systems still face today, and provides insight into why capped turbines have emerged [3]. The researcher (Gilbert) and his group presented in 1980 AD a theoretical study dealing with diffuser-boosted wind turbines (DAWT). 7 diffusers. They used a multi-slot diffuser, which greatly increased wind speed by utilizing different flow characteristics. .[2]

RESEARCH METHODOLOGY

The topic of the research focuses on how Iraq maximizes the use of wind resources for power generation, as well as determining the best place to collect wind energy in the region and choosing the appropriate turbine for low speeds, in addition to conducting this research to determine the effect of using the diffuser on the performance of horizontal wind turbines enhanced by the diffuser. NACA 6412 was chosen because this airfoil has a high lift and drag ratio on a low Reynolds number [4]. The full specifications of the wind turbines used are shown in Table (1-1). And that is based on the laws of conservation of mass as well as the laws of energy conservation, through the derivation of the Betz equation (the greatest power that can be obtained from wind by a wind turbine operating at 100% efficiency), which applies to horizontal and vertical turbines [5]. In this research, simulation of some turbine parts, including (rotor part, turbine blades as well as turbine shroud), (blade and the shroud, hub) by using the engineering program ANSYS, in order to evaluate the performance of shroud ed turbines and the possibility of establishing them in some areas of Iraq. Where this program is one of the modern programs and is used in mechanical engineering applications because it contains a large database for those applications.[6]

Table (11) shows the specifications of the turbine

Specification Value	Value
Generator	100Watt
The Ratio of Rotating Rotor with a Generator	1:1
Rotor’s diameter	1200mm
Blade's length	600mm
Total Blades	3

Tip - Speed Ratio

It is the ratio between the velocity at the tip of the blade and the wind speed, which increases with the length of the blade, and is an important factor in the design of wind turbines. TSR knowing the turbine tip speed ratio will help increase the energy output and efficiency of the wind turbine. Since if the turbine blades are spinning too slowly, a lot of the wind will pass through the gaps between the blades instead of giving power to the particular turbine. If the blades are spinning quickly, it can create a lot of turbulent air or act as a solid wall against the wind. Therefore, there is the optimum angular velocity at which maximum power extraction is achieved.[7]

The feather tip velocity [8] was obtained by the following equation:

$\lambda = \Omega r / u$

whereas

λ = Tip speed ratio

Ω = Rotational velocity (rad/s

r=Radius

u=Wind speed

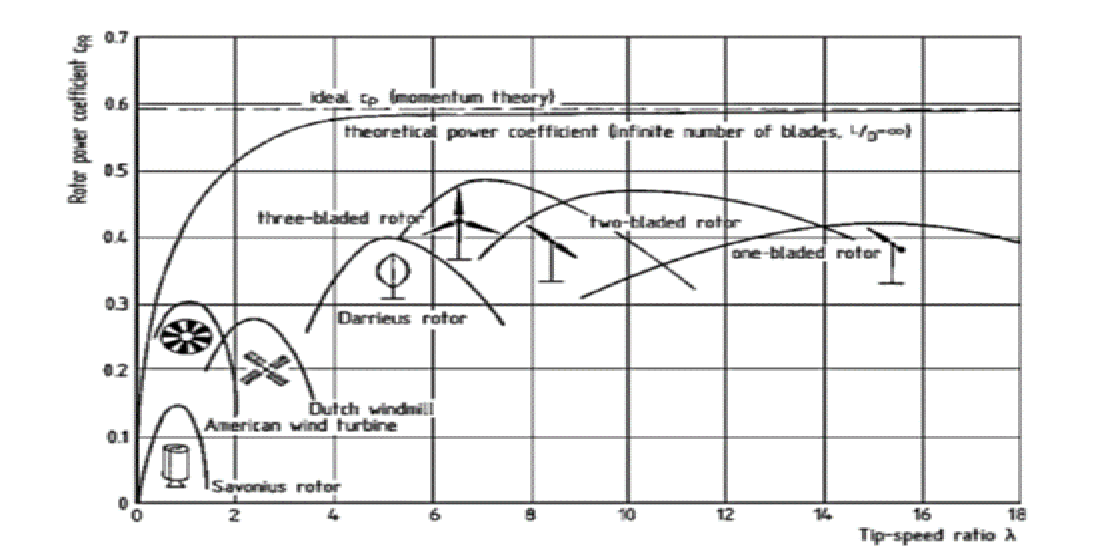


Figure 1: Shows the power factors of different types of wind turbines

With the feather tip velocity ratio.[9]

