International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

HYBRID-SOLAR AND WIND MILL OPERATED WATER PUMP

Prathamesh D. Dalvi[1], Dheeraj P. Dhokale[2], Dhiraj B. Gondkar[3], Rajat R. Kadam[4], Ayub.A.Tamboli[5]

[1234]Student,Department of Mechanical Engineering
JSPM's Padmabhooshan Vasantdada Patil Institute of Technology,Bavdhan,Pune,Maharashtra,India
[5]Associate Professor,Department of Mechanical Engineering
JSPM's Padmabhooshan Vasantdada Patil Institute of Technology,Bavdhan,Pune,Maharashtra,India

---

Abstract – As we see there is enough wind and solar energy globally to satisfy as much as humanity's energy requirements. Vertical axis wind turbines (VAWT) may as efficient as current horizontal axis system, might be practical and significantly cheaper to build and maintain than horizontal axis wind turbine (HAWT). They have other original advantages, like they are always facing the wind, which might make them a significant player in our daily routine for low cost, cleaner renewable sources of lifting water. The growing popularity of solar wind pumps in many rural areas, these areas typically have no access to electricity or shortage of electricity, which creates a problem when it comes to irrigation and watering livestock. VAWT's might even critical in mitigating grid interconnect stability and reliability issue currently facing electricity producers and pump the water from suppliers. Additionally cheap VAWT's may provide an alternative to the rain forest destruction for the growing of bio-fuel crops.

In this project we attempt to design and fabricate a Savonius water pumping Vertical Axis Wind Turbine. And also we make our model hybrid- solar and wind mill operated water pump. The solar energy gained by the solar panel and convert that electrical energy into mechanical energy which causes to rotate the shaft which is connected to crank plate. The circular motion of crank plate uses to lift the water as it converted in up and down motion using crank mechanism.

Key Words: **Pump, Water, Turbine, Wind, Blades, Air, Solar**

1. Introduction

A water pump operates on reciprocating motion -- up and down pushing and pulling on a piston which draws water up out Pumping water was one of the first and most important uses for windmills. And using the energy for turning a millstone to grind grain is also important. And the solar plate which is mounted near to the wind turbines creates an electrical energy in the form of DC current and transfer it to invertor. Invertor is an electronic device that changes 'Direct current (DC)' to 'Alternating current (AC)'. Invertor give the current to battery and the DC motor via transmission lines. The DC motor convert electrical energy into the mechanical (rotational) energy and give it to the main shaft which is connected to the crank mechanism. Presently windmills are mostly used for the generation of electricity, grinding grain or pumping water. There's one in a park just south of the University of Illinois here that pumps water of the well. In addition, there is a one-way valve to keep the water from flowing back into the well when the pump makes a return stroke.

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. These days, you can generate electricity with a windmill and Solar plate and connect that to an electric water pump.

1.1 Objective

The objective of this project is to design and build a self-starting vertical axis wind turbine and solar operated DC motor that is capable of pumping water in real world situations. The design of the turbine will include exploration of various self-starting options, as well as construction of both model and full-scale turbines. The full-scale turbine will be designed such that power created by motor and it can be connected to the pump by slider crank mechanism the rotational speed of the turbine which converts up and down speed or vertical speed by pump. The project objective is to give data collection regarding the effects of blade pitch angles. By using vertical wind axis turbine and DC motor power the pumping efficiency is increases.

2. Wind Turbine

A device that extracts energy from the wind is called as wind turbine. The energy gained from the wind is used for machining purposes such as cutting lumber or grinding stones, the machine is called a windmill, also it is used for pumping water called as wind pump. Wind turbines divided in two types:

a. Horizontal axis wind turbine
b. Vertical axis wind turbine

Table: Inputs

Undisturbed Wind Speed	6-15 m/s
Density of air	1.204 kg/m3
Viscosity of air	1.81E-05 Ns/m2
TSR	4
Solidity	0.15
Number of Airfoils	8
Blade Height	700mm

Table-1: Wind Specification

The dimensions for the VAWT being built for this project are given above. The turbine plate is 300mm diameter and 8mm thick and the PVC pipe are having dimension are shows in following table. This design selection provides an increased Reynolds number for the flow over the blades, and subsequently, increases the lift. Also, given the large thrust forces involved, a shorter airfoil length will be less likely to undergo bend.

2.1Wind Turbine/Blades Design

P =1/2 ρAu3

Where,

P =Power of wind (W)

A =Area of wind segment being considered (m2)

u = undisturbed wind speed (m/s)

ρ= air density in (kg/m3)

At standard temperature & pressure (STP =273K and 101.235KPa), equation reduces to:-

P =0.674ρAu3

Power of the wind

Area A = L x w = 0.7 x 0.1 = 0.07 m2

Pw = 0.647 x 0.08428x 53

= 7.077 W

A Turbine cannot extract 100% wind energy because some of the wind energy is in because some of the wind energy is used in pressure changes across the turbine blade. This decrease in velocity causes the pressure change and there usable energy. The mechanical power that can be obtained from the wind with a ideal turbine given as.

Pm = 1/2 x 0.7 x (16/27) x 0.1 x 53

= 2.59 W

In equation, A area is referred as the swept area of the turbine .For VAWT this area depends on the turbine diameter and turbine blade length. For an vertical axis wind turbine equation of swept area is

As = 0.750 x 1.125 =0.8375 m7.65625 = Cp x 13.647656

Cp = 0.56

Geometric definition:

Between the many factors that affect the aerodynamic factor , behavior of the rotor that important role is played by its solidity ,defined as

Where 'N' is a blade number, [-], c is a blade chord [m] and is rotor radius [m]

= 8 x 0.15 x 0.375 (8 is qty. of blades)

= 0.45

According to graph TSR = 5 for 0.45 solidity

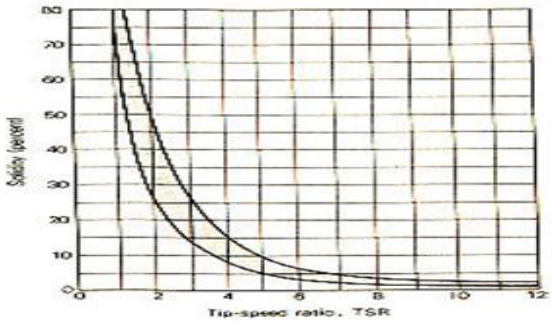

Chart -1: Rotary solidity as function of TSR

3. Solar Plate

Solar panel absorb the sun's ray as a source of energy for generating electricity. A photovoltaic (PV) module is a packaged, connect assembly of typically 6x10 photovoltaic solar cells. PV modules generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under Standard Test Conditions (STC) and typically ranges from 100 to 365 Watts (W). The efficiency of a module determines the area of module given the same rated output.

3.1 Construction

Photovoltaic modules use the light energy (Photons) from the Sun to generate electricity through the photovoltaic effect. The majority of modules use water-based crystalline silicon cells or thin-film cells. Solar plate should be protected from mechanical damage and moisture. Modules electrical connections are made in series to achieve desired output voltage.

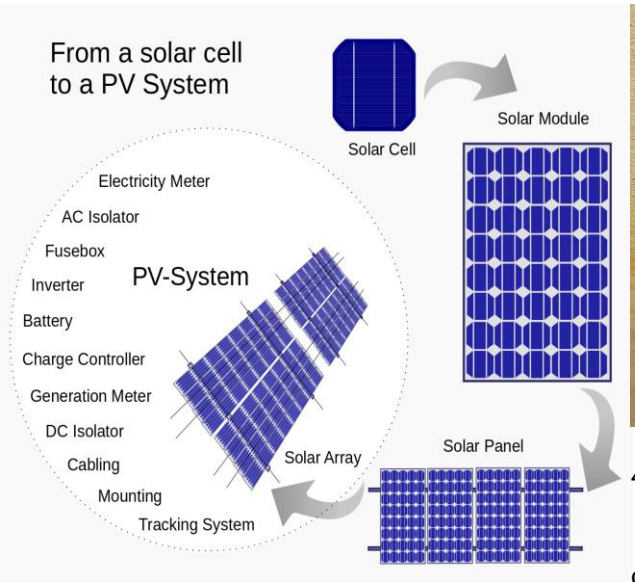

Fig-1: Construction of solar panel

3.2 Maintenance

Solar panel conversion efficiency is in the range of 20% and cause of reduction in efficiency is by dust, pollen etc. A dirty solar panel can reduce its power capabilities by up to 30% in high dust or desert areas.

4. Operation

4.1 How Turbine Works

Wind power uses the same concepts all most other energy sources, using some force to turn a turbine. The turbine will then transfer its energy into a pump where pumping of water will be done. The force to turn the turbine in wind energy comes from wind.

Traditionally, wind power could only be harnessed in high speed wind locations, where wind is annually over 13mph, but due to new technology and increased efficiency in pump, even lower speed winds can produce cost efficient wind power.

The wind imposes two driving forces on the blades of a turbine; lift and drag. A force is produced when the wind on the downwind side of the airfoil must travel a greater distance than that on the windward side. The wind traveling on the windward side must travel at a greater speed than the wind traveling along the downwind 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. Lift and drag are the components of this force vector perpendicular to and parallel to the apparent or relative wind, respectively. By increasing the angle of attack, as shown in figure 1, the distance that the downwind air travels is increased. This increases the velocity of the downwind air and subsequently the lift. The Bernoulli Principle is illustrated in figure 1

Fig -2: Project setup

4.2 How Wind Water Pump Works

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 circular 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 (and a little bit to the side and back each time, so you'll need a hinge joint when connecting the rod to the water pump's piston).

4.3 How Solar Panel Operated Dc motor Works

As we see previously the solar panel creates the electrical energy using the rays of Sun, panel produces DC current which is converted to AC current by using invertor. DC motor require a stable power supply, which can only be achieved by installing some sub-systems into the overall motor system. The invertor transmits the AC power to battery and stores it in battery. This energy is then used for running DC motor which is further connected to the shaft. The shaft is connected to the crank mechanism which is use for pumping the water.

4.4 Output of Solar Panel

The photons produce an electrical current as they strike the surface of the thin silicon wafers. A single solar cell produces only about ½(0.5) of a volt. However a typical 12 volt panel about 25x54 inches will contain 36 cells wired in series to produce about 17 volts peak output

5. Observations (Analysis)

5.1Observation table for Wind turbine:

Sr. No.	Discharge(v) m^3	Wind speed(u) m/s	Time(t) Sec
1.	1000	8	35
2.	1000	10	31

5.2 Observation table for Solar +Wind turbine

Sr. No.	Discharge (v) m3	Motor Rotations (N) RPM	Wind Speed (u) m/s	Time (t) Sec
1.	1000	120	8	32
2.	1000	120	10	28

6. Conclusion

The first part of the design process, which included research, engineering analysis, and turbine design selection was completed during the fall term. While preparing mechanism for this project we had applied knowledge of Machine Design, Newton's law, Theory of Machine. Furthermore we understand fabrication procedure that we have learnt in Production Technology. We had come across the various machines like welding, grinding, cutting, drilling Complications. The initial research and analysis portion of the project provided.

From the given data it is clear that rotary motion of the turbine and rotary power given by motor converted into the reciprocating motion of the single acting piston rod of pump. By the use of variable speed gear box, the reciprocating speed can be varied. That ultimately gives the variable discharge as per the requirement of the user.

Acknowledgement

We take this opportunity to thanks to the teachers and our guide whose constant encouragement made it possible for us to take up challenge doing this project. We express our deepest gratitude towards our honourable head of the department, Dr. R. K. Kulkarni for his constant encouragement for this work.

We are grateful to Prof. A. A. Tamboli sir his technical support, valuable guidance, encouragement and consistent help. He is constant source of inspiration and information for us.

Last but not least, we are thankful to our entire staff of mechanical department for their timely help and guidance at various stages of the project.

REFERENCES

1) Ulanoff, L. elon Musk and SolarCity unveil 'world's most efficient' solar panel, Mashable, 2 October 2015, accessed 28 June 2016.
2) Milestone in solar cell efficiency achieved: New record for unfocused sunlight edges closer to theoretic limits. Wilson da Silva. Science Daily. 17 May 2016.
3) U.S. Department of Energy. "Wind and Hydropower Technologies Program".
EarthLink (2005). "See how it Flies – A new spin on the perceptions, procedures,
And principles of flight." Retrieved from
4) Chang, Professor L. (2005) "Advanced Topics in Environmental Engineering -
Wind Power," Ch. 4. University of New Brunswick. Retrieved from
5) Kirke, Brian Kinloch, 1998. "Evaluation of Self-Starting Vertical Axis Wind
Turbines for Stand-Alone Applications". Griffith University, Australia.
6) Pawsey, N.C.K., 2002. "Development and Evaluation of Passive Variable-Pitch
Vertical Axis Wind Turbines", School of Mechanical and Manufacturing
Engineering, The University of South Wales, Australia.
7) Gipe, Paul, 2004. "Wind Power," Chelsea Green Publishing Company, Page 97