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Effect of surface roughness on friction Factors of gas flow through micro-tubes

Shuhei Ueda[1], Chungpyo Hong[1], Yutaka Asako[2], Danish Rehman[3], Gian Luca Morini [3]

Abstract

Advanced development to the microfabrication technology has increased the need for an understanding of fluid flow and heat transfer of micro flow devices such as micro-heat exchangers, micro-reactors and many other micro-fluid systems. Therefore, numerous experimental and numerical studies have been performed in an effort to better understand flow characteristics in microchannels. It is well understood that microchannel gas flows are significantly affected by the combined effects of rarefaction (slip on a surface), surface roughness and compressibility. In the present experimental study (Fig. 1), the effects of surface roughness on average and local friction factors of nitrogen gas flow through micro-tubes quantitatively investigated since the effect of surface roughness on micro-channel flows is relatively large compared to conventional tube flows). The $f_{f,\,ave}$ obtained for the glass and the fused silica micro-tube and the $f_{f,\,ave}$ obtained for the stainless steel micro-tube in the range of Re < 5000 coincide with *Blasius* correlation. However, the $f_{f,\,ave}$ obtained for the stainless steel micro-tube deviates from *Blasius* correlation and it coincides with the values obtained by the Colebrook-White equation in the range of Re>7000 because of the effect of the surface roughness (Fig. 2).

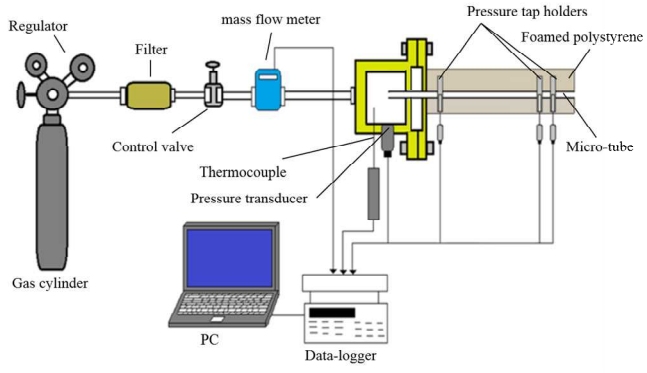

Fig. 1 Schematic of experimental setup

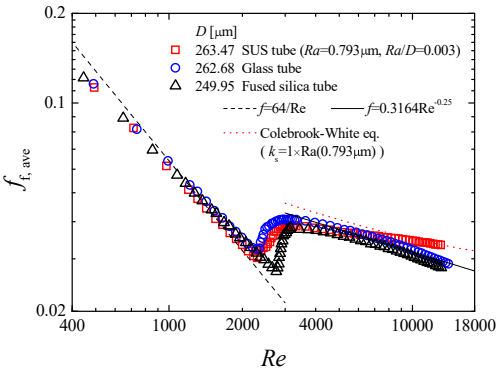

Fig. 2 Average friction factor

[1]Kagoshima University, 1-21-40 Korimoto, Kagoshima, 890-0065 Japan

[2]University Technology Malaysia, Jalan Sultan Yahya Petra 54100 Kuala Lumpur, Malaysia

[3]University of Bologna, Via del Lazzaretto 15/5, 40131 Bologna, Italy