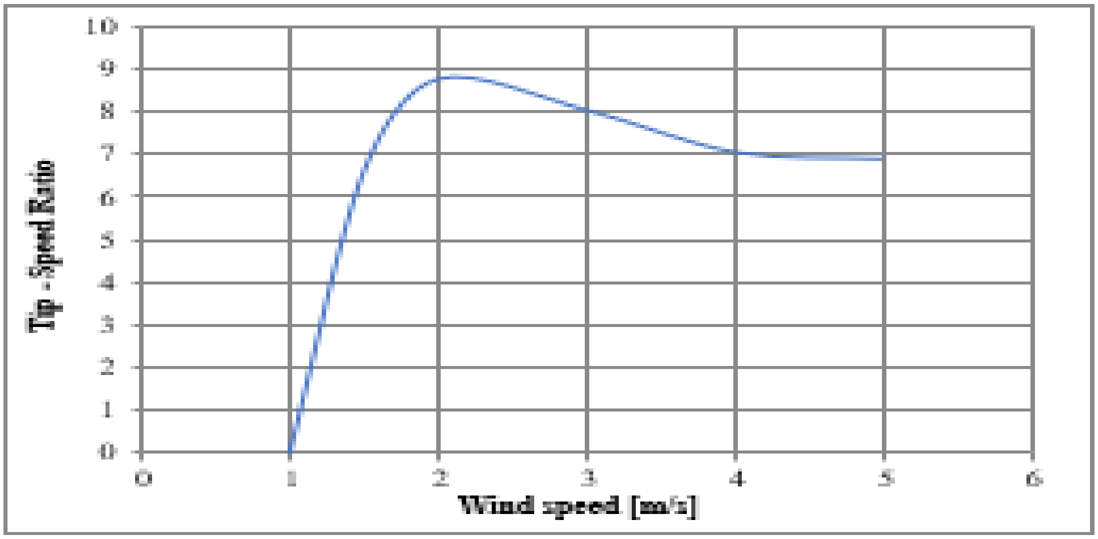


Figure (2): shows the relationship between linear wind speed with TSR

The use of wind energy in Iraq

In terms of the characteristics of time and space, wind is the most dynamic and fastest changing factor in climate; This means that the projected power will change significantly from time to time, so accurate measurements must be relied on to track wind speed and wind characteristics in terms of direction, continuity, and strength. The wind speed data in Iraq comes from the global energy forecast network database provided by NASA for Space Sciences. The atlas shows wind speed and energy at any point inside Iraq at three altitudes (30, 50, 90 meters), in addition to other relevant scientific data. . The accuracy of the update time is up to 3 hours. The annual average wind speed at 50 meters, the majority of the Iraqi land area is more than or equal to (8 meters per second). We find that there is a variation in wind speed between seasons, and this indicates the pressure differences experienced by the region, which are related to the amount of solar radiation reaching the surface of the earth, and its contrast between summer and winter and the seasons of the autumn and spring equinoxes. This means that Iraq is one of the most promising countries for the development of wind energy in the world. Al-Mustaqbal, Nasiriyah and Basra are the regions with the highest wind speed [1]. Arab countries including Iraq have good wind speed and good intensity, but the development and utilization of these winds is still limited to countries that are characterized by strong winds such as Egypt, especially coastal areas. Iraq is also one of the countries in most need of this energy due to the increasing and urgent demand for electric power since 1991 [10]. In 2004, witnessed the opening of the Energy and Fuel Center of the University of Science and Technology, which focused on several directions, including renewable energy trends, solar and wind energy applications, and the search for renewable energy as an alternative source of energy in Iraq. At the end of 2010, the

Ministry of Electricity coordinated with international organizations and companies to establish a renewable energy and environment center. Iraqi ministries and universities aim to introduce renewable energy into the production and distribution sector to support the grid and provide electricity to remote areas at different capacities [11]. Table (2) shows the wind speed in the main climatic stations for Iraq at an altitude of 50 meters, which was taken from the maps of the World Wind Atlas.

