IMPROVING GAS TURBINE EXPERIMENTS THROUGH ADDITIVELY MANUFACTURED INSTRUMENTATION

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Abstract

Current technological development and research efforts in the subject of gas turbines highly focus on improving efficiency and reducing fuel consumption and emissions, as those are directly related to savings for engine manufacturers and airlines. In order to tackle the challenges in this area, improvements on the experimental setups and measurement techniques used for flow analysis during research and development are extremely important, as well as enhancing simulation and computation capabilities that precede the testing phases. Additive manufacturing (AM) has opened new doors for instrumentation development in terms of new materials and geometries, including the production of specialized parts to generate and measure flow conditions in laboratory environment. Highly customized pressure probes, rakes, and test articles with integrated sensors are amongst some of the technologies that have improved measurement techniques in the past few years. With the development of new materials and AM techniques, these will play an even bigger role in the future of gas turbine research. An example of a customized device enabled by AM is the StreamVaneTM, which consists of an additively manufactured screen that generates pre-determined swirl distortion profiles in wind tunnels or inlets of full-scale engines. Used in combination with particle image velocimetry, experiments were performed in two different scales to analyze the development of a single-vortex distortion and to assess the quality of the generated flow. Results showed a similar behavior of the flow in both scales, indicating that further analyses and iterations of distorted inlet flow design can be performed in small-scale wind tunnels, reducing the overall costs of the experimental phase of research and development of turbofan inlets. An analysis of the turbulence aspects of the StreamVane further confirmed its suitability as an enabling technology for research testing of full-scale fans by dramatically reducing cost and complexity of the full-scale tests.