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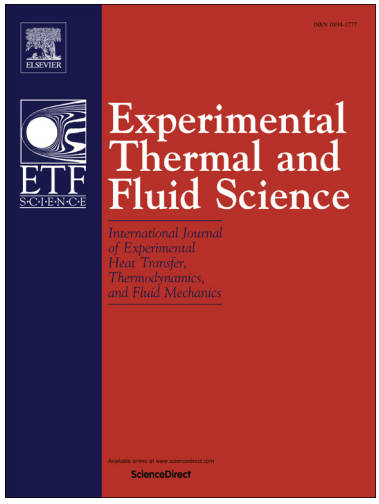

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The Friction Characteristics of Low-Frequency Transitional Pulsatile Flows in Narrow Channel

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Abstract

Narrow or mini-channels are widely used in various devices of process and energy engineering including research-reactors, compact heat exchangers and fuel cells. Friction characteristics in laminar-turbulent transition range of low-frequency pulsatile flows in a narrow rectangular duct have been studied. The experiments were conducted under the conditions of time-averaged Reynolds number 575<Re_{ta}<5583, pulsatile amplitude 0.056<A_u<0.988, and dimensionless frequency $0.52 \le \sqrt{\omega'} \le 2.34$. The results indicate that: 1) the impact of flow fluctuation on friction characteristics is most significant in the transitional range. The pulsatile amplitude and dimensionless frequency have comprehensive impact on time-averaged friction characteristics. The ratio *C* ($C = \lambda_{ta}/\lambda_{st}$) of time-averaged friction factor to steady-state friction factor, increases with the increasing pulsatile amplitude A_u and dimensionless frequency $\sqrt{\omega'}$. A dimensionless acceleration was proposed to analyze the influence form and degree of pulsatile parameters. 2) The increasing of $\sqrt{\omega'}$ and A_u cause a decrease in the pulsatile critical Reynolds number $\mathrm{Re}_{ta,cr}$. In addition, a correlation is proposed to predict the pulsatile critical Reynolds number. Transitional pulsatile flow may undergo cross regime process, i.e., laminar, transition, turbulence and re-laminarization. The decrease of pulsatile critical Reynolds number caused by the increasing $\sqrt{\omega'}$ and Au, and the cross regime process was inferred to be responsible for the increase of time-averaged friction factor.

Keywords

Pulsatile flow; Laminar-turbulence transition; Friction characteristics; Critical Reynolds number; dimensionless acceleration

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