The monthly average wind speed at a height of 50 meters for different regions of Iraq

Different from Iraq for the period from 1981 AD to 2019.

STATION / MONTHS	Mosul	Tal Afar	Sinjar	Baghdad	Rutba	Basra	Nasiriyah
January	3.78	4.04	4.50	4.68	5.93	5.47	5.30
February	3.91	4.23	4.70	4.93	6.19	5.86	5.70
March	4.05	4.43	4.81	5.09	6.22	5.80	5.80
April	4.20	4.58	4.91	5.08	6.07	5.66	5.72
May	4.52	4.99	5.18	5.41	5.79	6.04	6.18
June	5.09	5.79	6.09	6.76	6.44	8.05	8.15
July	5.10	5.69	6.04	6.99	6.70	7.99	8.22
Father	4.96	5.47	5.68	6.47	5.86	7.20	7.58
September	4.55	4.98	5.10	5.61	5.08	6.30	6.55
October	4.18	4.33	4.45	4.93	5.13	5.28	5.48
November	3.83	3.93	4.24	4.68	5.24	5.33	5.26
December	3.75	3.99	4.38	4.66	5.59	5.40	5.27
annual rate	4.3	4.7	5.0	5.4	5.9	6.2	6.3

Diffuser-Augmented Wind Turbine. Diffuser-Augmented Wind Turbine Concept

The DAWT diffuser concept is to increase the power output of a wind turbine by accelerating the wind speed approaching the wind turbine. When the wind speed increases, less pressure will appear in the back of the wind turbine, which is a vacuum to absorb the wind and accelerate it towards the blades, where it will act as an accelerator to accelerate the wind speed approaching the wind turbines. The generation of wind energy in wind turbines is directly proportional to the wind, meaning that any slight increase in wind speed leads to an increase in energy. If we can increase the wind speed by exploiting the fluid dynamics, the power can be increased from the wind turbines and Figure (3-2) shows the wind movement in the shroud ed wind turbines.[12]

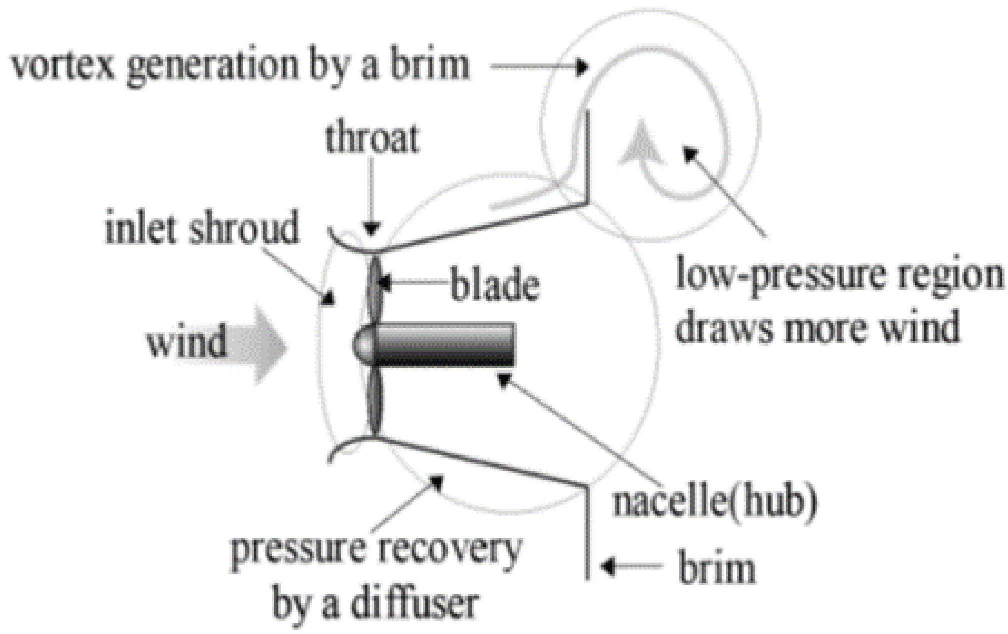


Figure 3: Shows the wind movement in a shroud ed wind turbine[2]

Results of the zero angle simulation for the three cases (DF, SH, NZ):

