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Computational Fluid Dynamics Analysis of Horizontal Axis Windmill Blade by Using ANSYS Software

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Abstract: The aim of the research is to design and analysis of vertical axis wind turbine blade. With a change of material by the replacement of physical and mechanical properties of the existing material which is used to generate power. To increase the power to weight ratio with a light weight material. The computational fluid dynamic analysis is carried out to determine the influence of different materials. That light weight material is compared with the existing material aluminum alloy.

Key words: CFD, windmill blade, ANSYS, mechanical properties, weight, alloy

INTRODUCTION

A wind turbine CFD analysis on aerodynamic design optimization of wind turbine rotor blades is said by Amano and Malloy (2009), Harks (2010) and Polinder *et al*. (2005). The wind turbine creates the precise measure of vitality in various materials. The most reliable wind turbine arrangements were allowed to turn at a rate of the speed of the wind (Ahmed, 2011; Castaignet *et al*., 2011) illustrates the design and analysis of horizontal axis wind turbine rotor and model predictive control of trailing edge flaps on a wind turbine blade. Wind turbine edges with a cover that directions air through the sides and speeds it up, explained by Casas *et al*. (2006). Mechanical, thermal, linear and nonlinear optical properties of Barium L-Tartrate single crystal is explained by Rajesh and Kumar (2017). An experimental, numerical simulation of magnetic pulses for joining of dissimilar materials with dissimilar geometry using electromagnetic welding process is discussed (Muthukumaran *et al*., 2017). A structural and optical absorption study of cobalt substituted strontium ferrites, SrCoxFe12-xO19 is discussed by Mangai *et al*. (2016).

Material selection: Determination of material of wind turbine cutting edge is likewise the principle property work in the effectiveness of the sharp edge turbine outline. There are numerous materials accessible in the market which can be use to choose the material, however in the perception of deferent material we select the Al 585 as an edge material. Al 585 has a few advantages which cause we chose. The properties of Al 585 are given in Table 1.

Other properties:

- Material Al 585
- Density 5.03 g/cm^3
- Melting point 1200°C
- Elastic modulus 192-201 (GPa)
- Poisson's ratio 0.21
- Tensile strength 436-521 (MPa)
- Thermal conductivity 28 (W/m-K)

MATERIALS AND METHODS

Betz law Fuentes *et al*. (2012) was first defined by the German Physicist Albert Betz in 1919. Betz law can be utilized to decide the power from a perfect turbine rotor, the push of the breeze on the perfect rotor and the impact of the rotor operation on the neighborhood wind field. This straight forward model depends on a direct energy. The law expresses that it is just hypothetically conceivable to change over a most extreme of 59.3% of the dynamic vitality in the breeze to mechanical vitality utilizing a wind turbine. And this greatest power yield happens when the downstream breeze has 1/3 the speed of the upstream breeze (Table 1).

Figure 1 shows the density of aluminum material used in the windmill blade. The horizontal axis wind mill blade density level was shown in Fig. 2 and the density level of the turbine blade are denoted by different color.

Dynamic pressure of the horizontal axis windmill blade was shown in Fig. 2. The dynamic pressure is the important one in the computational dynamic analysis the maximum dynamic pressure of the horizontal axis windmill blade was denotes by the red color.

Table 1: Properties Al 585

Zone	Pressure	Viscous	Total	Pressure	Total
Wall	6786.4204	-2.1729453	6784.2475	0.044319572	-1.4190692e-05
Plane		0.044305382	-25623.848	-0.16717863	

