Center for Environmental & Applied Fluid Mechanics

"Understanding and Reducing the Impact of Ingested Particles on Gas Turbine Propulsion Engines"

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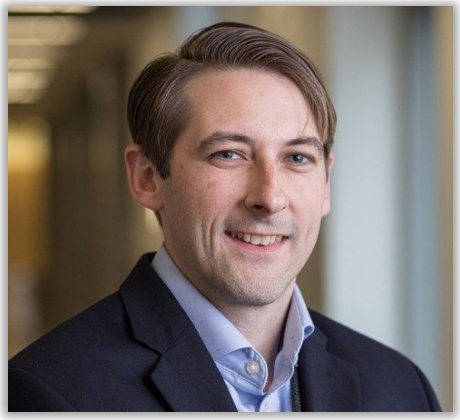

Abstract: This talk will highlight research at the Virginia Tech Advanced Propulsion and Power Laboratory (VT APPL) on problems posed to gas turbine propulsion engines by environmental solid particulates.

Air-breathing propulsion engines are exposed to a wide array of environmental influences that affect their performance, durability, and safety. One of the most pervasive of these effects is caused by airborne solid particulates that get ingested in the inlet and subsequently circulate through engine components. Once in the engine, the particles cause several damage modes to hardware and can act as a sort of engine cholesterol, clogging gas paths. Contributing to engineering solutions requires multidisciplinary approaches and strong links between fundamental research and field observations.

Our research has included applications to particle separators and engine systems while filling fundamental gaps such as the details of particle bounce and breakage. Particle separators aim to eliminate particulate impact on turbomachinery by removing particles before they enter the engine. Unfortunately, no practical particle separator can remove all particles that are entrained into the inlet flow. Our studies on vortex tube separator arrays have shown that the separation efficiency of these devices is sensitive to material properties and electrostatics in addition to the most basic understanding gained from aerodynamics and Stokes number (the ratio of particle time scale of motion to the fluid time scale). Inside the engine, the particles themselves evolve in size and shape as they strike rotor blades, making the prediction of their effects on the engine a systems-level problem. The talk will include a sampling of interesting results from our turbine engine-based research such as observation of rapid "milling" of particles in an axial compressor and patterns of erosion onset throughout the axial compressor. The talk will conclude with a discussion of converging research thrusts that can significantly advance the complex problem posed by particles in gas turbine engines.

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