Skin Friction Measurement using Oil Film Interferometry

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Abstract

As a result of the no-slip condition, fluid velocity at fluid-surface interfaces must be equivalent to the surface velocity. This condition gives rise to viscous shear stresses, or skin friction, on all surfaces within a flow. Determination of skin friction is essential in many fluids experiments in order to understand more complicated phenomena. Ideally, skin friction can be found from conservation equations, but in some situations with turbulent flows this approach no longer provides acceptable accuracy. Consequently, superior techniques have been developed over the past two decades. This research investigates the use of oil-film interferometry to find such shear stresses on a wind tunnel floor within a turbulent boundary layer. The method entails placing small drop of silicon oil on a surface inside the wind tunnel. With a free stream flow, the shear stress on the oil's surface causes it to thin out in the flow direction. When carefully illuminated by a monochromatic light source, Fizeau fringes become visible within the oil and invariably change with time. Single images of these fringes are captured with a video camera at some time interval. Measuring the distance between each fringe at every time interval and correlating it with known parameters yields the time-dependent thickness of the oil film. These results in conjunction with the thin oil-film equation reveal the value for the shear stress on the surface.