International Journal of Engineering Research and Development
eISSN : 2278-067X, pISSN : 2278-800X, www.ijerd.com
Volume 2, Issue 3 (July 2012), PP. 59-64

Development of Glass Fiber Reinforced Polymer Composite Ceiling Fan Blade

S.Prabhakaran[1], M.Senthil kumar[2]
[1,2]*Department of Mechanical Engineering, PSG College of Technology, India*

Abstract—In the recent world most of the household appliances and industrial appliances are using electric power. Because of the enormous use of Electric power, electricity shortage is main problem throughout the world. Ceiling fan is the one of the appliance that consumes electric power. This has been minimized by means of reducing the weight of the blade. The best way to reduce the power consumption without sacrificing safety is to employ fiber reinforced composite materials in the fan blades. The objective is to compare the power consumption, cost and weight of composite fan blade with that of aluminium fan blade. In this work the design and fabrication of composite fan blade made up of glass fiber reinforced polymer is carried out by which weight of the fan blade can be reduced. Compared to existing ceiling fan blade, the composite blade saves 30% of power, and 34% less in cost. From the fabrication it was found that the weight reduction of 28% is achieved using composite material without sacrificing the strength.

I. INTRODUCTION

A ceiling fan is a device suspended from the ceiling of a room, which employs hub-mounted rotating blades to circulate air normally the ceiling fan blades are made up steel, wood, aluminum etc., In existing ceiling fan consumes more power because of the more weight of the fan blade.

Less power consumption, less weight, effective utilization of natural resources is main focus of the electrical appliances company in the present scenario. The above can be achieved by introducing better design concept, better material and effective manufacturing process.

Aluminium fan blade have many advantages such as less density compared to steel, corrosion resistance, and good aesthetic look. In spite of its advantages, it stays back in low strength to weight ratio, paint coating problems etc.,. It is reported that weight reduction with adequate improvement of mechanical properties has made composites as a viable replacement material for conventional steel.

In the present work, the aluminum fan blade used in ceiling fan is replaced with a composite fan blade made of glass/epoxy composites. Power consumption in both blades are tested. The objective was to compare the power consumption, weight, and cost savings.

II. COMPOSITE CEILING FAN BLADE

In recent days, various materials like composites are experimented in almost all parts of the house hold appliances and it has also ventured into ceiling fan. Due to reduction in weight, composite materials are preferred over conventional aluminium blade.

2.1 Advantages of Ceiling Fan Blade

One of the most advantageous reasons for considering their use over existing blade is their reduced weight.

- High strength to weight ratio.
- Excellent corrosion resistance.
- Good aesthetic appearance.
- No need for painting

2.2 Glass Fiber and epoxy resin

The aim of fiber reinforced plastics is to combine the stiffness and strength of fibrous material. This material has corrosion resistance, low density and mould ability. The majority of reinforced plastics produced today are glass reinforced epoxy or polyester resins, both of which are thermosetting. Normally E-glass used as reinforcement because of high strength, easily available, and less cost.

Glass fibers have also been used with phenolics, silicones, polystyrene and polyvinyl chloride. Glass fibers are the obvious choice as reinforcing agents, principally because of the relative ease with which high strengths can be obtained fiber a few microns in diameters.

It is possible to produce composites with a range of strength according to glass content and nature of the reinforcement. The epoxy resins have lower shrinkage than the other resins.

.

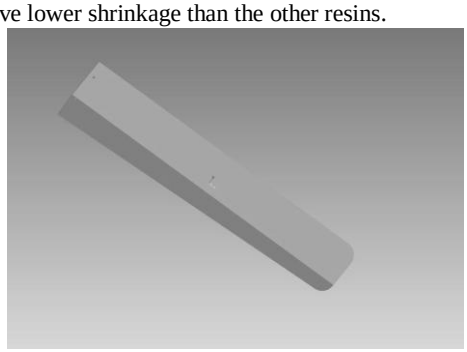

Fig.2.1 Modeling of ceiling fan blade

2.3 Existing Blade Specifications:

- Manufacturer: Crompton greaves
- Model: HS 1400
- Rated power: 76 watts
- Rated speed: 290 rpm
- Minimum air delivery: 270 m^3/min
- Existing blade weight (three blades) = 0.75Kg
- Material = aluminium
- Density of aluminium = 2.7gm/cc

III. FABRICATION OF COMPOSITE CEILING FAN BLADE

Fan blade specimens are manufactured for knowing the fabrication method and to know the difficulties faced while manufacturing.

3.1 Manufacturing Process

The composite products can be manufactured by the following methods.

- Hand lay-up process
- Pultrusion process
- Filament winding method
- Resin transfer moulding(RTM)
- Sheet moulding compound(SMC)
- Reaction injection moulding(RIM)

Among these method Hand lay-up is cheap and easy method. So in this composite blade manufacturing Hand lay-up method is used.

