Optimal Conditions for Energy Extraction from VAWTs

INTRO
Motivations of this work build upon previous research in controlled autorotation of small particles in a flow tank [1-2]. This research explores the introductory capabilities of a new VAWT design, the S-WIND, by first testing the performance of its small-scale prototype. Future research aims to explore the efficiency of densely-packed arrays of the S-WIND through CFD analysis as a potential scalable alternative.

METHODS
Researchers created a 16' long wind tunnel to view the S-WIND prototype’s performance in ideal conditions. Researchers also utilized an anemometer, tachometer, and multimeter capable of continuous data collection to measure model performance.

DISCUSSION
The difference in power output between staggered vs. spiral configuration for 10, 8 blades is marginal. The spiral configuration contributes to aesthetics of the design when coupled with the blades’ support frame. Future research plans are to create a digital model capable of CFD analysis to gather precise data, and to study densely-packed arrays of S-WIND VAWTs. This future research will build upon previous research suggesting counter-rotating arrangements have potential to improve power densities up to an order of magnitude greater than HAWTs [3].

RESULTS

<table>
<thead>
<tr>
<th>Config.</th>
<th>Avg. RPM</th>
<th>% Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-B Spiral</td>
<td>65</td>
<td>+10.80%</td>
</tr>
<tr>
<td>8-B Stgrd.</td>
<td>60</td>
<td>+14.50%</td>
</tr>
<tr>
<td>10-B Stgrd.</td>
<td>62</td>
<td>+0.78%</td>
</tr>
<tr>
<td>6-B Spiral</td>
<td>61</td>
<td>+15.61%</td>
</tr>
<tr>
<td>6-B Stgrd.</td>
<td>66</td>
<td>+15.57%</td>
</tr>
</tbody>
</table>

S-WIND Average Power Output in Watts (in Wind Tunnel)

Config.  | Avg. Power Output |
---------|------------------|
10-B Spiral | 65 Watts |
10-B Stgrd. | 60 Watts |
8-B Stgrd. | 62 Watts |
6-B Spiral | 61 Watts |
6-B Stgrd. | 66 Watts |

ADDITIONAL FIGURES

Minimized Upwind Angle of Attack Concept
Spiral and Staggered S-WIND Prototype Configurations
Wind Tunnel Setup

I gratefully acknowledge the NEJDA/NJ Wind Institute for providing me with this opportunity. I also would like to thank Dr. Ashwin Vaidya for his continual guidance and support in my Mathematics career at Montclair State University.