Experimental investigations for annular effect in a regenerator-exchanger of magnetocaloric heat pump

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Abstract

Magnetocaloric refrigeration system is identified as a candidate to replace the conventional devices. In this kind of system, the active magnetic regeneration (AMR) cycle is usually applied for magnetizing/demagnetizing magnetocaloric materials (MCM), and oscillating flow is used to realize the heat transfer between coolant and MCM. Various studies on magnetocaloric device mainly focus on the system designs, such as utilization of magnetocaloric materials and distribution of magnetic field, to maximize the temperature span and cooling power. However, the oscillating flow behavior, which is less studied, plays another significant role that could affect the performance of caloric devices. In this flow, a particular phenomenon named annular effect could appear in the boundary layer. It creates a maximal flow velocity gradient near the fluid-solid interface. This irregular velocity gradient could potentially increase the heat transfer efficiency even the COP of heat pump.

Therefore, this article presents an experimental investigation for visualization of annular effect. The experimental bench is composed of two main parts: a quartz duct of square cross section made for the observation area, and the fluidic system, which generates the oscillating flow via two synchronized electromagnetic valves and a circulator pump. To determine the velocity profile, Laser Doppler Velocimetry (LDV) method is used to measure the sparkling frequency of micro particles.

Figure below shows the near wall velocity profile as function of the phase. The comparison between experimental results and numerical simulation will be realized. The further study about the heat transfer in oscillating flow could be expected in the case that the modification of experimental bench could be completed.

Keywords: Caloric device, Heat pumping, Refrigeration, Oscillating flow, Visualization, Laser Doppler Velocimetry, Annular effect.

Key Results

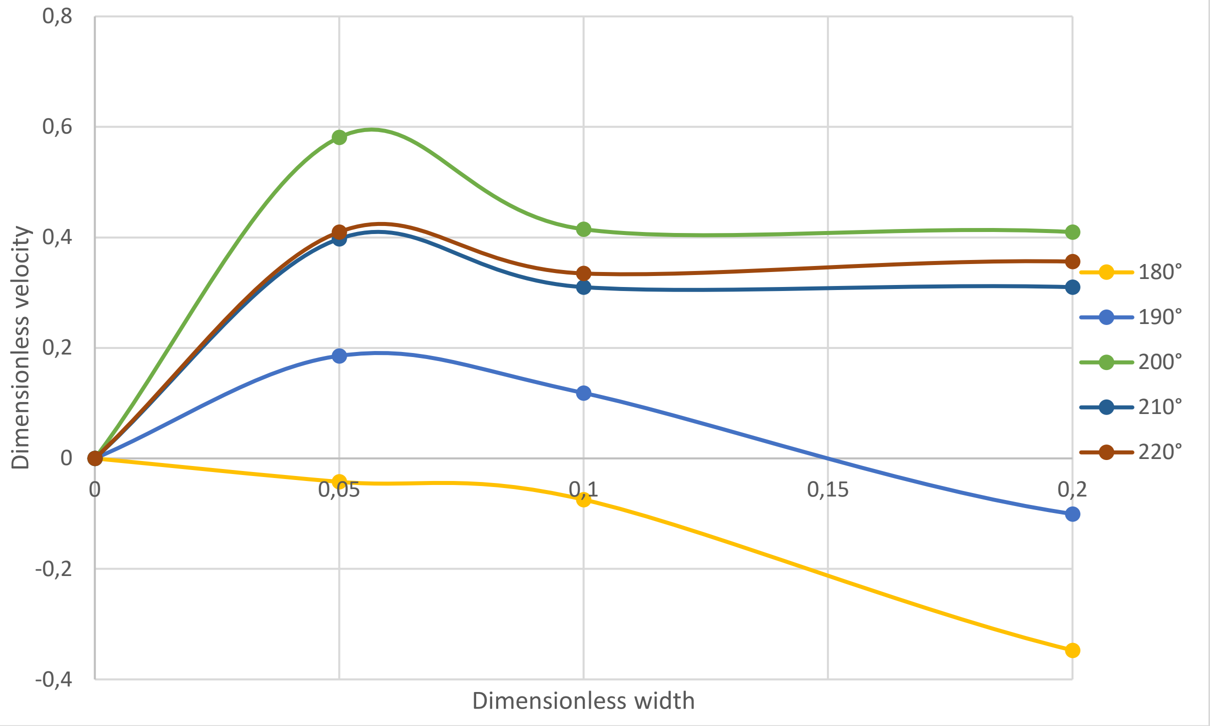

Figure: Near wall velocity profile as function of the phase

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