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REVIEW ON MATERIALS USED IN WINDMILL BLADE DESIGN

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***Abstract** - The paper project describes the use Non-conventional energy sources has been on a high these days. Since they are more found to pollution free as well as are abundant in nature. Here we discuss about the non-conventional energy source i.e. wind. The paper dwells on the type of materials used for windmill blade design. Since the most important part of a windmill is blade which harness the nature's wind in production of energy so the type of materials used should be more effective and efficient in a sense that it can ensure smooth rotation and harness maximum wind. Composite materials are found to be more effective in blade design. Blade design usually refers to that of blade and nacelle, so the materials used for it is carefully studied.*

Keywords: *non-conventional energy source, windmill, blade, Composite materials*

1. INTRODUCTION

This Wind Energy technology has played a significant role in power production since 1990's. The ability to harness wind used in rotation of blades which in turn help in energy production. Use of Non-conventional energy resources has increased because of overdependence on conventional sources of energy. Wind being the primary non-conventional energy source is been widely used all over the world. But harnessing wind is not that easy considering the fact that the windmill must be designed properly as well as the materials used must contribute to the energy production. So windmill blade design is one of the major concerns in design of windmill. The materials used for blade and nacelle must be carefully considered. In windmill blades contribute to greater part of system efficiency. Dimensions and number of that component vary on the basis of turbine strength its development in past related to its material used in design varied from cloth to wood and sheet metal and other materials but nowadays composite materials have been used by manufacturers considering its increased efficiency.

2 LITERATURE REVIEW

1. K Suresh Babu et al. [1] discussed different material to manufacture wind turbine blades using Multiple Attribute Decision Making (MADM). They modelled turbine using Catia and done analysis using FEM. They done analysis based on steel, aluminium, Glass E, Carbon, Aramid. In their findings they concluded that composite materials such as carbon fibres offer high stiffness, low density, and high fatigue life.

2. S. Ravikumar et al.[2] in their journal named "Design and analysis of wind turbine blade hub using Aluminium alloy AA6061-T6 they replaces conventional spheroid graphite cast iron GGG 40.3 with above mentioned aluminium alloy. They have done analysis using ansys considering IEC 61400-1. From the results they concluded that aluminium alloy is only beneficial costwise. Considering Strength and Factor of safety conventional cast iron hub offers more safety and strength (fos=7.6)

3. Bulent Eker et al.[3] investigates the performance and cost reduction obtained by using composite materials as wind turbine blades, in their findings composite called intelligent composites can replace the conventionally used glass fibres offering advantages like decrease in danger factor, control of structural vibration, increase in efficiency etc

4. Kunduru Akhil Reddy et al. [4] uses CFD ansys to analysis or evaluate variable-speed, fixed-pitch horizontal axis wind turbines blade. They used Q-BLADE software to design the blade and determine power output. Analysis done based on S series aerofoil's such as S815 and S811, tip selection is done based on NACA 64A-010 and NACA 653-618 aerofoil's with less thickness. From their analysis they proved that the blade suitable with no or less deformation.

5. Sumedha Singh Rathore et al [5] discussed various blade profiles and blade materials that yield higher electrical parameters that is higher efficiency. They discussed five blade profiles with Height to radius ratio .25,.5,1,1.25,1.5 among them the height to radius ration equalling 1 is obtained as optimum profiles. They also compared materials like aluminium carbon fibre stainless steel as blade material in terms of strength, cost velocity, deformation etc and aluminium is chosen as the best material.

3. OVERVIEW OF BLADE DESIGN

Composite materials are generally used in design of blade and nacelle. Composite used in blade used be carefully studied in order for obtaining maximum efficiency.

A wind turbine blades has two faces which are joined together and stiffened either by one or several integral webs linking the upper and lower parts of the blade shell or by a box beam. The flap wise load is caused by the wind pressure, and the edgewise load is caused by gravitational forces and torque load. The flap wise bending is resisted by the spar, internal webs or spar inside the blade, while the edges of the profile carry the edgewise bending. From the point of loads on materials, one of the main laminates in the main spar is subjected to cyclic tension-tension loads (pressure side) while the other (suction side) is subjected to cyclic compression-compression loads. The laminates at the leading and trailing edges that carry the bending moments associated with the gravitation loads are subjected to tension-compression loads. The aeroshells, which are made of sandwich structures, are primarily designed against elastic buckling. The different cyclic loading histories that exist at the various locations at the blades suggest that it could be advantageous to use different materials for different parts of the blade. A major trend in wind turbine development is the increase in size and offshore placements. Increasing size is motivating by the desire to reduce of the leveraged cost of energy. With increasing size, the weight of the rotor blades increases, so that gravitational loads become design drivers. Also longer blades deflect more, so that structural stiffness (to ensure tip clearance, i.e., to avoid the blade to hit the tower) is of increasing importance. Thus, from a materials perspective, the stiffness-to-weight is of major importance. In addition, with the turbine designed to be in operation for 20–25 years, the high-cycle fatigue (exceeding 100 million load cycles) behavior of composites and material interfaces (bond lines, sandwich/composite interfaces) is of major importance.

4. CONCLUSION

The dependence on fossil fuels have increased drastically which has led to the increase on pollution so its high time that we should switch on to the conventional source of energy. Wind energy one of the most used conventional source of energy must be widely used. This can be achieved by proper installation of windmill also carefully design the blades of the windmill as well as type of materials used in blade design must be carefully looked.

Development of new epoxy resin systems which have low mix viscosity, better wetting of fibers and allow low infusion pressure in the vacuum assisted resin transfer molding (VARTM) should lead to the blades with minimum production defects. Further, automated component deposition during VARTM can allow improving the wind blade quality as well. Yet, the increase in size of turbine blades most likely leads to more manufacturing defects. Thus, the development of more damage tolerant materials is desired. Resins with faster cure and lower curing temperature allow reducing the processing time and automating the manufacturing.

Carbon fibers represent a very promising alternative to the traditional E-glass fibers. Other alternatives are high strength glasses, basalt, aramid and natural fibers. Carbon fibers ensure higher stiffness while their disadvantages are higher costs, lower compressive strength and high sensitivity to local defects (e.g., misalignment). In several studies, the combination of carbon and E-glass fibers was recommended as a promising solution, which allows to achieve the combination of higher stiffness (due to carbon fibers) with limited cost increase. With view of resin matrix, thermoplastics have some advantages over traditionally used thermosets, e.g., recyclability. The investigations on the applicability of these groups of materials for wind blade composites have been carried out intensively during the last years.

The strength and durability of wind blades are controlled by damage processes at the micro level, in fibers, on the fiber/matrix interfaces, between plies. It suggests an idea that if these micro scale properties of the materials are enhanced, the strength and lifetime of the composites, and, generally, wind turbines is increased. This can be realized by nanoscale modifications of the material structures, i.e., by introducing nanoscale particles (of the size order 1–10 nm) in the fiber sizing, matrix and interfaces between plies. The materials with nanoengineered matrix (or sizing) and micro scale (e.g., carbon fiber) reinforcement can demonstrate in some cases the up to 80% higher fracture toughness and lifetime than the neat composites

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