Experimental investigation of forced convective heat transfer in cylindrical pipe flow

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I. Introduction

In recent years, forced convective heat transfer in cylindrical pipe flow plays an important role in many technical cooling systems. Considering heat transfer issues, heat transfer coefficient is one of the most important numbers.

$$h = \frac{Nu \cdot K}{L} \tag{1}$$

From general dimensional analysis, Nusselt number represents function of Reynolds number (Re) times Prandtl number (Pr) as following equation.

$$Nu = \alpha \cdot Re^{\pi_\beta} \cdot Pr^{\pi_\gamma} \tag{2}$$

Here, factors α, β and γ are constant value depend on flow regime and calculated from experimental result. By using above (1), we can easily find out heat transfer coefficient from (2).

Many studies have pointed out that heat transfer coefficient vary depending on the type of flow: laminar, transition and turbulent. Gnienlinski [1] showed calculation method for laminar heat transfer coefficient of two kinds of boundary conditions. (I) Constant wall temperature (UWT) and (II) Constant heat flux (UHF). Petukhvov and Kirillov [2] showed calculation method for turbulent flow. There are very scare experimental data of laminar-to-turbulent transitional region. Bertsche et al, [3] focused on reliable prediction of heat transfer coefficient for transitional flows. In their study, Bertsche et al, showed experimental heat transfer coefficients for Reynolds number $500 < Re < 23000$ and Prandtl number $7 < Pr < 41$.

Most of studies focused on providing experimental data with water and air. In this paper, we focus on forced convective heat transfer in cylindrical pipe flow with water and glycole. A 50/50vol% mixture of water and glycole which is a typical liquid coolant in automotive applications were used as a operating fluid. The experiment carried out considering a board range of Reynolds number, spanning from laminar to fully turbulent flow. In this paper we apply the techniques of Laser-induced fluorescence (LIF) to find out temperature distribution in cylindrical pipe flow. Moreover, the investigation shall also include the measurement of wall friction coefficient.

References

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