Optimization of Wind Power Utilizing Tubercles

InVentus 2.0
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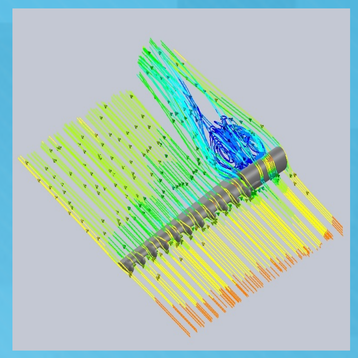
Methodology

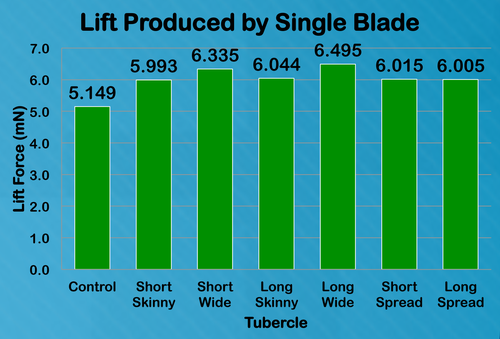
- Began with research in three main sections: existing wind turbines, fluid dynamics, and the design of tubercles.
- On the leading edge of the blade, tubercles help to channel the fluid that passes through them. This process increases the lift produced by the blade.
- Based on research, 6 basic designs for blades with tubercles were modeled:
  - Short, small diameter
  - Long, small diameter
  - Short, large diameter
  - Long, large diameter
  - Short, small diameter, varied distance
  - Long, small diameter, varied distance
- In order to verify the physics of the tubercles a Solidworks Flow, virtual simulation software, was used. Solidworks Flow produced results in lift for air flowing over a blade model. These were conducted on single blades at an 11.5º pitch and a 10 mph wind speed.
- From virtual testing, the data had to be validated in the physical world. This test was conducted in the form of running a wind tunnel on a purchased wind turbine assembly with blades based on the control and the best preforming virtual blade.

Humpback Whale Fin

Results



Lift for an individual blade was specifically tested due to the indication it gives to the efficiency of the overall wind turbine assembly. The results produced by Flow showed that the blade design with large radii and long tubercles was the most efficient, producing ~26% more lift as compared to the control.



Abstract

In today's society there is a global push to become more sustainable. A major focus in this pursuit is to increase green energy. Wind power is one of these underutilized solutions, offering unlimited power with little cost to the environment. However, concurrent wind power comes with major problems, namely turbine inefficiency. This project focused on designing a tubercle array on the leading edge of turbine blades to maximize efficiency. In order to test which design maximized efficiency, we used a base CAD model to which different tubercle designs were added. These were then tested in a simulation software called Solidworks Flow to determine the increased efficiency.

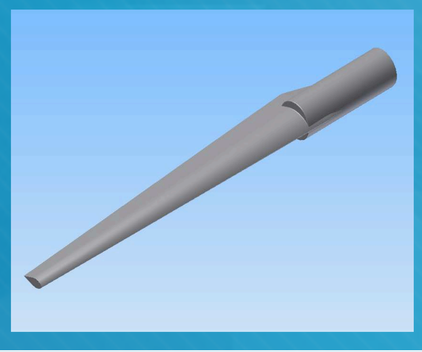
Conclusions

Two of the major impacts of our project are the increased energy production produced by wind turbines and applications of wind turbines to other blades. By increasing the efficiency of wind the blade our project has the potential to increase the effectiveness of wind energy. By increasing the amount of wind energy dependence on other power sources, such as coal and oil could be decreased. This would mean a decrease in the dependence on foreign resources and thus an increase in national security. Our project, while it was designed for wind turbines, could feasibly be applied to any rotary air foil such as fans or helicopter blades. It also has the potential to improve static airfoils such as plane wings.

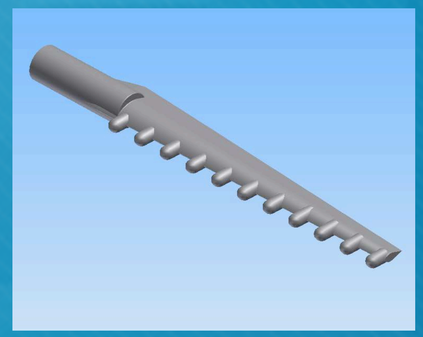
Goals

This project is built upon the already discovered fact that whale fin like tubercles placed on the leading of wind turbine blades increase the efficiency. This project expected to determine the parameters of the tubercles as to maximize the efficiency of the blade design.

Control Blade Design



Large Radii and Long Tubercle Design



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References

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