Universiti Malaysia PAHANG
Engineering • Technology • Creativity

FACULTY OF MECHANICAL ENGINEERING

BMM4873 COMPUTATIOINAL FLUID DYNAMICS

Assignment 2

1. Objective

Many numerical works have been done on a fluid flow separation and reattachment flow through a backward-facing step due the reason that it is commonly used as a benchmark for validation of numerous flow characteristics. Some of the applications include multiphase flows, HHAC, combustion, nuclear reactor cooling, etc [1, 2]. Thus, it is important to understand the flow behavior inside such channel.

The main task in this simulation is to conduct 2D simulation of flow and heat transfer through a backward-facing step as shown in Figure 1.

After finishing this assignment, it believed that the students will learn how to

- create the computational domain and generate good quality mesh (pre-processing)
- setup the solver in Fluent (Solving)
- analyze the numerical results (post-processing)

2. Problem Description

The physical problem the student required to run is a two-dimensional, steady, laminar convective flow through a backward-facing step as detailed in Figure 1.

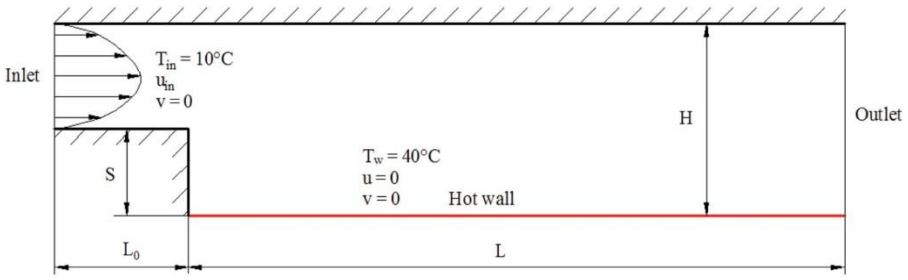

Figure 1. Schematic of a 2D backward-facing step Geometry [1].

Cold air at 10 ^{o}C enters from the left edge and leaves through the right edge. The lower edge of the channels is heated at constant temperature of 40 ^{o}C and the reaming walls insulated. The dimensions and the boundary conditions are tabulated in Table 1

Geometry Details	
Dimensions	**Values (in mm)**
S	15
H	45
L_o	15
L	1500

Boundary Conditions	
BC Type	**Value**
Inlet	T_{in}=27, v_{in}=0, u_{in}=0.5 m/s
Outlet	P=0, T=room temperature
Hot Wall	T_w=40^{o}C, u=v=0 (no slip)
Insulated Wall	Zero heat flux, u=v=0

3. Instructions and Expected Results

(a) **Model creation and boundary conditions setup:**

- Use the step-by-step guideline provided for the lab exercise tutorials as reference when creating the computational domain and mesh.
- Check the mesh quality to ensure that a proper mesh quality is achieved.
- Select the appropriate fluid flow model

(b) Result generation and analysis

Your analysis should include the following:

- Velocity, pressure and temperature distribution (contour) inside the channel
- If possible, include streamlines for velocity.
- Discuss this change in reattachment location with the mesh refinement.
- Perform simulations for inlet velocities of 0.75, 1 and 2 m/s. Compile your results and create a graph highlighting the relationship between inlet velocity and reattachment points.
- Other results

References

[1] W. A. Xie and G. N. Xi, "Fluid flow and heat transfer characteristics of separation and reattachment flow over a backward-facing step," International Journal of Refrigeration, vol. 74, pp. 177-189, 2017/02/01/ 2017.

[2] H. H. Choi, V. T. Nguyen, and J. Nguyen, "Numerical Investigation of Backward Facing Step Flow over Various Step Angles," Procedia Engineering, vol. 154, pp. 420-425, 2016/01/01/ 2016.