CFD Simulation of flow through pipe: A comparative study on cyclic and inlet-outlet type boundary conditions in OpenFOAM

Nikhil Sharma

Department of Mechanical Engineering
Malaviya National Institute of Technology Jaipur, Rajasthan India

Abstract

The aim of this project is to fully understand the working and usage of cyclic boundary conditions in OpenFOAM and use it to simulate pipe flow. Pipe may be modelled as a sector of cross section as the flow is axisymmetric. The objectives of the project are:

- To simulate a laminar and turbulent flow(using standard k-ϵ model) through pipe using cyclic boundary conditions.
- To simulate the same turbulent flow using different turbulence models (realizable k-ϵ, k-ω and k-ω SST).

The results obtained using cyclic boundaries are compared with those of a full length pipe and available analytical results. A source term is needed to drive the flow when using cyclic boundaries, to add this term without modifying the source code, *fVOptions* utility is used. Transient, incompressible, turbulent solver pimple-Foam is used for the simulations as it can deal with advanced modelling capabilities unlike icoFoam which is a very basic solver with very little modelling capabilities. Fluid properties and flow parameters are given below in table 1.

	Unit	Laminar	Turbulent
Density(ρ)	kgm^{-3}	996	996
Dynamic viscosity(μ)	$kgm^{-1}s^{-1}$	$7.98 * 10^{-4}$	$7.98 * 10^{-4}$
Reynolds Number	-	2100	10^5
Mean velocity	ms^{-1}	$8.4 * 10^{-2}$	4.01
Radius of the pipe	m	0.01	0.01
Length of the pipe	m	3	2

Table 1: Different parameters used in the simulations

REFERENCE

1. S. Patankar, C. Liu, and E. Sparrow. Fully developed flow and heat transfer in ducts havingstreamwise-periodic variations of cross-sectional area. 1977.