The results of the current study show an analysis and development of small wind turbines by increasing the power generated by the turbine. And that by adding the diffuser compared to the traditional turbine. Through this study, three different diffuser design concepts were developed and simulations were carried out using FLUENT, we observe an increase in the generated power compared to conventional wind turbines. Figure (4) shows the relationship between the change in the linear wind speed and the power generated by the conventional wind turbine (without shroud), while Figure (6) shows the distribution of speed and pressure on the fins of the turbine when the wind speed is 5 m/s and a rotational speed of 550 revolutions per minute

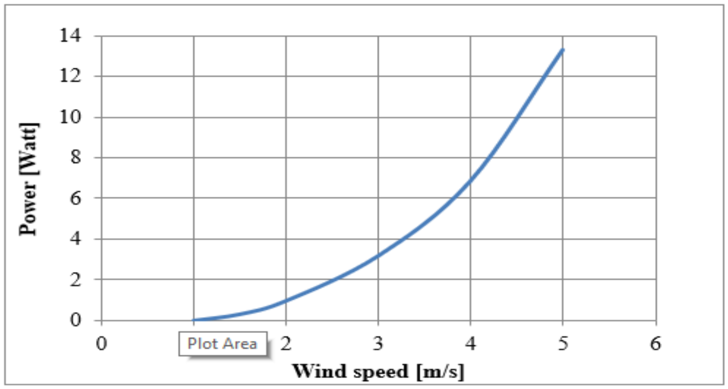


Figure 5: The relationship between the change in the linear speed of the wind and the power generated From a conventional wind turbine (Turbine only)

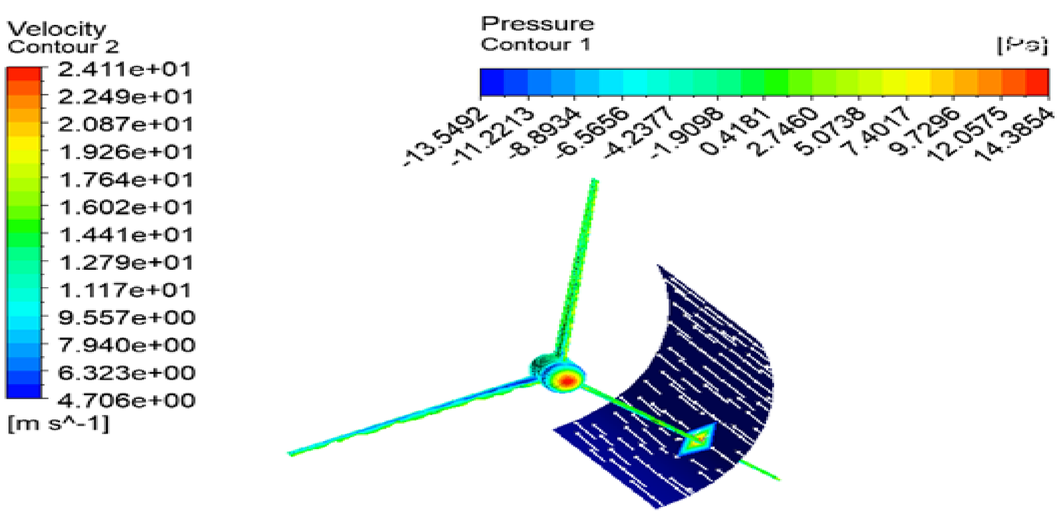


Figure 6: shows the distribution of velocity and pressure on the fins of the turbine when they are

The wind speed is 5 m/s and the rotational speed is 550 revolutions per minute.

The first case when the blade angle is zero degrees ANGLE(˚0)

First: Diffuser wind turbine

We notice an increase in the energy generated compared to traditional wind turbines

