

DESIGN AND FABRICATION OF WATER PUMPING SYSTEM USING WIND MILL

Shaik Nayeem*

B.Pavan kumar*

B.Arun bhaskar*

A.Jnanendra*

K.Vijay kumar*

ABSTRACT

In our project wind energy is used to rotate the wind blades. This blade coupled to the shaft. At the end of shaft the flywheel is placed. The eccentric arrangement is provided in the flywheel. When the blade rotates automatically flywheel also rotates. Due to the eccentric arrangement the rotation motion of the flywheel is converted into linear motion. This reciprocating motion is given to the handle of the pumping system. The up down motion of the handle is given to the piston, where the water is sucked using pressure variation from lower ground. Finally the water is supplied to the outlet. Wind blade provides the continuous motion which helps to supply the water continuously .Since time immemorial, the main source of energy has been coal, oil, natural gas, nuclear energy, wood and coal. However, all these sources are limited and are the main cause of pollution and this has led to development and more focus on sustainable energy supply with minimum pollution effects. Hence research and analysis has shown that wind energy, solar energy and biomass are the most prominent solutions to the above problems because they are eco-friendly and readily available in nature.

KEYWORDS:VAWT, HAWT, solidity, eccentric pump connection, reciprocating pump.

*** Godavari Institute of Engineering and Technology, Rajahmundry, Andhra Pradesh, India.**

1. INTRODUCTION

The wind is a clean and plentiful source of energy. Wind Power is the use of wind's force to generate some form of measurable power or work. Many developing nations are without feasible methods of obtaining clean, drinkable water. Obtaining water requires walking long distances or crossing through dangerous territory, and this is often riddled with disease. Additionally, clean water is needed for agricultural purposes to aid local hunter and to sell crops for economical advances .

Some methods of providing water to areas in need are by wells, water taps and water purifiers. Unfortunately, water purifiers can be more expensive and may not eliminate all pathogens, wells and water taps all require time and energy to transport the water to surface.

A wind pump is a windmill used for pumping water, either as a source of fresh water from wells. It is one of the oldest methods of harnessing the energy of the wind to pump water .

Most windmills for water-pumping applications are of the horizontal-axis variety, and have multi-bladed rotors that can supply the high torque required to initiate operation of a mechanical pump. Windmills can also be used to generate electricity, but electricity-generating units usually consist of vertical-axis rotors or high-speed propeller rotors, due to the requirement for low starting torques.

1.1 Definition

Wind: This is air in motion and it is a natural resource that is freely available in space and moves at varying speeds depending on the geographical location.

Wind energy: Wind energy originates from solar energy where the sun heats the atmosphere unevenly causing some parts to be warmer than others. The warmer patches of air rise and other air patches blow in to replace them. Thus alternating air flow which results in wind.

Windmill: Windmills are machines that are used to harness the kinetic energy of the wind which blows over the blades rotor assembly causing it to rotate on a shaft. The resulting shaft power is then used to provide mechanical work for pumping water.

1.2 Objective

Lifting the water without using electricity and fossil fuel. Setup must be nonpolluting and less noise operation. Setup cost should be less and maintenance free, one time investment is preferable. It must produce some amount of power. Installation must be easy and cheap. Fuel must be cheap, clean and renewable. Solution for the above problem must be eco- friendly.

2. LITERATURE REVIEW

G. M. Bragg¹ et al. [1978] performance matching and optimisation of wind powered water pump procedure is presented which allows optimum selection of pumps and windmills for a given water pumping situation. When information on the wind, pump characteristics and windmill characteristics is available, the best pump and windmill for the application may be selected, and the design and off-design performance of the complete system may be predicted. Roto-dynamic pump is used. Generally a pump of low specific speed has relatively low rpm. low flow rate and high head operate is best operating system.

Alfredsson² et al. [1980], reported a lower power coefficient for downscaled wind turbine models. In this research, influences of inflow turbulence intensity to the wind turbine performances and wake recovery were evaluated. An experimental study of the performance characteristics of a model wind turbine operating in the wake of another turbine of the same model using both laminar and turbulent flow was performed.

H. Makita³ et al. [1991], is capable of generating turbulent flow with high turbulence intensity in relatively small facilities. Following the same concept a similar system was built and installed in the low speed wind tunnel between the contraction and test section. The system allows the wind tunnel to create arbitrary velocity profile with controllable turbulence intensity. This system was built to generate turbulent inflow conditions similar to the atmospheric boundary layer.

Abdeen Mustafa Omer⁴ et al. [1997], Energy for water pumping in rural areas in Sudan, Mean wind speeds of 4 ms⁻¹ are available over 50% of Sudan, which suited for water lifting and intermittent power requirements, while there is one region in the eastern part of Sudan that has a wind speed of 6 ms⁻¹, which is suitable for power production.

