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Measurements of 3D velocity and scalar field for a film-cooled airfoil trailing edge[1] MICHAEL BENSON, CHRISTOPHER ELKINS, JOHN EATON, Stanford University — Turbine blade tips commonly are cooled by venting air through slots upstream of the trailing edge. The effectiveness of this approach is governed by the rate of mixing of the coolant with the mainstream flow, which is strongly under-predicted by conventional RANS models. Experiments were conducted for a simple airfoil with a modern trailing edge cooling geometry. The full 3D coolant concentration distribution was measured using Magnetic Resonance Imaging (MRI). The scans measured the concentration distribution with a spatial resolution of 0.5 mm^3 and an uncertainty near 5%. Magnetic Resonance Velocimetry (MRV) was used to provide 3D, mean velocity measurements in the identical flow. Blowing ratios of 1.0, 1.3, and 1.5 were examined at Reynolds numbers of 50,000 and 100,000 based on airfoil chord length. The coupled concentration and velocity measurements were used to develop a qualitative picture of the flow structures contributing to the rapid mixing. Surface concentration measurements provide film cooling effectiveness data, which were compared for validation purposes with traditional thermal measurements. The MRI-based technique for measuring film cooling effectiveness avoids the large uncertainties caused by conduction in the thermal tests.

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