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Fabrication of Windmill Reciprocating Water Pumping System

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***Abstract* – Since 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. Water supplies such as wells and dugouts can often be developed on the open range. However, the availability of power supplies on the open range is often limited, so some alternate form of energy is required to convey water from the source to a point of consumption. Wind energy is an abundant source of renewable energy that can be exploited. For pumping water in remote locations, windmills are one of the methods of harnessing the energy of the wind to pump water. The Goal is to build a windmill driven water pump and to design a small scale irrigation system. The windmill drives a pump that pumps water from a source for use in irrigation.**

***Keywords* – Fabrication of Windmill, Energy, Water Pumping.**

I. INTRODUCTION

Every one of us will need of some kind of water source for drinking, bathing, washing clothes, preparing food and for irrigation. We may get the water from various sources like, lake, river, ponds, open well, bore well. So we have to pump the water from the source and use the water for the various purposes. Agriculture, an important sector of our economy accounts for 14 per cent of the nation's GDP and about 11 per cent of its exports. India has the second largest arable land base (159.7 million hectares) after US and largest gross irrigated area (88 million hectares) in the world. Rice, wheat, cotton, oilseeds, jute, tea, sugarcane, milk and potatoes are the major agricultural commodities produced. More importantly, over 60 per cent of the country's population, comprising several million small farming households depends on agriculture as a principal income source and land continues to be the main asset for livelihood security.

After Independence, India followed an agricultural development strategy that focused on self-sufficiency in staple foods like wheat and rice. Agrarian reforms were undertaken in the form of consolidation of holdings, abolition of landlordism etc. However, for most part of the country, these reforms have remained just in paper thus not ensuring equitable distribution of land.

"Policy support, production strategies, public investments in infrastructure, research and extension for crop, livestock have significantly helped to increase food production and its availability." (Agriculture Policy: Vision 2020, IARI, New Delhi). Our food grain production more than doubled from 102 million tons in 1973 to 247.6 million tons in 2012-13. Most of it can be traced to productivity gains and not so much to increase in cultivated area. However, production gains from green revolution technologies could not sustain beyond the mid-1980s. Even now, average yields of most crops in India are rather low. After an initial thrust the public sector investment in agriculture decelerated considerably. Planned outlay in agriculture and allied activities declined from 14.9 per cent in the 1st plan to 5.2 per cent by the 10th plan. The state's thrust in India's agriculture was on enhancing production of a few commodities like rice and wheat in specific regions much to the detriment of rain fed dry areas which account for nearly three-fifths of the net sown area and where most of the poor farmers reside. This led to regional imbalances. Growth in non-farm employment was limited except in certain pockets like Punjab. The availability of food grain per person has increased only marginally and over 25 per cent children suffer from serious malnutrition. In addition the marginalization of land holdings continued with 63 per cent of holdings being below 1 hectare as per the agricultural census of 2000-01.

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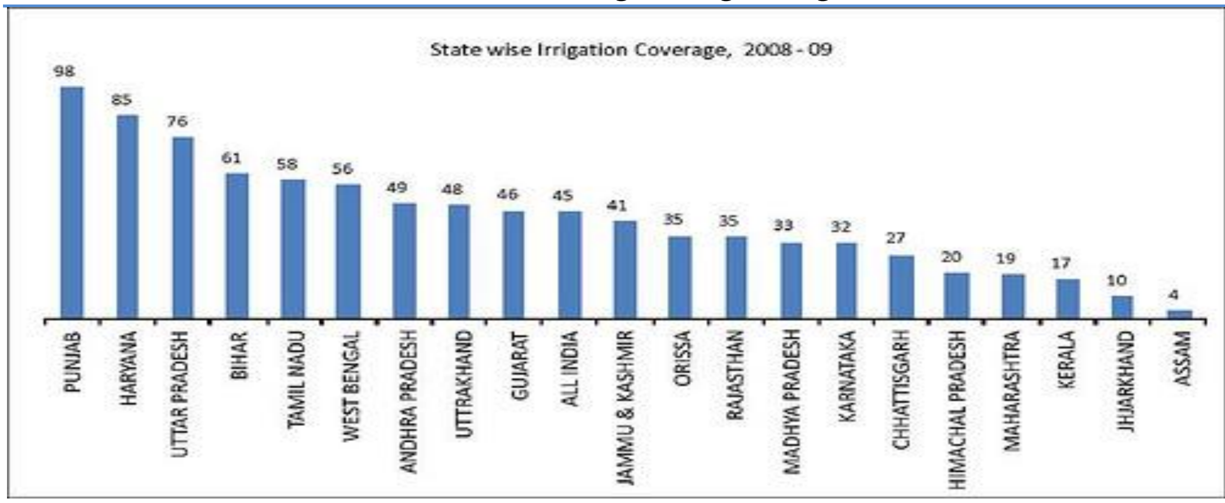