3.2 Hand Lay-Up Method

In Hand lay-up, liquid resin is applied to the mould and then fiber glass is placed on the top. A roller is used to impregnate the fiber with resin. Another resin and reinforcement layer is applied until a suitable thickness builds up. It is very flexible process that allows the user to optimize the part by placing different types of fabric and mat materials. Because the reinforcement is placed manually, it is also called the hand lay-up process. Though this process requires little capital, it is labor intensive.

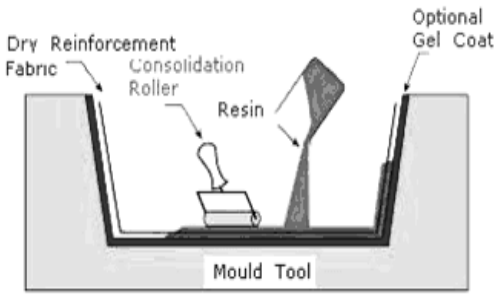

Fig.3.1 Hand Lay-Up Method

Basic Raw Material

- E-Glass fibers

- Epoxy resin
- Hardener
- Wax

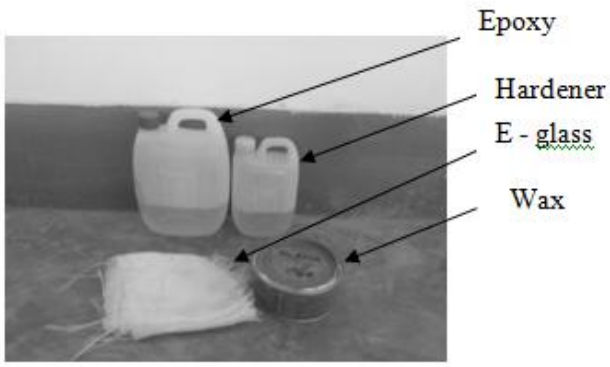

Fig 3.2 Raw Material

Tools Required

The mould design for the hand lay-up process is very simple as compared to other manufacturing process because the process requires room temperature to cure with low pressures. In this project existing fan blade is used as mould.

3.3 Fabrication of Ceiling Fan Blade

In the hand lay-up process the thickness of the composite part is built up by applying a serious of fiber glass layers and liquid resin layers. A roller is used to squeeze out the excess resign and create uniform distribution of the resign throughout the surfaces. By the squeezing action of the roller, homogeneous fiber wetting is obtained, the part is then cured at room temperature for about one week and once solidified it is removed from mould.

The number of layers of that were required is first determined by finding the thickness of the fiber which was found to be 0.25mm. Allowances are provided to the mould so that after fabrication they could be trimmed to accurate size. The fibers are cut to required shape and size.

3.4 Fabricated work result:

Existing fan blade weight = 295gms
Composite blade weight = 215gms
Percentage of weight saving = 28%

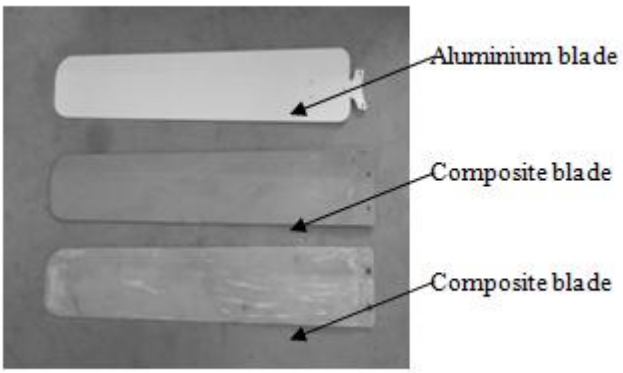

Fig. 3.3 Ceiling fan blades

IV. COST ESTIMATION

Item	Quantity	Cost (Rs.)
E-Glass (woven roving 200GSM)	0.182kg	30/-
Epoxy resin	0.12kg	40/-
Epoxy hardener	0.016kg	8/-
Wax	5grams	5/-
Colouring agent	15grams	5/-
	Total cost	88/-

Table 4.1 Cost Estimation

Cost of one composite ceiling fan blade= Rs.88/-.
Cost of three composite ceiling fan blades=Rs.264/-.
Cost of existing ceiling fan blades = Rs.400/-
Cost savings= Rs.121/-
Percentage of cost savings = 34%

V. POWER CONSERVATION

The main objective of this paper is to calculate power conservation of the composite ceiling fan blade compared to the existing ceiling fan blade. For that the experiments are conducted for both blades. First the existing blade is fitted with fan hub and tests are conducted to find the power consumption. After that the composite blade is fitted with the fan hub. Again the tests are conducted, and power consumption are find out.