Muhammad Mehtar Hussain⁵ et al. [2007] low cost windmill for ground water lifting the windmill actuated bore-well pumping unit consisting of a tall tower structure made of two

parallel bamboo posts supported by two inclined bamboo posts each. An iron shaft made from iron pipe is mounted on bearings near the top of the tower, ends of which rest on the parallel bamboo posts on either side. At the Centre of the shaft, a wind turbine with four blades is mounted. The shaft is connected to the hand pump handle on the ground through mechanical linkages (crank lever mechanism).

Ronit K. Singh⁶ et al., [2012], design and performance testing of a small wind turbine rotor for low wind speed applications, Turbine performing best at 18 degree pitch angle. Peak power coefficient attained by the 2-bladed rotor design at 6 m/s wind speed was 0.29.

Prasad S.S.⁷, et al. [2012], Optimized Design of Rotor Blade for a Wind Pump, Increasing the chord width or the number of blades may not necessarily result in higher CP on the other hand; a good combination of the blade parameters with lower chord width and fewer numbers of blades can result in higher CP. In the present case, a blade with 30mm chord at the tip and 500 mm chord at the root with 4 blades. and with twist varying from 8 degree at the tip to 32 degree at the root gives a CP of 0.43, which is the best for the rated wind speed and the diameter of the rotor..

Salih⁸ et al. [2015], mechanical and electrical performances of wind turbines are highly affected by wind characteristics. These affects have to be considered during the analysis of wind turbine performance.

Ronak D Gandhi⁹ , et al, [2015] Design and development of windmill operated water pump studying this paper we observe that blade length is proportional to swept area, for larger blade greater swept area, it will catch more wind they produce more torque. Here bevel gears are used to transfer power made of plastic material.

3 .FABRICATION OF WINDMILL

Simple 3D diagram is drawn by using the catia v5 software as shown in fig 1. Windmill having mainly 6 components as (1) Wind blade, (2)Hub with mild steel plates on circumference, (3)Shaft with eccentric connection plate at one end, (4) plain Bearings,(5)Reciprocatingpump,(6)Bodyframe.

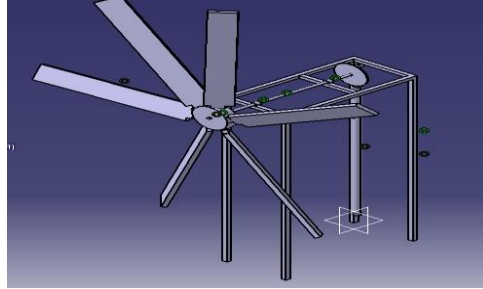


Fig1. 3D view of water pumping windmill

3.1. Blade :

Six blades of aluminium alloy. All the blades are of same dimensions. Dimensions are of length 70cm, width 13cm, thickness 2mm.



Fig2. Wind mill blades

3.2. Hub:



Fig3. Hub with mid steel plates on it

Hub of mild steel on which blades are attached. The hub is having the mild steel plates on the circumference of it which are used to connect the blades on the hub with the help of

3.3. Bearings :

There are 2 plain bearings are used. The bearings are made of 52000 chrome steel. There is low frictional loss between the shaft and bearing. The bearings are placed on the body frame and supported by it.



Fig4. Plain bearing with shaft in it

3.4.Body frame:

The frame which is made by seamless square pipes and are act as supporting body of the windmill.The dimensions are of height 140cm, length 80cm, width 40cm.

3.5.Assembly

An assembly line is a manufacturing process (most of the time called a progressive assembly) in which parts (usually interchangeable parts) are added as the semi-finished assembly moves from workstation to workstation where the parts are added in sequence until the final assembly is produced.

3.6.Piston and connector :

The piston which is kept inside the cylinder bore.The connector which used to connect and act as a link between eccentric plate and the piston plunger.These are made up of cast iron material.The dimensions are piston diameter of 1inch and connector is 10mm.



Fig5. Connecting rod

3.7.Connect the shaft with eccentric plate:

The eccentric plate is connected at the end of the shaft and at another end the hub is placed using bolting. The eccentric plate is attached by welding process on shaft.



Fig 6.shaft with eccentric plate

3.8. Bolts

These bolts are used to attach the blades to the hub and also for connecting the connector. All the bolts are of same dimensions. Bolts are made up of carbon steel. The dimensions of the bolt are 8mm dia.



Fig7. Bolts

3.9. Connect the eccentric plate and pump using connector:



Fig8. Eccentric plate with piston pump

The connector is used to link the eccentric plate and the pump using bolting. The connector should not be tight more with bolts because it should be rotate.