Fig. 1.1. Source: State of Indian Agriculture (2011-2012 Report)

II. Literature Survey

Windmills were already in use to pump the water out, Simon Stevin suggested improvements, including the idea that the wheels should move slowly, and a better system for meshing of the gear teeth. These improvements increased the efficiency of the windmills used to pump water out of the polders by three times. He received a patent on his innovation in 1586.

The nature of my invention consists in having the wings or sails attached to movable or rotating spindles having levers or equivalent devices connected to them, said levers or equivalents being also connected to a head which rotates with the wings or sails and upon the same shaft, the head having a lever connected to it, which is operated by a governor which slides the head upon the shaft and causes the levers or their equivalents to turn the wings or sails so as to present a proper resisting-surface to the wind, and thereby produce a uniform velocity of the Wings or sails, which are made to have a greater or less Obliquity, according to the velocity of the wind. [1]

Early immigrants to the New World brought with them the technology of windmills from Europe. On US farms, particularly on the Great Plains, wind pumps were used to pump water from farm wells for cattle. In California and some other states, the windmill was part of a self-contained domestic water system, including a hand-dug well and a redwood water tower supporting a redwood tank and enclosed by redwood siding (tank house). The self-regulating farm wind pump was invented by Daniel Halladay in 1854 eventually, steel blades and steel towers replaced wooden construction, and at their peak in 1930, an estimated 600,000 units were in use, with capacity equivalent to 150 megawatts. Very large lighter wind pumps in Australia directly crank the pump with the rotor of the windmill. Extra back gearing between small rotors for high wind areas and the pump crank prevents trying to push the pump rods down on the down stroke faster than they can fall by gravity. Otherwise pumping too fast leads to the pump rods buckling, making the seal of the stuffing box leak and wearing through the wall so all output is lost.

Fig. 2.1. Self-regulating farm wind pump by Daniel Halladay

III. Specifications of the Problem

Actually there are not few problems in agriculture sector that can be solved. There are many even if we want to take out just the biggest ones. So at least even if we are not considering How to solve the entire problem at least we should consider How to prevent farmers' suicide in India then we will be able to protect many lives which will give us the growth as well as development in agriculture sector.

In India, farmers use electricity mainly for energizing irrigation pump sets to extract groundwater. The number of electric tube wells has increased tremendously over time with the availability of free electricity. The increase in tube wells required more power connections which increasingly affected the financial condition of the state electricity boards. While global coal consumption did decline by 1% in 2015, the world set new consumption records for petroleum and natural gas. The net impact was a total increase in the world's fossil fuel consumption of about 0.6%. That may not seem like much, but the net increase in fossil fuel consumption, the equivalent of 127 million metric tons of petroleum was 2.6 times the overall

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increase in the consumption of renewable (48 million metric tons of oil equivalent).

