A computation of flow and heat transfer past three heated cylinders in a vee shape by a double distribution MRT thermal lattice Boltzmann model

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1. Introduction

The study of fluid flow and heat transfer behaviour around a bluff body is important in number of practical fields such as heat exchanger systems, gas turbine blades, flame stabilizer, electronic cooling, vehicle, and building aerodynamics. This research is also useful for validation of numerical codes to compute complex flows with huge experimental database on drag force and heat transfer. Thus, during last years, a host of experimental and numerical investigations has been carried out to understand flow and heat transfer past a single square, circular or any other geometric shapes of cylinder in cross flows. Nevertheless, substantially few works have addressed the interference effects between multiple cylinders and the number of publications available becomes drastically smaller as the number of cylinders involved increases.

Lam and Cheung [36] studied the shedding frequency characteristics and flow interaction between three circular cylinders arranged in an equidistant triangular cluster at different angles of incidence and spacing ratios. In their experiment, they clearly showed that some well-known flow patterns in two-cylinder arrays have been significantly changed owing to the presence of a third cylinder. Igarashi [26] studied experimentally the aerodynamic forces acting on three cylinders having different diameters composed of a main cylinder and two sub-cylinders closely arranged in line. They indicated that the flow patterns were changed by the reattachment of the separated shear layer from the upstream cylinder to the downstream cylinder. Horibe et al. [25] conducted an experimental work to determine the effects of the distance between three cylinders formed across and its axial variation on the forced convection heat transfer characteristics at a Reynolds number of \(4.6 \times 10^4\). Experimental investigation employing a digital particle imaging velocimetry (DPIV) method and laser induced fluorescence flow (LIF) visualization technique was conducted by Lam et al. [37] to examine the characteristics of the flow pattern observed around the four cylinders in an in-line square configuration.

Kundu et al. [31] adopted a numerical approach using the stream function-vorticity formulation to simulate laminar flow and heat transfer over a row of in-line cylinders placed between two parallel plates. They concluded that the shape and appearance of standing vortices and the shedding of vortices which affect the heat transfer of the flow are controlled by the spacing between cylinders and the distance between plates control. Chatterjee et al. [8] have performed numerically the unsteady forced convection heat transfer from a row

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