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### Recent developments of vertical axis wind turbines

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Vertical axis wind turbines (VAWTs) have been valued in recent years for their low manufacturing cost, structural simplicity and convenience in urban settings. Despite their advantages, VAWTs have several drawbacks including low power coefficient, poor self-starting ability, negative torque and the associated cyclic stress at certain azimuth angles. Using an optimal pitch control analysis, the power coefficient was significantly improved at low tip speed ratios in the range of zero to three. Experimental studies of a VAWT with a variable pitch control system were performed in an environmental wind tunnel, whose test section is 4m by 2.6m in cross section. The results demonstrated remarkable improvement on starting torque and the aerodynamic characteristics at low tip speed ratios as compared with VAWTs with only fixed pitch control. The unsteady flow fields around NACA 0015 airfoils with and without an upstream turbulence generator were investigated in a water tunnel by means of particle image velocimetry (PIV). The turbulence was generated by a square bar mesh situated at the inlet of the test section. The airfoil pitching waveform is performed under the condition calculated from the angle of attack histogram of a vertical axis wind turbine (VAWT). The instantaneous vortex structures around the pitching airfoil were revealed. It allowed us to study the effects of free stream turbulence on dynamic stall over airfoils at pitching waveforms similar to those encountered in VAWTs. It was found that increasing free stream turbulence intensity significantly postponed the dynamic stall process to higher incidence angles.

### Biography

Jim S-J Chen, Professor, Department of Mechanical Engineering, Temple University, Philadelphia, USA, received his PhD from Drexel University in 1985. He has published over 100 refereed journal and conference papers in the areas of heat transfer, solidification, materials processing, heat pump, and wind power. In recent years, he has been invited to speak in several wind power and renewable energy conferences nationally and internationally. He is currently a member of Franklin Institute's Committee on Science and the Arts. He is also a member of ASEE and ASME.

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