World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:12, No:03, 2018

Fluid-Structure Interaction Analysis of a Vertical Axis Wind Turbine Blade Made with Natural Fiber Based Composite Material

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Abstract : One of the problems considered when scientists talk about climate change is the necessity of utilizing renewable sources of energy, on this category there are many approaches to the problem, one of them is wind energy and wind turbines whose designs have frequently changed along many years trying to achieve a better overall performance on different conditions. From that situation, we get the two main types known today: Vertical and Horizontal axis wind turbines, which have acronyms VAWT and HAWT, respectively. This research aims to understand how well suited a composite material, which is still in development, made with natural origin fibers is for its implementation on vertical axis wind turbines blades under certain wind loads. The study consisted on acquiring the mechanical properties of the materials to be used which where bactris guineenis, also known as pama de lata in Colombia, and adhesive that acts as the matrix which had not been previously studied to the point required for this project. Then, a simplified 3D model of the airfoil was developed and tested under some preliminary loads using finite element analysis (FEA), these loads were acquired in the Colombian Chicamocha Canyon. Afterwards, a more realistic pressure profile was obtained using computational fluid dynamics which took into account the 3D shape of the complete blade and its rotation. Finally, the blade model was subjected to the wind loads using what is known as one way fluidstructure interaction (FSI) and its behavior analyzed to draw conclusions. The observed overall results were positive since the material behaved fairly as expected. Data suggests the material would be really useful in this kind of applications in small to medium size turbines if it is given more attention and time to develop.

Keywords : CFD, FEA, FSI, natural fiber, VAWT
Conference Title : ICCMREE 2018 : International Conference on Composite Materials and Renewable Energy Engineering
Conference Location : Paris, France
Conference Dates : March 15-16, 2018