FMRC Fluid Mechanics Research Seminar Series

Design and Optimization of Wind Turbines to Understand the Effect of Turbulence on the Performance

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Abstract: The turbulence effects on the performance of the wind turbines can be either seen in the field, or by very expensive LES computations or by wind tunnel tests with small scale wind turbines. The last method is chosen in this study. One necessary condition for the investigations result in clear findings, is optimum design of the tested wind turbine. Hence, as a first step, an aerodynamic shape optimization method for a horizontal axis wind turbine is developed and verified through experimentation with a laboratory-scale wind turbine. Our method is based on matching the rotor's and the coupled generator's torque. Prior to shape optimization, an initial rotor design is established with a hybrid use of Schmitz and blade element momentum theories. The experimental verification of the developed method is conducted with a small-scale wind turbine. Later, experimental investigations have been conducted by exposing an efficient wind turbine model to different turbulence levels in a wind tunnel. The developments of turbulence scales in the flow direction at various Reynolds numbers and the grid mesh size were measured. Those measurements were conducted with hotwire anemometry in the absence of the wind-turbine. This study has shown the higher the turbulence level, the higher the power coefficient. This is due to many reasons, such as boundary layer turbulence interaction and damping of tip vortices and those effects will be discussed in the seminar.

Biography: Asst. Prof. Dr.-Ing. Özgür Ertunç is an aeronautical engineer and does research in the field of thermo-fluid dynamics. He completed his doctorate study on turbulent flows in 2006 at the Fluid Mechanics Institute (LSTM) of Friedrich-Alexander University Erlangen-Nuremberg. He founded and managed the “Unsteady Fluid Mechanics” and “Fluid Dynamics and Turbulence” research groups in 2002 and 2010 respectively at LSTM. Since 2013, he is a faculty of the Department of Mechanical Engineering in Özyeğin University. He conducts research on transition and turbulence, technological applications of turbulent fluids, multi-phase flows, stimulated unsteady flows, optimization of flow devices and processes, micro fluid dynamics and wind turbine design & optimization. He has acquired and conducted more than 30 industry oriented projects and 9 basic research projects.