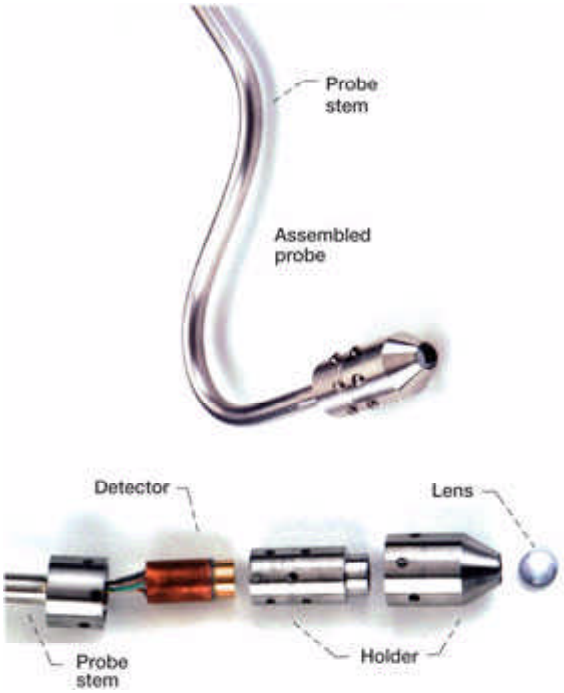
Heated Surface Temperatures Measured by Infrared Detector in a Cascade Environment

Investigators have used infrared devices to accurately measure heated surface temperatures. Several of these applications have been for turbine heat transfer studies involving film cooling and surface roughness, (ref. 1), Typically, these measurements use an infrared camera positioned externally to the test section. In cascade studies, where several blades are used to ensure periodic flow, adjacent blades block the externally positioned camera's views of the test blade. To obtain a more complete mapping of the surface temperatures, researchers at the NASA Glenn Research Center fabricated a probe with an infrared detector to sense the blade temperatures. The probe size was kept small to minimize the flow disturbance. By traversing and rotating the probe, using the same approach as for total pressure surveys, one can find the blade surface temperatures. Probe-mounted infrared detectors are appropriate for measuring surface temperatures where an externally positioned infrared camera is unable to completely view the test object.



Sketch of infrared probe.

This probe (see the figure) consists of a 8-mm gallium arsinide (GaAs) lens mounted in front of a mercury-cadmium-zinc-tellurium (HgCdZnTe) detector. This type of photovoltaic detector was chosen because of its high sensitivity to temperature when the detector is uncooled. The particular application is for relatively low surface temperatures, typically ambient to 100 °C. This requires a detector sensitive at long wavelengths. The detector is a commercial product enclosed in a 9-mm-diameter package. The GaAs lens

material was chosen because of its glass-like hardness and its good long-wavelength transmission characteristics. When assembled, the 6.4-mm probe stem is held in the traversing actuator. Since the entire probe is above the measurement plane, the flow field disturbance in the measurement plane is minimized. This particular probe body is somewhat wider than necessary, because it was designed to have replaceable detectors and lenses.

The signal for the detector is fed through the hollow probe body. The detector's signal goes to an externally mounted preamplifier. The detector assembly, along with a preamplifier, is calibrated as a function of the surface temperature for various detector temperatures. The output voltage is a function of both the detector and object temperatures.

Reference

1. Boyle, R.J., et al.: Infrared Low-Temperature Turbine Vane Rough Surface Heat Transfer Measurements. ASME J. Turbomachinery, vol. 123, no. 1, 2001, pp. 168-177. (Also NASA/TM-2000-210220.)

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