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Vertical Axis Wind Turbine Performance Scaling at High Reynolds Numbers with Varying Solidity MARK MILLER, Pennsylvania State University, ALEXANDER PIQUE, Princeton University, SUBRAHMANYAM DUVVURI, Indian Institute of Science, MARCUS HULTMARK, Princeton University — The large physical size and numerous design configurations of the Vertical Axis Wind Turbine have made it difficult to fully characterize the operational envelope of these machines. Laboratory experiments have been performed on a limited number of configurations due to the high-cost associated with testing full-scale models in large wind tunnel facilities. Ongoing work at Princeton University and Penn State has aimed to examine VAWT operation in detail using the controlled conditions of the laboratory, while simultaneously matching the full-scale aerodynamic parameters of interest: the Reynolds number and the tip speed ratio. To achieve this, a specialized, high-pressure wind tunnel facility has been employed to reach very large Reynolds numbers of 5 million, based on diameter and free-stream conditions, independent of changes to the tip speed. Results are presented from a 10 cm diameter model at many different tip speed ratios and Reynolds numbers which match and even exceed those of the full-scale, 2 m diameter commercial turbine from Wing Power Energy. Furthermore, experimental results are presented when varying the model solidity by changing the number of blades, showcasing the effects on turbine performance as a function of these aerodynamic quantities.

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