Low Cost Wind Turbines using Natural Fiber and Glass Fiber Composites

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ABSTRACT

India's new emphasis on multi-dimensional development of non-conventional energy is an open economy, for the growing energy need of 1000 million people may accelerate rapid utilization of available non-conventional sources of the energy. The search for alternative energy sources and technology that can help tap energy from sources hitherto not in use, has become especially relevant in the wake of the energy crisis in the rural sector. In India, there are still eighty thousand villages where darkness is not dispelled by electricity. Moreover, their remote location hinders any access to a grid. There are several energy production methods and only one of them or a hybrid system can be implemented by rural communities at an affordable investment. By using contra-rotating turbine energy capturing efficiency can increase for power generation.i.e. Electricity can be generated at low wind velocity as 3 meters per second. An effort has been made to produce low cost wind turbine of 0.80 kilowatts for domestic utilization, 3 kilowatts for farm management and pumping water for irrigation. This paper describes the techniques on how cost effective turbine blades are manufactured using wood, natural and glass fiber materials and cheap labor at remote sites. It also suggests the users of locally available material for building towers and turbines to improve the economy and provide employment opportunity for the folks of rural area. As details of experiments results showed this is cost effective technology to manufacture wind turbine for rural area. If this non-renewable source of energy integrates with a hybrid system, it will give permanent solution to the energy crisis.

Keywords: Contra-rotating turbines; wind velocity; hybrid system; power generation; wood; natural and glass fiber materials.

1. INTRODUCTION

India's new emphasis on multi-dimensional development of non-conventional energy is an open economy, for the growing energy need of1000 million people may accelerate rapid utilization of available non-conventional sources of the energy. The search for alternative energy sources and technology that can help tap energy from sources hitherto not in use, has become especially relevant in the wake of the energy crisis rural sector. Wind power is sustainable and clean source of

energy[2]. In India, there are still eighty thousand villages where darkness is not dispelled by electricity. Moreover their remote location hinders access to a grid. How to reduce the cost of wind energy is a vital engineering challenge presented by the interlocking disciplines of aerodynamics, structure, control, electrical conversion, and electronics.[6] There are several energy production methods such as solar, wind biomass etc., only one of them or a hybrid system can be implemented by rural communities at an affordable investment. The contra-rotating turbines capture more energy from wind and provide more power. Wind tunnel tests on a prototype have shown that the design is up to 40 per cent more efficient and far less noisy than a conventional single-rotor system. The rotational direction and speed of the rotors are adjusted in response to the wind circumstance [4]. The benefits of having contra-rotating blades are well known. In fact, the design has existed for more than a century and is widely used, for example, in propeller systems of submarine torpedoes [3]. The concept is also used in airplane and boat propulsion systems, not to mention those remote-controlled toy helicopters you can fly inside your house. Experiments to date also suggest that a turbine with such a design can operate at lower wind speeds, allowing it to tap into a broader range of wind resources. Electricity can be generated at wind velocity of magnitude of 3 meter per second. To provide electrical power to rural community, an effort has been made to produce low cost wind turbines of 0.80 kilowatts for domestic utilization, 3 kilowatts for farm management and irrigation. Although, it is mean for rural area, but can be implemented in urban area, to provide electricity in crisis as well as reduce load on grid. These systems can be installed on the flyovers, bridges; reservoir sites and other sensitive area for lightening and operating vigilance devices. This paper describes, how cost effective turbine blades are manufactured using wood, natural and glass fiber materials and cheap labor at remote sites. Natural fibers are emerging as low cost, lightweight and apparently environmentally superior alternatives to glass fibers in composites. It also suggests the uses of locally available material for building towers for wind turbines for improving the economy and increasing the employment opportunity in rural area. If this non- renewable source of energy is integrated with highbred system, it will give permanent solution to energy crisis.

