Simulating Hagen-Poiseuille flow in OpenFOAM.

Talk to a Teacher

http://www.sakshat.ac.in

National Mission on Education through ICT

http://spoken-tutorial.org

Saurabh Sawant

Date: August 22, 2019

Learning Objectives

- **To create and mesh 3D cylindrical pipe.**

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Learning Objectives

- **To create and mesh 3D cylindrical pipe.**
- **To simulate the Hagen-Poiseuille flow having fixed pressure ratio.**

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Learning Objectives

- To create and mesh 3D cylindrical pipe.
- To simulate the Hagen-Poiseuille flow having fixed pressure ratio.

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Learning Objectives

- To create and mesh 3D cylindrical pipe.
- To simulate the Hagen-Poiseuille flow having fixed pressure ratio.
- To visualize the velocity contour in ParaView.

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System Requirement

- **Linux Operating System Ubuntu version 12.04**

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System Requirement

- **Linux Operating System Ubuntu version 12.04**
- **OpenFOAM version 2.1.1**

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System Requirement

- **Linux Operating System Ubuntu version 12.04**
- **OpenFOAM version 2.1.1**
- **ParaView version 3.12.0**

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System Requirement

- The tutorials were recorded using the versions specified in previous slide.
- Subsequently the tutorials were edited to latest versions.
- To install latest system requirements go to Installation Sheet.

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Prerequisites

- **Basic Fluid Dynamics**

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Prerequisites

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Prerequisites

- **Basic Fluid Dynamics**
- **Hagen-Poiseuille flow**

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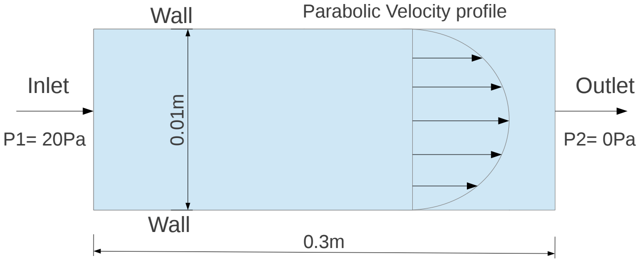
Hagen-Poiseuille Flow Diagram



For Water,
μ = Dynamic Viscosity = 1e-03
η = kinematic viscosity = 1e-06

Formulas and Analytical Solution

- **Pressure Drop along the pipe:**

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Formulas and Analytical Solution

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Formulas and Analytical Solution

- **Pressure Drop along the pipe:**
  - $P_1 - P_2 = \frac{32\mu U_{avg} L}{D^2}$

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Formulas and Analytical Solution

- **Pressure Drop along the pipe:**
  - $P_1 - P_2 = \frac{32\mu U_{avg} L}{D^2}$
  - $U_{avg} = \mathbf{0.208\ m/s}$

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Formulas and Analytical Solution

- **Pressure Drop along the pipe:**
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- **Maximum Velocity:**

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- **Maximum Velocity:**
  - $U_{max} = 2U_{avg} = \mathbf{0.416\ m/s}$

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  - $\text{Re} = \frac{U_{avg} D}{\nu} = 2080$

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Formulas and Analytical Solution

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- **Reynolds Number:**
  - **Re** $= \frac{U_{avg} D}{\nu}$ $=$ **2080**
  - **Hence, the flow is transient.**

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Solver

- **IcoFoam**

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Solver

- **IcoFoam**

Solver

- **IcoFoam**
- **It is a Transient Solver**

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Solver

- IcoFoam
- It is a Transient Solver

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Solver

- IcoFoam
- It is a Transient Solver
- