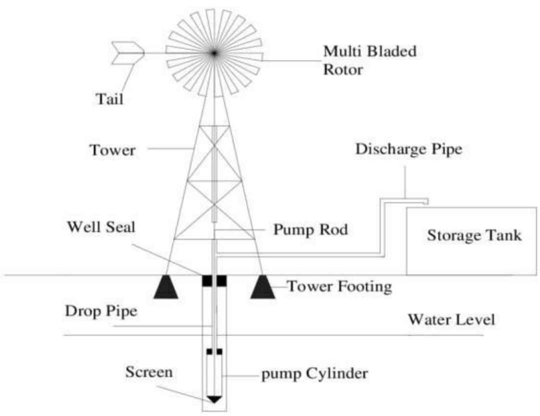
Design and Fabrication of Water Pumping Mechanism using Wind Energy

N Dinesh[1], B. Naveen Kumar[2], L. Thillai Abimanyu[2], P. Vignesh[2]
[1]Assistant Professor, [2]UG scholar
Department of Mechanical Engineering,
Hindusthan Institute of Technology,
Coimbatore -641032.

***Abstract* : - Water is the primary source of life for mankind and one of the most basic necessities for rural development. Most of the rural areas do not have access to potable water. In some regions of the country access potable water is available through use of manual pumping and Diesel engine. The aim of the project is to provide water pumping facility which can be used instead of electrical pump in order to lift water to tanks for irrigation. It is achieved by using windmill water pump which use renewable wind energy, and preserve the environment. An economic comparison is conducted, on the basis of cost analysis, for wind mill and Diesel water pumping systems and the results shows that windmill water pumping systems are more feasible than diesel based systems.**



1. INTRODUCTION

Wind power technology dates back many centuries. There are historical claims that wind machines which harness the power of the wind date back to the time of the ancient Egyptians. By the late part of the 17th century, the typical "European Windmill" became established and this became the norm until further developments were introduced during the 18th century. The major advances in the design of the wind pump, however, took place in the USA. By the 1920's, 6 million wind pumps were being used in the USA alone and their manufacture and use became commonplace on every continent.

Water is the primary source of life for mankind and one of the most basic necessities for rural development. The rural demand of water for domestic and crop irrigation supplies is increasing. People living in rural areas of use different water sources for their domestic purpose, such as spring, pond, ground, etc.

Therefore, mechanized water pumping system will be the only reliable alternative for lifting water from the ground. Diesel, gasoline and kerosene pumps including windmills have traditionally been used to pump water. However, reliable solar photovoltaic (PV) and wind turbine pumps are now emerging on the market and are rapidly becoming more attractive than the traditional power sources. In addition, nowadays, with regular fuel crises and rising prices there has been a revival of interest in wind pump technology.

2. LITERATURE REVIEW

Need of renewable way of water pumping .It has been reported that an annual total water pumping capacity of 30,000 m*3 is possible from a depth of a total dynamic head of 50 m by using wind turbines 2.5 kW of capacity. Renewable energy sources are being used in a wide range of applications including water pumping for rural irrigation all over the world.

A brief account of the usage of water pumping using wind energy.

Wind has been in use by the mankind for thousands of years. Its usage can be traced back from the medieval times. Around 3000 years, wind was mostly used for pumping water and grinding grains. In earlier times, fossil fuels were significant source of producing electricity. Fossil fuels posed serious damaging effects on the environment and people were exploring for alternative resource. Wind energy was cheapest, widely available, and renewable and posed minimal damaging effects on the environment. This raised the interest and attention towards wind energy. Government institutions funded the research in wind technology to be adopted as the mainstream source of power production in the world. Scientists and researchers successfully designed several wind turbine prototypes which worked really well with the site conditions. By the late nineteenth century, wind energy was in operation to produce electricity. Later, this technology was enlarged and utilized as onshore wind energy. Latest developments and some risks involved in the onshore wind energy has evolved the offshore wind technology. Offshore wind energy is more sophisticated and capable of producing more power than its predecessor. Now- a-days, wind energy has become more reliable source of power. It is one of the fastest growing sources of electricity which is believed to have the potential to meet the electricity demands around the world.

3. BASIC PRINCIPLE

Windmill water pump uses wind energy to lift water by using translation motion of wind to rotate the blades which is connected to the rotor with gear that transfer the rotation motion of windmill to reciprocating motion on crank shaft that act on reciprocating pump to lift water.

