Extended Abstract

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Traditionally, intrusive instruments such as total pressure and total temperature probes have been used to measure compressible flow conditions. While these instruments are effective and widely used, they generate turbulence and produce blockage which could be undesirable in a variety of applications. Throughout this research, the utilization of non-intrusive acoustic measurements for flow velocity and temperature detection in compressible flow (Mach>0.3) environments was investigated. First, a completely unique acoustic technique was developed for compressible flow applications. The new approach was used to accurately measure single-stream jet velocities and temperatures in compressible flow conditions for the first time. Later research explored the use of this technique at the exhaust of a JT15D-1A turbofan research engine. Ultimately, 1.1 kg/s and 200 N root mean square errors in mass flow and thrust were observed for the tested engine conditions. Overall, the results of this experiment demonstrated that acoustic measurements could be used to estimate engine mass flow rate and thrust in a non-intrusive manner. The final portion of this research focuses on the non-intrusive detection of fluid velocity and temperature gradients. Since existing acoustic tomography techniques require an incompressible flow assumption, a completely unique approach has been proposed and wont to perform a validation experiment within the singlestream jet facility. The recent experimental findings indicate that non-intrusive acoustic measurements could be used to measure velocity and temperature gradients in compressible flow environments as well. Further research is currently being conducted to better understand the accuracy limitations of the proposed tomography technique. To the authors??? knowledge, this is the first time a non-intrusive acoustic technique has been used to characterize engine flows with Mach numbers greater than 0.3. Recent Publications 1. Otero R, Lowe K T and Ng W F (2017) Extension of sonic anemometry to high subsonic Mach number flows. Measurement Science and Technology 28(3):035306. 2. Otero Jr R, Lowe K T and Ng W F (2017) Non-intrusive acoustic measurement of flow velocity and temperature during a high subsonic Mach number jet. Measurement Science and Technology 29(1):015106. 3. Otero Jr R, Lowe K T, Ng W F, Ma L and Kim C Y (2017) Nonintrusive gas-turbine engine-exhaust characterization using acoustic measurements. Journal of Propulsion and Power 1-9. Non–invasive transducers don't inherit contact with the fluid and are placed on the surface of the pipe. Intrusive devices protrude into the flow and warp the flow profile. The distortion often results in mis-measurement by introducing asymmetry to the speed profile. The reason non-intrusive and particularly non-invasive flow meters are so popular is because they are doing not protrude into the flow, don't are available to contact with fluid and do not generate any pressure losses. Non intrusive devices don't interfere with the flow profile. No pressure drop is observed meaning that these devices are more cost effective to work . They are also non-invasive which suggests they are doing not inherit contact with the fluid being measured. This is very beneficial when measuring dangerous or corrosive fluids that would damage sensor heads. It also means the transducers can be used alongside heavily fouling fluids and not be affected.

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