3.10. Set Outlet In Cylinder

Cylinder is connected with the pipe. It is made of mild steel.



Fig 9. Pump with plunger

3.11. Assembled parts in different views:

The hub, blades, eccentric plate, pump, body frame etc.,



Fig10. Side view of windmill



Fig11. Top view of windmill

3.12.Final assembly:

The complete view of the windmill with all the components. This is the fabricated windmill which was designed in the catia software.



Fig 12. Final assembly

4.EXPERIMENTATION

4.1.How Blades Work:-

The wind imposes two driving forces on the blades of a turbine; lift and drag. A force is produced when the wind on the leeward side of the airfoil must travel a greater distance than that on the windward side. The wind travelling on the windward side must travel at a greater speed than the wind travelling along the leeward side. This difference in velocity creates a pressure differential. On the leeward side, a low pressure area is created, pulling the airfoil in that direction. This is known as the Bernoulli's Principle.

4.2. How Wind-Mill Work:

A water pump operates on reciprocating motion -- up and down pushing and pulling on a piston which draws water up out of the well. In addition, there is a one-way valve to keep the water flowing back into the well. A windmill generates rotary motion by turning a shaft. The speed of the turning can be adjusted by using gears of different sizes. To turn the rotary motion of a shaft into reciprocating motion, a slider crank mechanism is used. A link is attached perpendicular to the rotating shaft, and another rod is attached vertically from the edge of the wheel to the pump down below. Because the center of the wheel does not move but the edge goes round and round, the rod will be pulled up and down.

4.3.Design procedure:

The designing of rotor of this small wind turbine is based on the following steps. These are the steps involved in the rotor design.

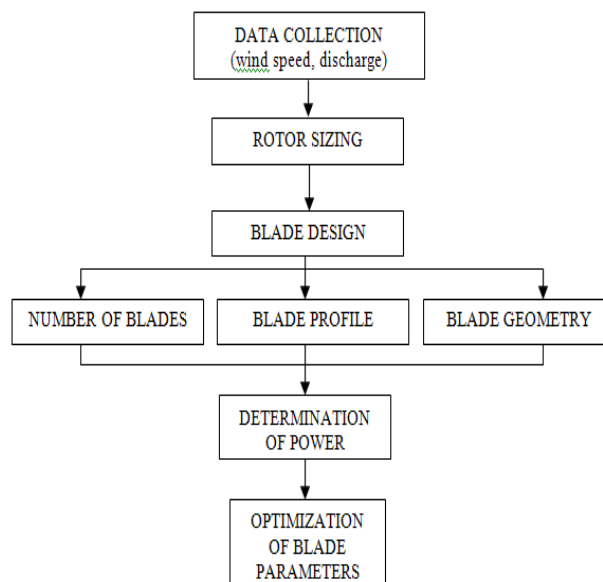


Fig 13.Design procedure

4.4.Measuring devices:

4.4.1.Tachometer :

This is used to find out the RPM of the wind blades rotation.



Fig 14. Tachometer

4.4.2. Wind speed meter Anemometer app:

This is used to find the velocity of the air, In this experiment there is no anemometer available, so instead of anemometer we used one application in mobile to find out the wind speed.

4.4.3. Measuring jar:

The measuring jar is used for finding the discharge of water at the outlet. This jar contains the accuracy of 5ml.



Fig15. Measuring jar

4.5. L shape bend for water outlet:

This is welded to the pump surface which is used to flush the water which is sucked by the water pump. The size of the L bend is 15cm dia.

4.6. Experiment setup and readings:

For the experiment to take readings the windmill is placed on terras for exposure to wind. The values noted are wind speed , RPM, discharge are measured. By using the above measuring devices we took the readings, the experiment was done at different wind speeds.

5. RESULTS AND DISCUSSION

5.1. Power Required To Pump Water

$P = \rho ghQ$, Density of water = 1000kg/m³, $g = 9.8\text{m/s}^2$, Head of water= 5 feet

$h = \text{head of water} = 2\text{m}$, $Q = 0.0002315\text{m}^3/\text{s}$, $P = 1000 \times 9.8 \times 2 \times 0.0002315$, $P = 4.5 \text{ watt}$

5.2 Power Required To Drive Pump

Efficiency = 90%, Efficiency = (output/input)*100, Input = $(4.5/90) \times 100 = 5 \text{ watt}$

This is power required to drive pump.