Fig 5.1 Experimental setup

Units conserved for one hour
Existing fan = 0.052units
Composite fan = 0.037units
(1 unit = Rs.4.50/- for Institution and Industries)

Power consumption for existing fan
0.052units*8hour*30days*12months = 150units (for one year)
Cost for running the exisiting fan = Rs.675
(150units*Rs.4.50)

Power consumption for composite fan
0.037units*8hour*30days*12months = 106units (for one year)
Cost for running the Composite fan = Rs.477
(106units*Rs.4.50)

5.1 Power conservation:
No.of Units consumed for existing fan = 150 units
No. of units consumed for composite fan = 106units
Power conservation = 44units
Cost saved for a year =Rs.198
Percentage of power savings = 30%

VI. COMPARISON

Table 6.1 Comparison

Description	**Existing blade**	**Composite blade**	**% of reduction**
Weight	295grams	215grams	28%
Power consumption	0.052units	0.037units	30%
Cost of Blade	Rs.400/-	Rs.264/-	34%

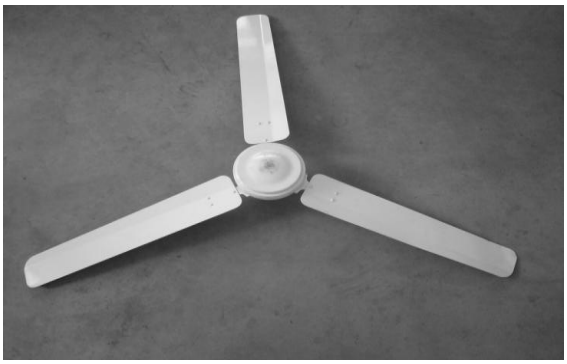

Fig.6.1 Existing Ceiling Fan Blade

Fig.6.2 Composite Ceiling Fan Blade

VII. CONCLUSION

Design, fabrication and testing of existing and composite fan blade (using glass fiber material) are completed and also composite blade is tested and compared with existing blade. In this project the composite blade has been designed and fabricated. This composite blade has more strength over existing fan blade. The existing fan blade weighs about 295grams where as the weight of composite fan blade is 215grams, which is 28% lesser than existing blade. It is tested that the power consumed by the existing blade (0.052units) is more when compared to composite blade(0.037units). So when we use composite fan means we can reduce 30% of power consumed by the existing ceiling

fan. Cost of composite ceiling fan blade is Rs. 279/- which is 44% less than existing aluminium blade. The strength of the composite blade also high when we compared with aluminium blade. From the study, it is concluded that fiber reinforced plastic material is a suitable material for manufacturing the composite ceiling fan blade.

REFERENCES

[1]. T. Y. Kam, J. H. Jiang, H. H. Yang, R. R. Chang, F. M. Lai, and Y. C. Tseng (2010), "Fabrication and Testing of Composite Sandwich Blades for a Small Wind Power System", PEA-AIT International Conference on Energy and Sustainable Development.

[2]. M. Grujicic, G. Arakere, E. Subramanian, V. Sellappan, A. Vallejo, and M. Ozen (2010), "Structural-Response Analysis, Fatigue-Life Prediction, and Material Selection for 1 MW Horizontal-Axis Wind-Turbine Blades", Journal of materials engineering and performance, Vol.19, pp.790–801.

[3]. G. Baskaran, S. Gowri, and R. Krishnamurthy (2010), "Study on vital static properties of fine blanking of GFRP composites with that of conventional drilling", Advanced Manufacturing Technology, Vol.50, pp.659–666.

[4]. Luke S. Lee, and Ravi Jain (2009), "The role of FRP composites in a sustainable world", Clean Technology Environment Policy, Vol.11, pp.247–249.

[5]. Chung Hae Park , Abdelghani Saouab , Joel Breard , Woo Suck Han , Alain Vautrin , and Woo Il Lee (2009), "An integrated optimisation for the weight, the structural performance and the cost of composite structures", Composites Science and Technology, Vol.69, pp.1101–1107.

[6]. Marc A. Rosen (2009), "Development of an Enhanced Ceiling Fan: An Engineering Design Case Study Highlighting Health, Safety and the Environment", Minerva Canada.

[7]. The US Environmental Protection Agency (2009), "ENERGY STAR® Testing Facility Guidance Manual", Version 1.1.

[8]. M. P. Cavatorta (2007), "A comparative study of the fatigue and post-fatigue behavior of carbon–glass/epoxy hybrid RTM and hand lay-up composites", Journal of Material Science, Vol.42, pp.8636–8644.

[9]. A. Goren, and C. Atas (2007), "Manufacturing of polymer matrix composites using vacuum assisted resin infusion molding", International Scientific Journal, Vol.34, pp.117-120.

[10]. Mahmood M. Shokrieh, and Roham Rafiee (2006), "Simulation of fatigue failure in a full composite wind turbine blade", Composite Structures, Vol.74, pp.332-342.

[11]. M A Drewry, and G A Georgiou (2006), "A review of NDT techniques for wind turbines", Wind turbine NDT, Vol.49.

[12]. Ronald Jarnagin (2006), "Selecting a Ceiling Fan", Florida Energy Extension Service.