57:020 Mechanics of Fluids and Transport Processes

Simulation of Laminar and Turbulent Pipe Flows

Submitted to: Professor Frederick Stern

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Date:Month/Date/2013

I. CFD PreLab 1 Questions (submitted before PreLab1, 10 points)

II. Test and Simulation Design (10 points)

Using your own words to describe the purpose of the CFD simulation.

III. CFD Process (10 points)

Using either table or Flow chart to describe the correct CFD Process, which options will be used in CFD PreLab 1 and CFD Lab 1, and what parameters (with values) need to be specified for each option.

IV. Data Analysis and Discussion (50 points)

A. Figures and tables in CFD PreLab 1 (laminar pipe flow, 10 points)

$$Error = \frac{Factor_{CFD} - Factor_{AFD}}{Factor_{AFD}} \times 100\%$$

$Factor_{CFD}$	$Factor_{AFD}$	$Error$

Developing length=______(m)

Figure 1. Residuals

Figure 2. Centerline pressure distribution

Figure 3. Centerline velocity distribution

Figure 4. Wall friction factor distribution

Figure 5. profiles of axial velocity at all axial locations with AFD data

Figure 7. Velocity vectors at the region flow

Figure 6. Contours of radial velocity	begin to become fully developed.
Figure 8. Normalized developed axial velocity profile	

B. Questions in CFD PreLab 1 (6 points)

(1). Can you use centerline pressure distribution to determine the “developing length”? Why?

Answer: ……

(2). What is the value for radial velocity at developed region?

Answer: …….

(3). Summarize your findings and relate them to classroom lectures or textbooks.

Answer: ……..

C. Figures and tables in CFD Lab 1 (turbulent pipe flow, 10 points).

$$Error = \frac{Factor_{CFD} - Factor_{EFD}}{Factor_{EFD}} \times 100\%$$

$Factor_{CFD}$	$Factor_{EFD}$	$Error$

Developing length=______(m)

Total pressure drop=_______(Pa)

	Figure 1. Residuals
Figure 2. Centerline pressure with EFD	Figure 3. Centerline velocity distribution
Figure 4. Wall friction factor distribution	Figure 5. profiles of axial velocity at all axial locations with EFD data

Figure 6. Contours of axial velocity	Figure 7. Velocity vectors at the region flow begin to become fully developed.
Figure 8. Normalized developed axial velocity profile (Laminar and Turbulence)	

D. Questions in CFD Lab 1 (24 points)

(1). Where is the mesh was clustered? Near the wall or near the axis? Why?

Answer: ……

(2). In the developed region, is the pressure constant? Where are the minimum and maximum pressure locations? What does the axial velocity profile look like? Where does it reach maximum and minimum?

Answer: ……

(3). Where is the developing region? How can you determine the length of the developing region? (hint: centerline velocity). What is the difference for axial velocity profile between "developing" region and "developed" region?

Answer: ……

(4). Compare the normalized axial velocity profiles for laminar and turbulent pipe flows at x=100D, discuss the difference of axial velocity gradient (du/dy) on the wall, which is larger?

Answer: ……

(5). What are the correct boundary conditions (velocities u, v and pressure) on the pipe wall and on the pipe centerline?

Answer: ……

(6). Summarize your findings and relate them to classroom lectures or textbooks.

Answer: ……

V. Conclusions (15 points)

A. Conclusions regarding achieving purpose of simulation (3 points)

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B. What I have learned from CFD Lab. (6 points)

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C. Comments on the hands-on experience, the software interface, and overall lab performance (4 points)

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D. Suggestions and improvements (2 points)

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