5.3. Power Required Rotor To Shaft

Rotor to shaft efficiency is 95%., Input = $(5/95) \times 100$, Input = 5.6 watt

5.4. Power Required To Drive Windmill

Efficiency of windmill = 60, Input= $(5.6/60) \times 100 = 9.3 \text{ watt}$

5.5. Discharge:

$Q = V/t$, $Q = A d/t$, [A is the cross sectional area of a section of pipe], $A = \pi r^2$

$r = 0.0015\text{m}$, $\pi = 3.14$, $d/t = 0.0021 \text{ m/s}$, $\pi r^2 = 0.19625$

$Q = A v = \pi r^2 v$, $Q = 0.19625 \times 0.0021$, $Q = 0.0000412125 \text{ m}^3/\text{s}$

6. EXPERIMENTAL VALUES:

Table1. Result table of Performance test of fabricated wind mill

Avg Velocity (m/sec)	Speed (rpm)	Discharge (ml/min)	Time (sec)
3.7	32	60	60
4.1	38	75	60
4.6	42	85	60
5.4	48	110	60
3.9	36	65	60

GRAPHS:

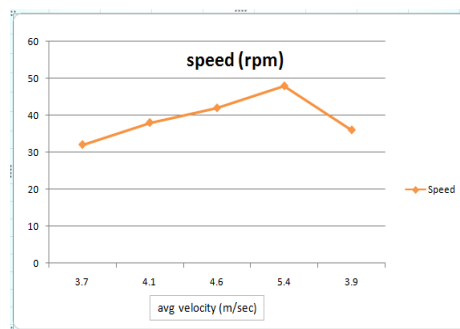


Fig16. Avg velocity vs speed

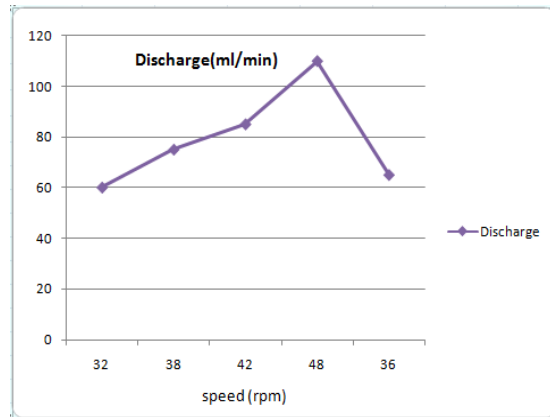


Fig17.Speed vs discharge

7.CONCLUSION:

Our work is to show that the horizontal axis wind energy conversion system are practical and potentially very contributive. Thus we have used our new design of wind turbine to pump out water. This will provide liters of water for drinking purpose. At the low wind velocity in the range below 4 m/s, the discharge is not so much effective, how ever with increased speed of wind energy considerably enhanced to the rate of v^3 , therefore discharge becomes high.

After comparing all the performance evaluation test values, it can be concluded from the results obtained from graphs that as the wind speed increases the water discharge also increases.

All materials used are locally available and at a low cost making the model economically viable.

8.SCOPE FOR FUTURE WORK:

Efficiency or power output of pump can be improved by optimizing blade parameters such as blade thickness , blade length , blade profile, number of blades etc. By keeping solar panels to rotate the wind mill we can pump easily where no power consumption is required to pump the water. Efficiency or power output of pump can be improved by changing the gear dimensions and slider crank mechanism.

REFERENCES:

- [1] G. M. Bragg, W.L. Schmidt: Performance matching and Optimization of Wind Power Waterpump ; 1978..
- [2] Alfredsson, P. H., F. H. Bark, and J. A. Dahlberg,: Some properties of the wake behind horizontal axis wind turbines. Proc. Third Int. Symp on Wind Energy Systems, Lyngby, Denmark, BHRA Fluid Engineering, 46.1980
- [3] H. Makita and K. Sassa. Active Turbulence Generation in a Laboratory Wind Tunnel. Advances in Turbulence 3, 1991, pp 497-505.
- [4] Abdeenmustafaomer compilation and evaluation of solar and wind energy resources in Sudan. Renewable energy ,12; 39. 1997
- [5] MuhammadMehtarHussain and Mushtaq Ahmad. Low cost wind mill for ground water lifting.Indian Institute of Technology Guwahati,2007
- [6] Ronit K. Singh, M. Rafiuddin Ahmed: Blade design and performance testing of a small wind turbine rotor for low wind speed applications Division of Mechanical Engineering, The University of the South Pacific,Laucala,2012.
- [7] Prasad S.S, VirupaxiAuradi, Optimized Design of Rotor Blade for a Wind Pump, International Journal of Renewable Energy Research, volume 2, number 4, 2012.
- [8] Salih Mohammed Salih, Mohammed QasimTaha and Mohammed K. Alawsaj: Performance analysis of wind turbine systems under different parameters effect, College of Engineering, University of Anbar, Iraq. 902. 2015
- [9] Ronak D Gandhi, PramodKothmir .Design and development of Windmill Operated Water Pump.pune university.2015