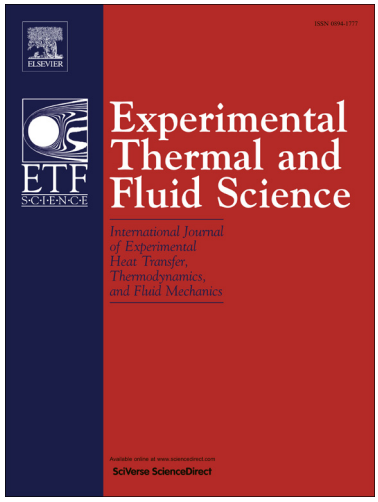

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Abstract

An experimental investigation is carried out to understand the hydrodynamics of single-phase water flow in a zigzag microchannel with a semi-circular cross-section (diameter 2 mm). The present study covers Reynolds numbers in the laminar regime, under both steady and transient conditions. Time-resolved velocity measurements were made using high-speed micro-PIV techniques. The influence of inlet unsteadiness on flow characteristics is investigated. Through time-resolved velocity measurements, a transition from a steady flow to a time-dependent oscillatory flow having a few dominant frequencies and subsequently to a complex transient flow is observed in the wavy channel. However, the transition to a transient flow occurs at much lower Reynolds numbers (Re_c ~ 215) than predicted numerically. The early transition is believed to be triggered by small inlet flow disturbances in the experiments, since the flow is very sensitive to the inlet conditions at sufficiently high Reynolds numbers. This hypothesis is supported by results from transient CFD simulations with fluctuating inlet boundary conditions.

Keywords: Hydrodynamics, Tortuous microchannels, Micro-PIV, Visualisation, Transient behaviour, Fluctuations

1. Introduction

The growing importance of compact heat exchangers for use in chemical plants and electronic cooling has led to enormous interest in flow in tortuous microchannels due to their great potential to enhance fluid mixing and heat transfer. The design and application of tortuous passages is raising the importance of understanding the fluid dynamics and transport behaviour in micro-structured systems.