

A new sensor for temperature measurement of water by laser interferometry technique

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Keywords: Interferometry, Temperature, Water, Measurement

We previously developed a temperature measurement system using interferometry and used it to measure unburned gas temperature in an engine cylinder. In this study, a new sensor is proposed to determine water temperature. This sensor utilizes the difference in measurement length between two laser beams. Both are the test beams, and there is no reference beam. The two beams pass mostly through equal or closely arranged paths; therefore, the effect of mechanical vibration on the two test beams is expected to be very small. Water temperature was measured with this new sensor system.

1. Experimental Method

A helium-neon laser with a wavelength of 632.8 nm was used as a light source. The laser beam was introduced through a selfoc micro lens (SML) into a polarization-maintaining fiber connected with a sensor part. The beam emitted from another SML was divided into two. Both beams enter a quartz block and are reflected at the corner to change direction by an angle of $\pi/4$. They then pass through the test section although the lengths of the two beams are different in the measurement region.

This sensor was installed on a side wall of a vessel as shown in Fig.1. The optical system mentioned above is installed in the sensor. Water was poured into the vessel and stirred with a hot magnetic stirrer. The water temperature was increased with a heater. The temperature near the sensor was also measured with a K-type thermocouple as a reference.

2. Results

First, a difference of 2.05 mm for the measurement length was prepared to perform the experiment. Both interference signals changed periodically with time when the temperature increased. Data were obtained for only one experimental run. Only the top and the bottom of the interference signal were analyzed here. As shown in Fig. 2, the temperature obtained from this interferometry system presents a good agreement with the temperature determined with a thermocouple.

The variation of the temperature increased at higher temperatures because the convective movement of water becomes stronger as the temperature increases.

When the measurement length of the sensors was changed, the temperature obtained from this system agreed well with that from the thermocouple.

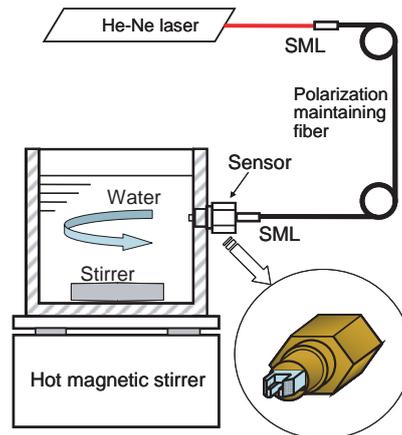


Fig. 1 Interference signals obtained from two detectors.

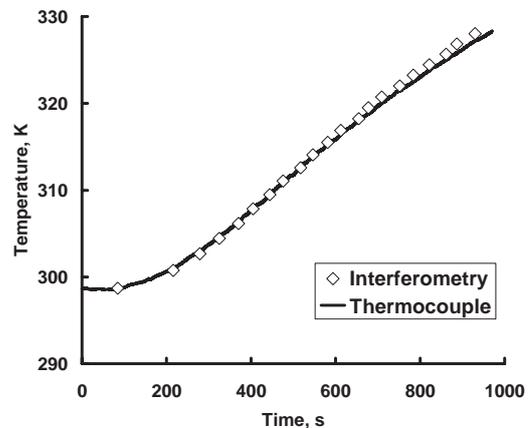


Fig. 2 Temperature determined from the interferometry system and from a thermocouple.

3. Summary

A new sensor for fluid temperature measurement using interferometry was developed. Water temperature was measured with this sensor and compared with that obtained using a thermocouple. It was confirmed that this sensor system is useful in detecting changes in fluid temperature. One of the features of this sensor is that it uses almost the same paths for two beams so that the vibration of the fiber does not affect the interference signals. Another feature of this system is that it minimizes the effect of the thermal boundary layer. It is expected that this optical system is strong enough to apply not only to laboratory use but also to industrial use in future.