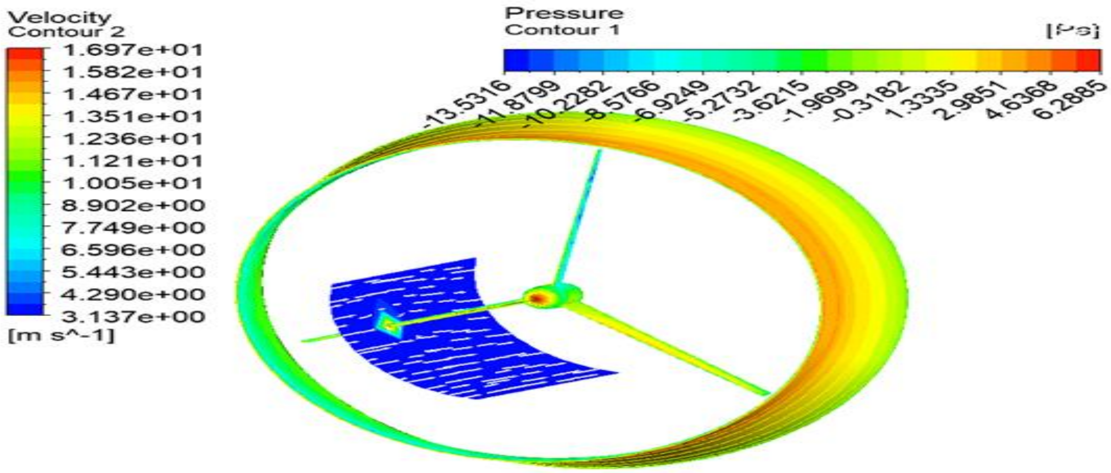


Figure (7) shows the results when choosing an air velocity of 3 m/s and a rotational speed of 385 revolutions per minute.

Second: Diffuser -shroud Nozzle wind turbine:

When testing the second type, the wind turbines shroud ed with the flanged diffuser showed an increase in power compared to the wind turbines in the first case. The results showed an increase in the energy produced by DWT

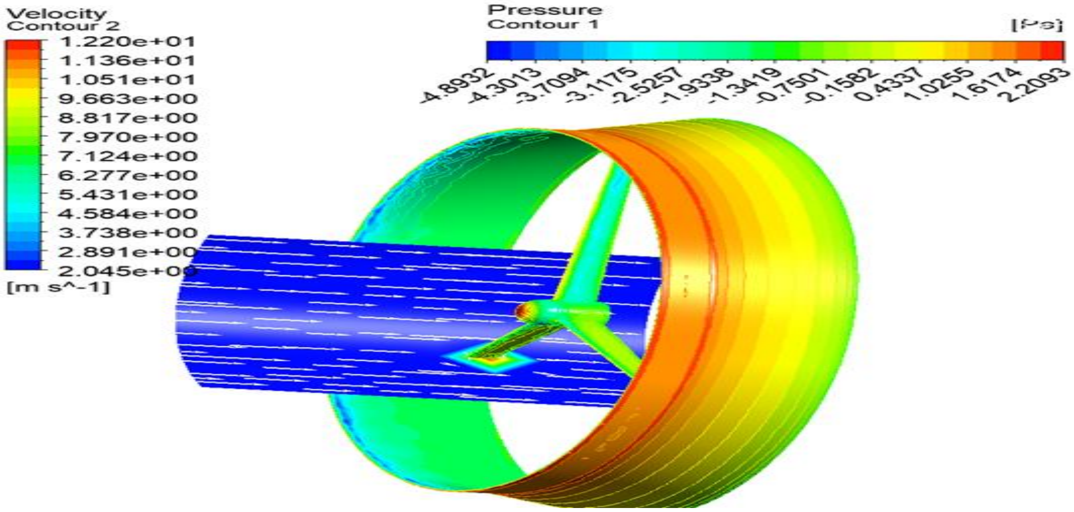
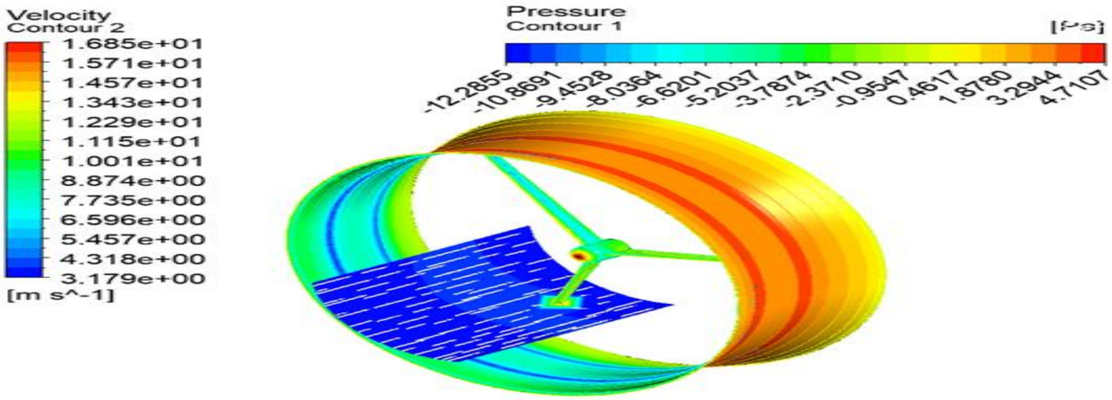