2. MATERIALS

For carrying out this experiment wood, light wood, wood dust, glass fiber and natural fiber like jute is used but mainly concentrated on the natural fiber as the researches shows that natural fibers are emerging as low cost, lightweight and apparently environmentally superior. Natural fiber composites are likely to be environmentally superior composites in most cases for the following reasons: (1) natural fiber production has lower environmental impacts compared to glass fiber production; (2) natural fiber composites have higher fiber content for equivalent performance, reducing more polluting base polymer content; (3) the light-weight natural fiber composites improve fuel efficiency and reduce emissions in the use phase of the component, especially in auto

applications; and (4) end of life incineration of natural fibers results in recovered energy and carbon credits[1]. The structural properties of composite materials are derived primarily from the fiber reinforcement. In a composite, the fiber contributes high tensile strength, enhancing properties in the final part, such as strength and stiffness while minimizing weight.

3. METHOD

Since the experiment was for the light weight and low cost wind turbine, the manufacturing method used in this experiment was resin transfer method (RTM) using mould techniques[2]. It is evident that the shape of the mould is solely responsible for the geometry, tolerance and surface finish of the parts made in the mould. Engineering design of the mould requires carefully considering a range of factors, such as loads on mould surface, heating methods for resin curing, mould cavity geometry, the sealing method between mould halves, mould closure and clamping, ejection of mould and ejection of the worked part so this method was best way to design this type of wind turbine blades .[5]

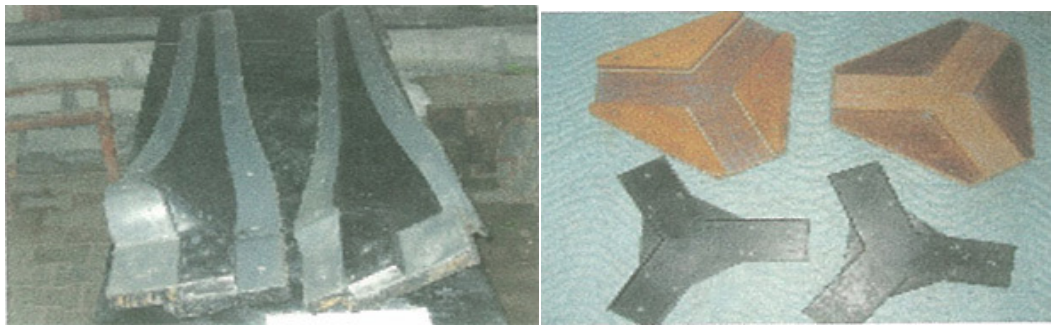

Fig. 1 Photograph of mould and tools

4. DEVELOPMENT

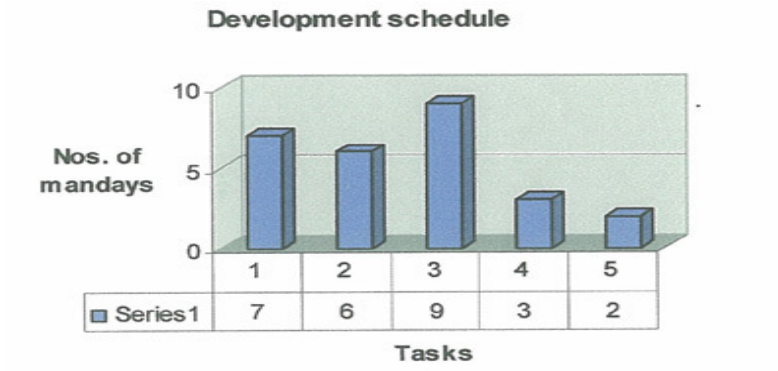

Fig. 2 Development Schedule

5. WIND GENERATORS FOR RURAL COMMUNITIES

Small wind turbine (anything between 0.3 to 10 kilowatts) can keep countless homesteads, farmers, remote communities, nomadic groups and installations, where grid may be lacking can provide power, has a room for blade manufacturer such as cottage industry. Presently, available turbines are mostly imported or have technological collaboration. To self sufficient and develop indigenous wind turbines for following category machines are indigenously designed and fabricated using simple techniques and local available materials and human skills. In India where high speed wind is available, a single rotor turbine shall be used and low wind speed area a contra-rotating turbine shall be suitable. Contra-rotating turbine shall be suitable. Contra-rotating wind turbine is shown in figure-3. Coefficient of power factor for a contra-rotating turbine is given in figure-4.

