Experimental validation of a CFD algorithm for controlled flow distribution

Guillaume Boutin[1], Gwenaël Biotteau[1], Nicolas Lefevre[1], Yilin Fan[1], Lingai L[1,*]

[1] Laboratoire de Thermocinétique de Nantes, UMR CNRS 6607, Polytech' Nantes – Université de Nantes, France
*corresponding author: Lingai.luo@univ-nantes.fr

Abstract Multi tubular channels flow is often used in industrial processes such as heat exchangers, fluidized beds, and catalytic monoliths. However, maldistribution of the flow into a bundle of parallel channel of multi tubular equipment is an important cause of the global efficiency reduction. Different solutions can be proposed. One of them consists to optimize the geometrical parameters such as the diffuser angle1 or adding hydraulic resistance inside the distributor. A simple way is to introduce a perforated baffle in the inlet distributor to improve the flow distribution uniformity. However, in any case the topology of the distribution of orifices, like the diameter and their arrangement, are either empirical or intuitive. Our research team developed a original algorithm2,3,4 to design the optimal arrangement and holes diameters.

The main objective of the present work is to validate this CFD algorithm by experimental investigations. In this way, we firstly fixed the geometry of the distributor and aerodynamics parameters such as Reynolds numbers and the inlet/outlet fluid locations. Three different geometries are investigated. The global flow consists to inject water by a main tube which is distributed using a baffle into 15 squares channels. The fluid is finally collected into one square tube. The position of inlet/outlet can be varied. First they are placed in the middle of the 15 channels and in the same axis. Secondly, a tangential inlet and outlet is considered and finally, the same inlet/outlet injection is considering with a variable section between the first and the 15th channel. The angle of this diffuser is previously optimized by the CFD algorithm.

The purpose, here, is to estimate the flow rate of each channel. PIV diagnostic was previously considered but, due to many PMMA/water interfaces many problem of refraction light occur, so we chose a fast flow imaging technique. Fluorescent tracer is injected in the flow as a Dirac-function and is excited by a uniform black light and its signal is collected on a fast CCD camera. Fluorescent traces may still be observed before exit of the test section. Using images post-processing the velocity field is re-constructed.
Keywords: Flow maldistribution; Controlled distribution; Flow imaging; Channel; Distributor;

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