Figure (8) Results at a velocity of 2 m/sec and a rotational speed of 280 rpm.

Third: Diffuser -shroud Nozzle wind turbine:

And when testing the third type, the results of the study in this case showed a significant increase in power and the increase in power is due to the pressure difference between the inlet of the diffuser and the outlet of the diffuser, where the pressure is low at the outlet of the diffuser that pumps much larger quantities of shroud wind turbine-diffuser to approach twice the resulting power About the Diffuser wind turbine of wind turbines. The reason for this increase is due to the vacuum area in pressure by vortices due to the edge effect and the shape of the diffuser. Thus, we get the goal of this work is to develop and design a new air diffuser that can collect and accelerate the wind.



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The best figure (9) shows the distribution of speed and pressure on the fins of the turbine when the wind speed is 3 m/s and the rotational speed is 385 rpm.

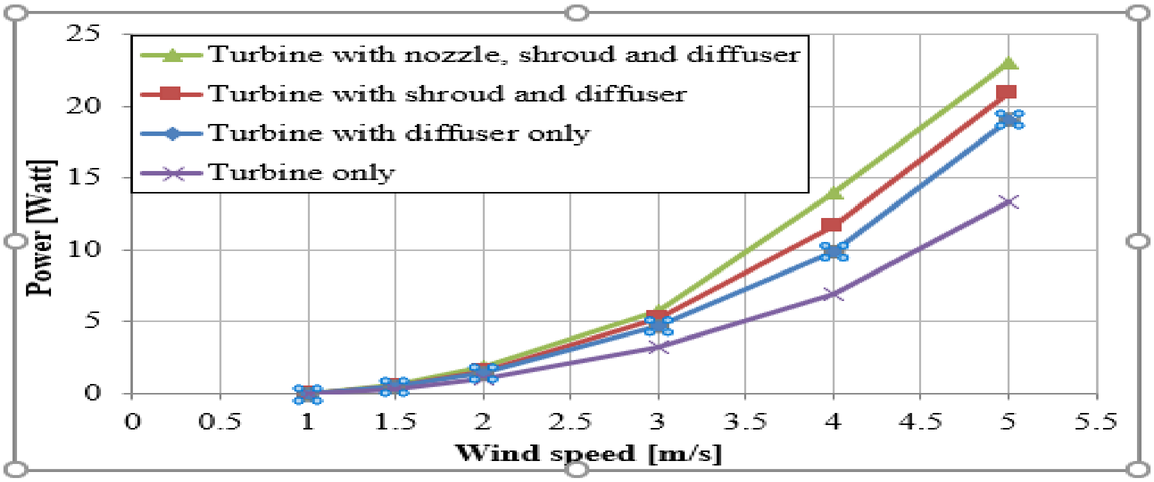

Figure 10: shows a comparison of wind turbine results for the three turbine cases

At the zero angle in addition to the case. Turbine only

CONCLUSIONS

After completing all the results of modeling and simulating the performance of diffuser-enhanced wind turbines for the three cases of the turbine (Diffuser- shroud Nozzle wind turbine) for the current study, as well as wind speed including Mosul and its parts, Nasiriyah, Baghdad and Basra at an altitude of 50 meters, it is proved through the results that wind turbines The shroud has improved performance at low wind speeds, and wind turbines tend to produce optimal power. The results showed that the use of a diffuser was able to increase the power in wind turbines by more than 50%, as the use of the air distributor in wind turbines can increase the efficiency of the turbine. Wind. The increase in the generated energy is due to the increase in wind speed. That is, wind turbines without a diffuser generate less electrical energy compared to wind turbines with the addition of a diffuser. We notice this from Figure .(9)

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