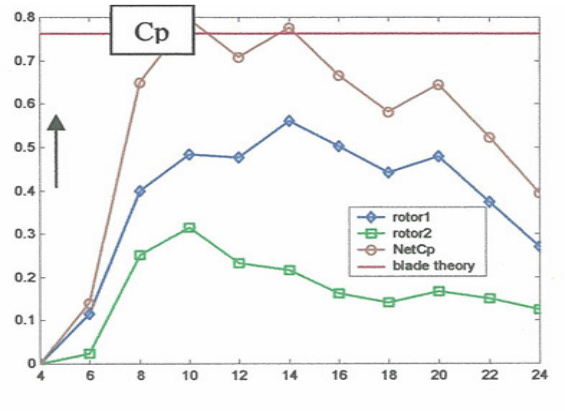

Fig. 3 Contra Rotating Wind Turbine Fig. 4 Cp of Contra Rotating Turbine

6. MICRO TURBINE OF 0.80 KW POWER

A micro wind turbine of 0.8 kW rated power has been developed and is in operation for lightning and battery charging. It can be installed on rooftop. A photograph of turbine is shown in figure 5. The main parts are three bladed turbine, generator, controller and electric energy storage(battery). The turbine blades are made of light weight wood, polyurethane foam. Jute and glass fiber and polyester resin. Master of turbine is prepared by rapid manual technique. A close tool is made using materials: wood, wood dust and glass fiber. A light weight structural core is formed using wood and polyurethane foam. Layers of jute fabric and few layers of glass fabric laid on the core and pressed in the close-tool. Blade surface is given a final touch. In this way, first batch of nine blades are fabricated within weight variation range 10-50gms and centre of gravity variation range of 0-20mm without balance. These blades show desired stiffness and are tested for 1.5 times of rated wind velocity. Test set is made on roof top using Cadpa stone and FRP laminated bamboo as a core to support the turbine. Blade fixing bracket is also fabricated using wooden tool.

Fig. 5 Photograph of Rooftop Turbine

7. MINI TURBINE FOR IRRIGATION AND FARM MANAGEMENT OF 3 KW POWER

Mini turbine of 3.0 KW rated capacity has been designed and developed for irrigation and farm management. The main parts are three bladed turbine, generator, controller and submersible pump. The turbine blades are fabricated using light weight wood, polyurethane foam and glass fibers and polyester resin. Master of turbine is prepared by rapid manual technique and close tool is developed to get net-shape component. A light weight structural core is made using wood and polyurethane foam. Designed layers of glass fabric is laid manually and pressed into the close tool. Afterwards blade surface is given a final touch. In this way, first batch of nine blades are fabricated within weight variation range 10-50gms and centre of gravity variation range of 0-25mm without balance. These blade shows desired stiffness and tested for 1.5 times of rated velocity. It is installed at test site at 18 feet height. Photograph of turbine is given in fig. 6. Structural core and tool are given in fig. 7.

Fig. 6 Turbine 3 Kilowatts Power

Fig. 7 Structural Core

8. CONCLUSION

This paper describes the need of indigenously developed cost effective technology to manufacture wind turbine for rural area. Turbine blades and tools are developed using local available materials and manpower. Micro -0.8 KW and Mini -3.0 KW turbines are in operation and under test for various requirements. This will open an opportunity for employment as well as improve productivity due availability of light to work more hours in a day. If this non- renewable source of energy is integrated with highbred system. It will give permanent solution to energy crisis.

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