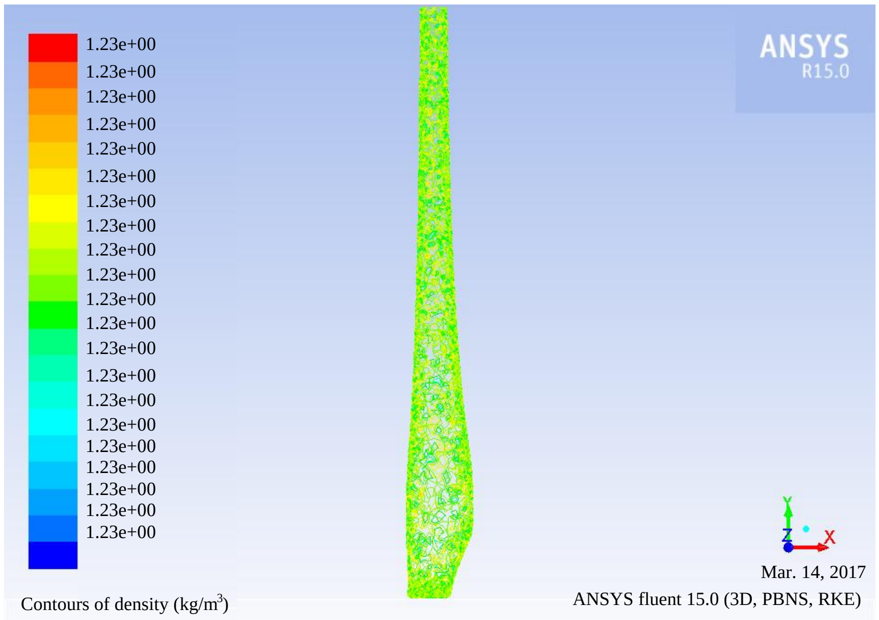

Fig. 1: AL 320 density

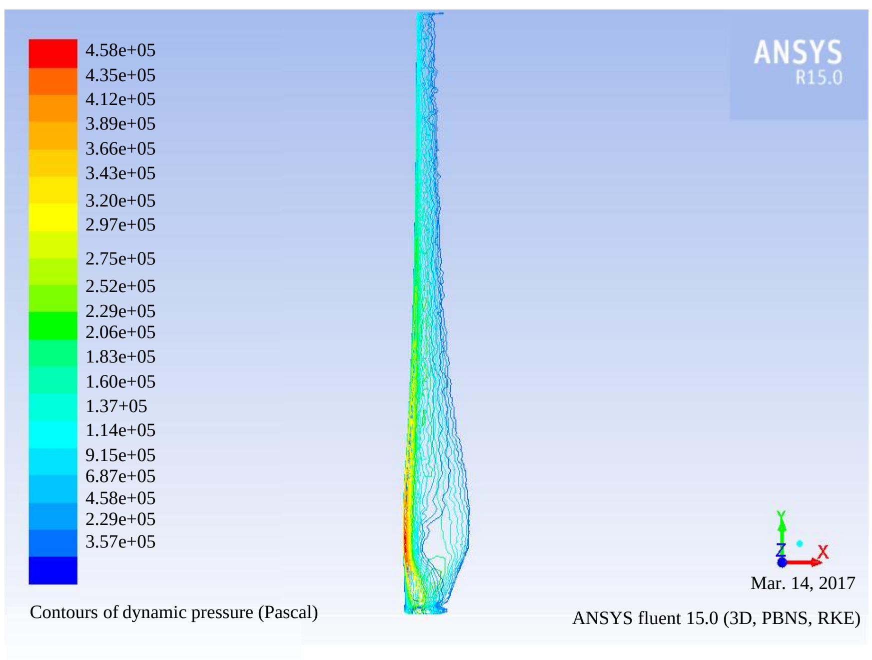

Fig. 2: Dynamic pressure

Figure 3 shows the total pressure exerted in the windmill blade made up of aluminum during rotation of the blade according to the wind force. The maximum pressure point of the aluminum blade was showed by the red color.

