CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
35722

Project Title
Wind Winds Windmills

Abstract

Objectives/Goals
This project investigated various blade configurations in order to optimize wind turbine efficiency.

Methods/Materials
* Build a wind tunnel; assemble the Kidwind Wind Experiment Kit with a base, a tower, a nacelle with gear set and generator, and a hub for mounting blades
* Modify gearbox for higher gear ratios; build rotor with twisted blades and stators with stationary blades
* Vary blade shape and dimensions, blade pitches, numbers of blades, gear ratios, and wind speeds.
* Record generated power on a load resistor.

Results
* (2.8 m/s wind/45° blade pitch/8:1 gear ratio) efficiency almost the same with 1, 2, 3, 6, and 12 blades
* (2.8 m/s wind/15° blade pitch/8:1 gear ratio) efficiency increased with 1, 2, 3, and up to 6 blades, but dropped at 12 blades
* (2.8 m/s wind/45° blade pitch/16:1 gear ratio) efficiency almost ⅓ of that of gear ratio of 8:1
* (1.2 m/s wind) Most of high gear ratio configurations did not work
* (1.2 m/s wind/30° blade pitch/12 blades) 16:1 gear ratio produced lower efficiency than 8:1 gear ratio
* With 15° pitch, inversed trapezoid blade with wider tip produced higher efficiency
* With 45° pitch, trapezoid blade with narrower tip produced higher efficiency
* (twisted blade/15° tip pitch/32:1 gear ratio) efficiency improved as the base pitch increased from 15° to 45°
* (twisted blade/15° tip pitch/16:1 gear ratio) efficiency plateaued at base pitch of 30° to 45°
* Highest efficiency of 12.3% reached with 32:1 gear ratio and base pitch of 45°
* Front stator caused drop in efficiency; rear stator caused even higher drop
* Front stator penalty much smaller in blow in configuration than that in blow out configuration; positive gain with 45° pitch

Conclusions/Discussion
* Drag should be minimized with lower blade pitch and torque should be maximized with higher blade pitch
* Optimized blade was twisted with high blade pitch at the base to increase torque and low blade pitch at the tip to reduce drag
* Stator can reduce drag by changing airflow direction, but also creates air blockage

Summary Statement
Drag should be minimized with lower blade pitch at the tip and torque should be maximized with higher blade pitch at the base in order to maximize windmill efficiency.

Help Received
Dad helped to purchase materials and build wind tunnel.