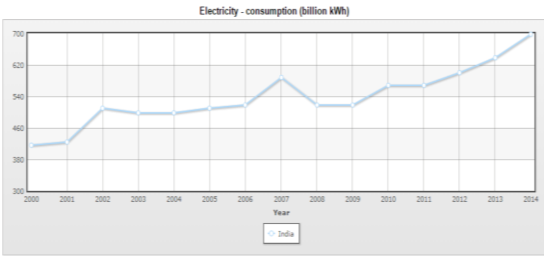

Fig. 3.1. Electricity consumption in India

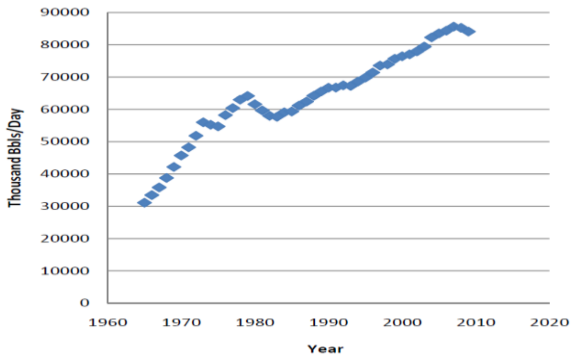

Fig. 3.2. Worldwide Oil Consumption

IV. Working Procedure

4.1 *Parts required*

1. One bicycle Rim of Diameter 64 cm
2. 4 Blades of length 45.5 cm,
3. Two Face Gears of Diameter 23 cm with 9 teeth each
4. L-shaped Connector
5. Connecting rod
6. One adjustable Stand/tower
7. One Pump
8. Some spokes and Bushes

4.1.1 *Bicycle Rim*

Here we used a bicycle rim as it is circular shape and readily Hub inside it. A hub is the center part of a bicycle wheel. It consists an axle, bearings and a hub shell. The hub shell typically has two machined metal flanges to which spokes can be attached. Hub shell is with free bearings.

Fig. 4.1.1. Bicycle Rim

4.1.2. *Blades*

We used four blades in our project; they are attached to the rotor with the help of spokes. We used aluminium metal sheets for making of blades. Aluminium is remarkable for the metal's low density and its ability to resist corrosion. Aluminium and its alloys are vital to the aerospace industry. Aluminium is a relatively soft, durable, lightweight, ductile, and malleable metal.

Fig. 4.1.2. Blades

4.1.3. *Gears*

We used two gears to transmit the power from rotor to pump. Gears are made of some bushes and a brake disc. Bushes are screwed into disc and the sides are grinded to make flat surface, so the gears can easily meshed with each other, each gear have 9 teeth.

Fig. 4.1.3. Gears

4.1.4. *L-shape Connector*

The L-shape connector is used to attach the gears in perpendicular to each other, hence horizontal motion can be converted into vertical motion. It is made of 1.5 inch square pipe. It is welded at the point of connection. The gears are connected are connected to L-shape connector by welding the Ball bearings inside the gear.

Fig. 4.1.4. L-shape Connector

4.1.5 *Connecting Shaft*

Connecting rod is connected between pump and gear. One end of connecting rod is connected to gear by means of link, as it converts rotational motion into reciprocating motion; the other end of connecting rod is connected to pump by means of link.

Fig. 4.1.5. Connecting Shaft

4.1.6. *Stand*

We made a stand using two hallow cylinders of 4 & 5 inches height and 3.5 & 4 inches diameter .Drilled three holes for inner cylinder and two holes for outer cylinder. This stand can be vary height from 6-9 ft. after setting the height, a screw is inserted into holes of inner and outer cylinder , so they can be fixed at a required position. Bottom of stand is welded with four flat plates, so the stand can stand firmly.

Fig. 4.1.6 Stand

4.1.7. *Pump*

There are two types of pumps

1. Volumetric (Positive displacement pump)
2. Centrifugal (Roto-dynamic pump)

Out of which we have used positive displacement pump. Positive Displacement Pump are further categorized;

- Progressive cavity pump
- Rotary gear pump
- Piston pump
- Diaphragm pump
- Screw Pump
- Gear pump
- Hydraulic pump

Hence for better displacement and sufficient water discharge we have used “Piston Pump (single acting reciprocating pump)” Piston pumps are generally connected to a surface-mounted motor and used to pump water from shallow wells, surface water sources, and pressurized storage tanks, or through long pipes. They are not tolerant to silt, sand, or abrasive particles because the piston seals are easily damaged. Filters may be used to remove the dirt. The dimensions of pipe are 1 inch and ¾ inch of outer and inner pipe, and the length of inner and outer pipes are 3ft and 4ft respectively. One cap is fitted at end of inner pipe with the help of gum. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power which usually come in many sizes that vary from microscopic for use in medical applications to large industrial pumps.

4.1.8. *Spokes and Bushes*

Spokes are used to attach the blades with the rotor and Bushes are used to make the gears. Spokes are inserted into blades by making small holes in blade with driller; bushes are attached to disc by screwing them to make gears.

