XXIII Congresso de Iniciação Científica da Unicamp 2015
17 a 19 de Novembro
Campinas
Brasil

Numerical Study of Aerodynamic Profiles for Small Wind Turbines Blades

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Abstract
This work studies the viability of energy generation on a smaller scale by small wind turbines under unfavorable wind conditions. Numerical simulations were run with the software Ansys Fluent using boundary conditions determined by the average wind conditions in Campinas.

Key words: wind turbine, aerodynamics, numerical methods.

Introduction

Wind energy has been gaining space in the energy matrix in the latest years. However there is a need for strong winds in order to activate the turbines that generate energy in a large scale. This project intends to study the viability of generating energy in a small scale, such as partially powering a building, by using smaller wind turbines and unfavorable wind conditions.
Wind turbines are moved by the lift generated in the blades due to the flow over their wing profiles. The finite volumes method was used for the analysis in Ansys Fluent in order to solve the Navier-Stokes equations. The method used the wind conditions in Campinas as boundary conditions and it would provide important information such as the energy conversion efficiency and the drag and lift forces, making it possible to analyze the viability of this generation method.

Results and Discussion

The goals of performing numerical simulations on tridimensional models of the entire turbine were not achieved due to the interruption of the project. What is presented here are the results of the literature review, boundary condition definition, and two-dimensional simulations in order to validate data.
Two wing profiles from the NACA database were drawn for the simulations. Image 1 shows the pressure field where the low pressure zone over airfoil, responsible for the lift, is noticeable. The data obtained from the initial simulations are displayed in Chart 1.

Image 1. Presure field for profile NACA 2412

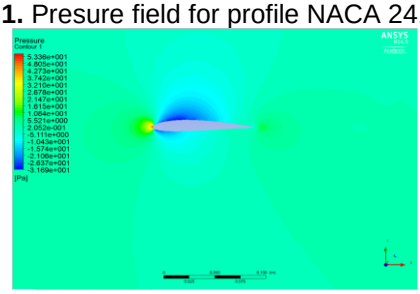

Chart 1. Comparison between database and simulation-obtained parameters

		Lift Coefficient			Drag Coefficient	
NACA profile	Reynolds number	Prel. Sim.	Final Sim.	Data-base	Sim.	Data-base
0009	68500	0,016	0,0017	0	0,026	0,017
2412	68500	1,8	0,127	0,12	0,019	0,021

Conclusions

Among other results obtained, there are the pressure and velocity fields , and the data listed in Chart 1. It is noticeable that data agrees only partially with the expected. Upon investigation, some flaws were found in the discretization of the meshing, which could have led to the differences that were observed in the results from what was expected. However, due to the early termination of the project there were no time to correct these details.

Acknowledgement

I thank my professor, Rogerio, for all the help for the whole length of the project.

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