3-D EXPERIMENTAL VISUALIZATION OF FLOWS AROUND STRAIGHT AND TWISTED SAVONIUS WIND TURBINES

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Savonius turbines, which operate omni-directionally from low-tip-speed ratio, are now spreading in urban areas to utilize kinetic energy of turbulence in natural wind flows. Among various approaches to the performance improvements, use of twisted blades are known to highly amplify the power as well as expansion of the working range in tip-speed ratio. This will not be explained by axial integration of horizontal two-dimensional fluid dynamics but will need explanation from three-dimensional driving mechanism.

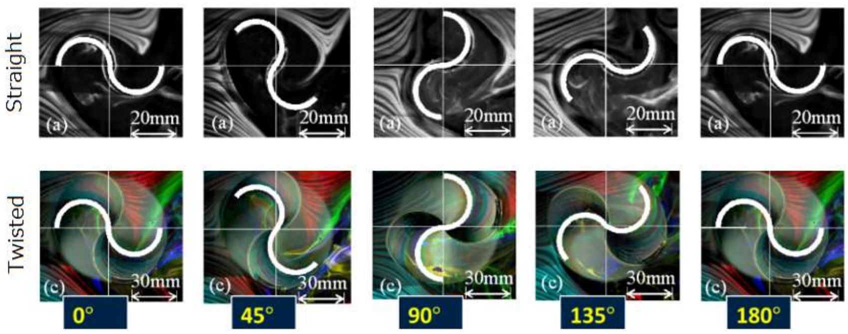

Fig. 1 Color streak-line visualization

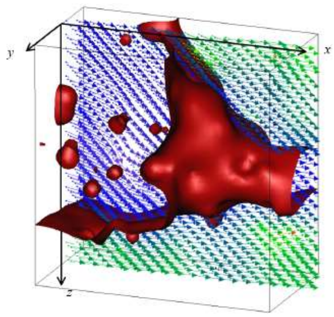

Fig. 2 3D PIV data

To eludicate the torque generation process, we have visualized 3-D flow structure arround a twisted Savonius turbine with an original color streak-line visualization technique as well as color 3-D PIV as shown above to compare with that of a straight Savonius turbines. Series of the results reveal that flow separation on spirally convex surface is supressed with Coanda effect intensified to generate additional torque. This function provides lift-driving mechanism which is therefore amplified at higher tip-speed-ratio. From 3D PIV data on the wake flow measurement, intermittent emission of streamwise vortex at the entire length scale is found instead of small chaotic eddies, of which helicity is induced by helical vortex shedding released from moving blades. We hence conclude that major part of the power produced by twisted Savonius turbine is attributed to harmoniously streamlined coupling of inflow and axial displacement of attached flow on the twisted blade.

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