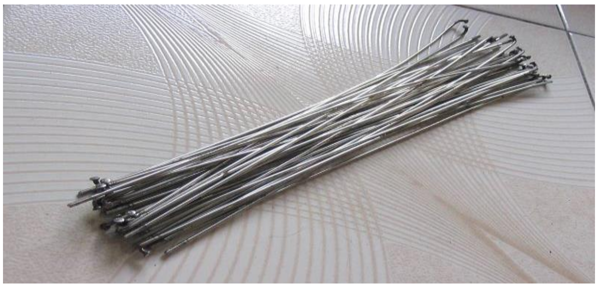

Fig. 4.1.8.1. Spokes

Fig. 4.1.8.2. Bushes

4.2 *Experimental Setup*

In This Experimental setup we used mechanical processes like welding, drilling, bending, shaping, fitting, etc. some of the work is done by ourselves and for some work we took the help of mechanical workers.

With the help of arc welding, we welded a circular plate with disc for rigid contact. We attached a flywheel to a hub of wheel; the hub rotates freely as we used ball bearings in it. Gear is prepared by screwing the plastic

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bushes; bushes are shaped to flat for better meshing. We used plastic bushes for making gears is to reduce weight of gears; it is useful for better transmission o energy. Two gears are attached perpendicular to each other by means of L-shape connector, the L-Shape connector is prepared by Welding two Square metal hallow shafts.

We uses iron material for hallow shafts because Iron is a lustrous, ductile, malleable and combination of low cost and high strength.We used aluminium sheets for making of blades, aluminium because it is light, durable and functional. We bent it to exactly half of its length. Pipes are attached to rim with bolts and Gum. Blades are attached to these pipes with the spokes by making holes on blades.

Fig. 4.2.1. Attaching of blades

Stand is an important part of a wind mill, two hallow cylinders are used for making an adjustable stand, we can vary the height of stand from 6ft to 10ft. two holes are drilled on inner and outer cylinders.

Fig. 4.2.2. Drilling of hallow cylinders

Bolts are used to fix the height of height after rising or lower of inner cylinder; bolts are inserted into coinciding holes of inner and outer cylinders.

Fig. 4.2.3. Bolts are inserting into coinciding holes

After the blades, gears and stand are prepared, L-shape connector which carries gears is attached to the stand with bolts**.** Bottom of the stand is supported by four long shafts which are welded at bottom.

Fig. 4.2.4. Assembling of stand and L-shape connector

A wooden piece is used as a connecting device to connect the gear and water pump. One rotational link is connected between connecting device and the pump; it converts rotational motion into linear motion which gives the up and down strokes to the pump.

Fig. 4.2.5. Wind pump

4.3. *Working Principle*

The blades of the windmill wheel catch the wind just like the sails on a sailboat which turns the rotor. The wheel is attached to a shaft. Using L-shaped connector, two gears are connected. The vertical gear is connected to a long connecting rod by a rotational link. When the windmill rotates, the rotary motion of the shaft is converted into reciprocating which gives linear motion to the piston in the pump. The pump rod goes down the tower through a watertight seal at the top of the well’s drop pipe, and to the pump cylinder, the part that moves the water. The cylinder is attached to the bottom of the drop pipe below the water level, and has a simple piston and two check valves.

As the piston rises, water moves up the pipe above it. At the same time, water is sucked through a screen and the lower check valve below the piston, into the lower section of the pump cylinder. When the pump rod reverses and begins to descend, the lower check valve closes and the piston check valve opens. This allows water in the cylinder to pass through, and the water that is trapped above the piston to be pushed up out of the cylinder and ultimately to its final delivery point. This cycle is constantly repeated as the wind wheel turns to move the pump rod up and down. If the wheel is moving, the pump piston is moving. As the wind speed increases, the speed and frequency of the piston stroke increases, so more water is pumped.

Fig. 4.3.1. Working principle of Wind pump

V. Result and Conclusion

5.1 *Result*

Thus we fabricated the wind mill reciprocating water pumping device by the using of rim, blades, gears, L-shape connector, connecting shaft and stand. These parts are made of light and low cost materials; this reduces the weight of the device so the energy loss is low.

We successfully completed the project by using processes like welding, drilling, bending, mechanical fitting, etc.

5.2 *Conclusion*

Our work is to show that vertical axis wind energy conversion systems are practical and potentially very contributive. Thus we have used our new design of wind mill to pump out water from the bore wells and wells. This will help at a major rate to conserve tons of watts of power every day.

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