Temperature Distribution Measurement of Transparent Fluids Using Twyman-Green Interferometer

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Temperature field measurement, especially real-time monitoring, has undeniable value in various aspects, but when the field is of uneven gas and high temperature, there’re still imperfections in current methods such as thermocouple or infrared imaging. Therefore, a real-time method based on Twyman-Green interferometry is proposed for measuring temperature distribution of this transparent fluid, which meets the demands of non-intrusive, continuous sampling in space, and high accuracy. Through the ideal gas equation and Glaston-Dell equation, the temperature of a point is connected to its change of refractive index, which can be turned into the shift of interference fringes. This calibration formula obtained here is used to fit the data of fringe shift by temperature at the outlet of the heat gun under different set temperatures. Then the measuring formula, its reciprocal process, is obtained, which is used to calculate the temperature of each point, visualizing this temperature field. After calibration, temperature fields in this condition and under any similar temperature can be measured and visualized in real-time. To explore the underlying properties of heated fluids, the Laplace equation is used to try to describe the model, and with its boundary conditions, the analytical solution is obtained. The simulated spatial distribution of temperature verified this hypothesis. The results showed that this method with a calibration system using Twyman-Green interferometry can successfully visualize the temperature field of gas, and provided a feasible method for other transparent fluids.

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