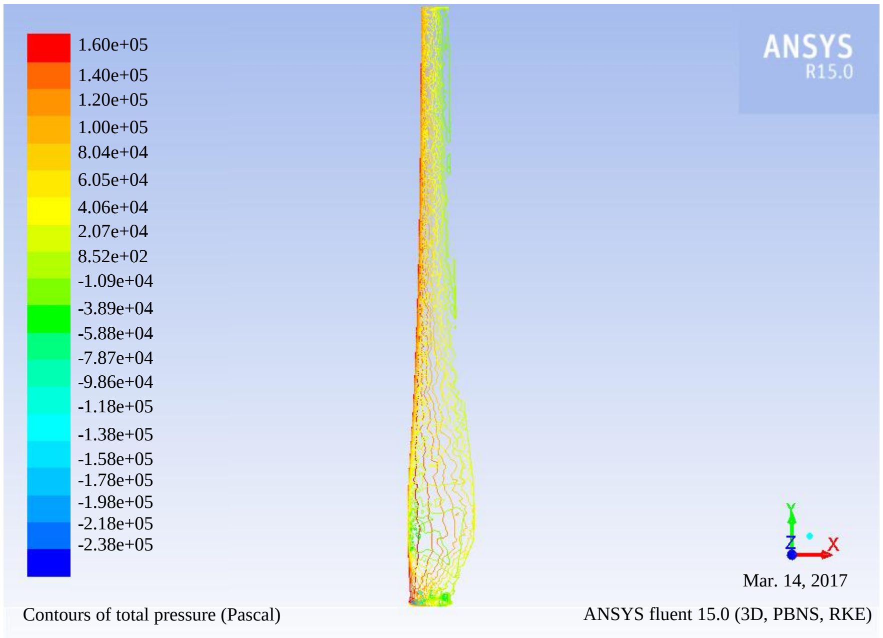

Fig. 3: Total pressure

Fig. 4: Silicon density

Figure 4 shows the density of silicon material used in the windmill blade. The density of the silicon was analyzed by the computational fluid dynamics analysis. The color variation denotes the various levels of the silicon blade density.

Dynamic pressure of the silicon windmill blade was shown in Fig. 5. The dynamic pressure is the important one in the computational dynamic analysis the maximum dynamic pressure of the horizontal axis windmill blade was denotes by the red color.

Figure 6 shows the total pressure exerted in the windmill blade made up of silicon during rotation of the blade according to the wind force. The maximum pressure point of the silicon blade was showed by the red color.

The shapes of speed extent got for different approaches from CFD reenactments are appeared in Fig. 7. In this figure, the pressure values in X-Z axis are clearly shown by the different colors. Every iteration is graphically noted in Fig. 7.