4. COMPONENTS

1. Mild Steel Frame
2. Pneumatic cylinder
3. Rotor blade
4. Slider crank disc
5. Shaft
6. Connecting rod

MildSteel pipes:

The frame is made from MS steel tubing. Two types of materials are used so as to increase the overall efficiencyof the system. The steel used in making the main frame has more thickness than the material used for the middle section of the frame, so as to support the total load on the vehicle. The dimensions are as follows.

1) 20mm*20mm*0.8mm – GP steel tube
2) 20mm*20mm*1.5mm – L bar

Pneumatic cylinder:

Pneumatic cylinders impart a force by converting the potential energy of compressed gas into kinetic energy. This is achieved by the compressed gas being able to expand, without external energy input, which itself occurs due to the pressure gradient established by the compressed gas being at a greater pressure than the atmospheric pressure. This air expansion forces a piston to move in the desired direction. Pneumatic cylinders can be moved both inwards and outwards by compressed air. Cylinders of this type are called double-action Cylinders.

Fig. Pneumatic cylinder

Cylinders also exist which can only be moved pneumatically in one direction. The return movement is caused by a spring. Cylinders of this type are called "single-action cylinders". The compressor cylinder is a single-action cylinder. In order to move a cylinder in both directions, two of the valves contained in the kit are required. To move the cylinder outwards, valve V1 must be open (the coil is supplied with electric current) and valve V2 closed (no current flowing).To move the cylinder inwards, valve V2 is open and valve V1 closed. The diagram also makes it clear why vent "R" on the valve is required. Without this vent, the cylinder would be unable to move as the same pressure would be exerted on both sides of the piston and the air would not be able to escape. The pneumatic system uses manually or electrically operated valves to control direction of movement. Directional control valves can be operated by hand lever or electric solenoid to maintain an adjustable travel rate. The internal porting or spool of the directional control valve regulates airflow.

To extend the cylinder piston, air flows into the directional valve pressure port, through the flow control valve, and into the cylinder. As pressure builds in one end of the cylinder and the rod starts to extend, air exhausts out the opposite end of the cylinder. The flow control valve on the end of the cylinder restricts exiting airflow, which builds pressure to slow rod movement.

The exhausting air passes through the flow control valve and the directional control valve located at the end of the cylinder and exhausts to the atmosphere. When the cylinder retracts, the flow control valve at the end of the cylinder controls the flow, and the first valve allows air freely through. Some cylinders have a cushion on one or both ends of travel. This cushion is a flow control valve that does not operate until the cylinder piston reaches a certain point in the cylinder. Then, the cushion restricts airflow to slow the cylinder movement. This allows it to move to the end of its travel at a slower speed. This adjustment is normally on the end of the cylinder head. See the air piping schematic to see what specific controls are provided with this equipment. Because pneumatic systems always contain moisture from the air, the system should not be allowed to freeze. Freezing can damage the seals and control surfaces, allowing air leakage past valves, or locking a valve from operating. Check valves may be inserted in the line to be sure the cylinder will stay in the desired position and not drift. This is useful in case some part is leaking, or there is a loss of air pressure inthe plant system.

Rotor blade:

Rotor blades are the most important in a windmill powered water pump assembly as it captures wind. A cup shaped PVC septic pipe material which proved to be helpful for generation of mechanical work leading to the generation of water pump. It has high corrosion resistance and abrasion resistance properties which proved for working of windmill blade in adverse environmental conditions with high wind speeds.

Rotor blades of wind turbines are subject to fatigue loads due to service loads and natural fluctuations in wind speed. This causes the risk of crack initiation in the adhesive layers which are used to bond the fibre composite parts of the rotor blade. Cracks may

Fig. RotorBlade

grow as the number of stress cycles increases, which can ultimately result in failure of the whole rotor blade. The need for higher efficiency of modern wind turbines leads to a persistent weight reduction, which in turn means that the rotor blades become longer and the slenderness ratio increases. This causes higher loads in the adhesive joints which increases the risk of crack formation.

Rotor blades are the most important parts of a wind turbine in terms of performance and cost of the wind power system. The shape of the rotor blades has a direct impact on performance as this decides the conversion of kinetic energy associated with the wind to mechanical energy (torque). In these types of wind turbines, the blades are designed to have a high lift to drag ratio, based on aerodynamic principles. The number of blades is selected for aerodynamic efficiency, component costs, and system reliability. Theoretically, an infinite number of blades of zero width are the most efficient, operating at a high value of tip speed ratio. But other considerations such as manufacturing, reliability, performance, and cost restrict wind turbines to only a few blades. The majority of wind turbines are the horizontal axis type with three blades. The turbine blades must have low inertial and good mechanical strength for durable and reliable operation.The slider crank disc is connected to the shaft at one end and the other end of the slider crank disc is connected to the actuator by means of a connecting rod. The slider crank disc converts rotary motion of the windmill to reciprocating motion.

