The Use of Liquid Crystal Technique in a Heat Transfer Experiment System

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ABSTRACT

The main objective of the present study is to construct a heat transfer experimental system, which utilizes liquid crystal technique. In this study, the fundamental theory for three basic heat transfer experimental methods utilizing liquid crystal technique was first described. They are（1）steady state method,（2）transient method with single-step heating at surface and（3）transient method with multiple-step heating at surface. Then important issues of using liquid crystal technique for the construction of an experimental system were investigated and summarized. The issues include the selection of liquid crystal, selection of experimental parameters, optical properties and temperature calibration of liquid crystal, lighting and viewing method, image system, and post processing of image data and heat transfer data. After an experiment system was constructed by considering those important issues, it was tested for the problem of flow over a flat plate with an unheated starting length and the problem of a long cylinder in cross flow. Two of the above-mentioned methods:（1）steady state method and（2）transient method with single-step heating at surface, were used in the experiments. Results of local heat transfer coefficient distribution were compared with known analytical solution or experimental results to check the correctness of the system. Using the steady state method and the transient method with single step heating at the solid surface, the experimental results of flat plate show that the local heat transfer coefficient data agree very well with the theoretical values, confirming the validity of the newly constructed experimental system and the newly developed software. For the case of a cylinder in cross flow, the local Nusselt number measured with the new system also compare reasonably well with the data in the literature.

Keywords : liquid crystal technique ; steady state method ; transient method ; step heating

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