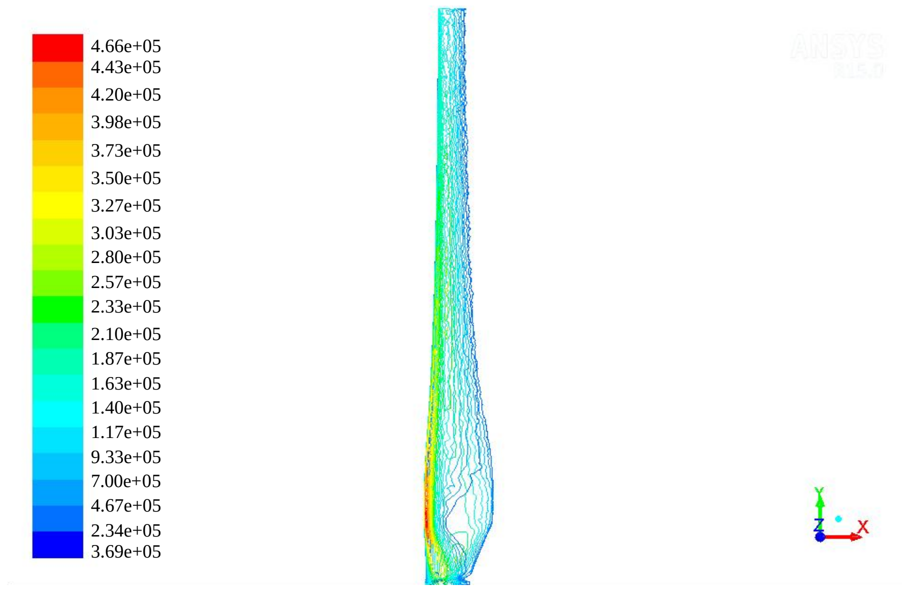

Fig. 5: Dynamic pressure

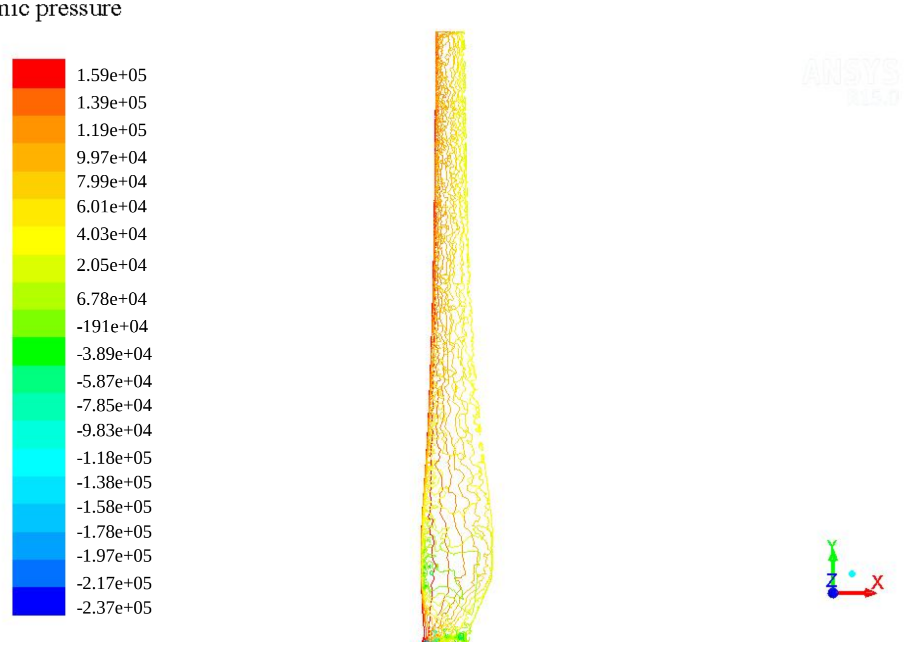

Fig. 6: Total pressure

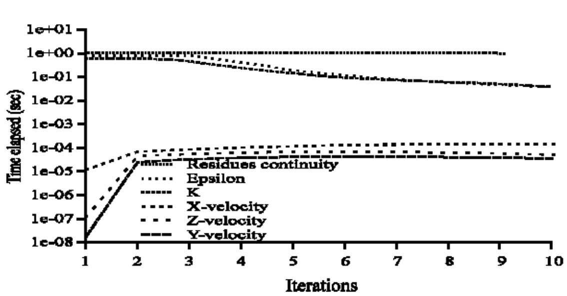

Fig. 7: Total pressure scaled residues

RESULTS AND DISCUSSION

On the main edge, we can see the stagnation point where the speed of wind is about zero. The fluid quickens on the upper surface of the airfoil while the speed of the fluid abatements along the lower surface of the airfoil. The horizontal axis windmill blade fully analyzed by the ANSYS WorkBench Software with two different materials they are aluminum Al 585 and silicon. Silicon blade was give better result than the aluminum blade.

CONCLUSION

A new attempt was made to calculate the drag forces on the blade surface using computational fluid dynamics tools. Wind turbine rotor blade has been analyzed for extreme load conditions. From the above outcomes, the velocity delivered by proposed material of silicon has the best pressure results. So, we can use silicon blade for reducing material cost and total weight reduction. This in wording the light weight material sharp edge creates more aerodynamics than that the current material aluminum compound.

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