Ball bearing:

A wide range of bearings perform different functions throughout a wind turbine. For instance: Spherical roller bearings are typically found in the pitch and yaw locations of a turbine and help ensure that the blades rotate smoothly. As long as proper maintenance procedures are observed, they do not usually experience many problems besides normal wear and tear over time.

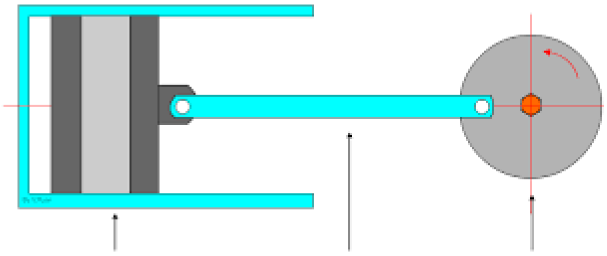


Fig. Slider crank disc

An in-line crank slider is oriented in a way in which the pivot point of the crank is coincident with the axis of the linear movement. The follower arm, which is the link that connects the crank arm to the slider, connects to a pin in the centre of sliding object. This pin is considered to be on the linear movement axis. Therefore, to be considered an in-line crank slider, the pivot point of the crank arm must be in-line with this pin point.

With an in- line crank slider, the motion of the crank and follower links is symmetric about the sliding axis. This means that the crank angle required to execute a forward stroke is equivalent to the angle required to perform a reverse stroke. For this reason, the in- line slider-crank mechanism produces balanced motion. This balanced motion implies other ideas as well. Assuming the crank arm is driven at a constant velocity, the time it takes to perform a forward stroke is equal to the time it takes to perform a reverse stroke.

Shaft:

A wind turbine's main shaft arrangement is part of a geared, hybrid, or direct drive design. Whatever the arrangement, it must withstand axial and radial loads and operate under harsh, continuously changing conditions.

Wind turbine main shaft bearings spin at relatively low speeds. Also, they experience continually variable loads. In offshore applications, turbine Bearings may be exposed to corrosive seawater. The high cost, and technical difficulty, of replacing them means that operators want them to last for the turbine's full operating life.

A connecting rod, also called a con rod, is the part of a piston engine which connects the piston to the crankshaft. Together with the crank, the connecting rod converts the reciprocating motion of the piston into the rotation of the crankshaft. The connecting rod is required to transmit the compressive and tensile forces from the piston, and rotate at both ends.

The predecessor to the connecting rod is a mechanic linkage used by water mills to convert rotating motion of the water wheel into reciprocating motion.

Fig. Ball bearing

Connecting rod:

Fig. Connecting rod

5. WORKING PRINCIPLE

To construct a wind pump, the bladed rotor needs to be matched to the pump. With non-electric wind pumps, high solidity rotors are best used in conjunction with positive displacement (piston) pumps, because single-acting piston pumps need about three times as much torque to start them as to keep them going. Low solidity rotors, on the other hand, are best used with centrifugal pumps, water ladder pumps and chain and washer pumps, where the torque needed by the pump for starting is less than that needed for running at design speed. Low solidity rotors are best used if they are intended to drive an electricity generator; which in turn can drive the pump. Windmill water pump uses wind energy to lift water by using translation motion of wind to rotate the blades which is connected to the rotor with gear that transfer the rotation motion of windmill to reciprocating motion on crank shaft that act on reciprocating pump to lift water.

Fig. Fabricated Project

6. CONCLUSION

This research work has revealed that there are multiple suitable locations where this system can be installed. Wind pumps not only save the environment by limiting the use of fossil fuels but also meet the water needs at both commercial and domestic levels. More technological innovations and automation in the field of wind powered water pumping can lead to more efficient and reliable system.

7. REFERENCE

[1] Abdul R Beig, S.M Muyeen. Electric renewable energy resources.2016.
[2] C. Nagel, M. Brede. Adhesives in engineering.2012
[3] Len Calderone. Water management. 2000
[4] Renewable and Sustainable Energy Reviews Volume 25, September 2013, Pages 351-370
[5] Website link https://www.alternative-energy-
[6] tutorials.com/energy-articles/wind-water- pumping.html
[7] https://en.m.wikipedia.org/wiki/Windpump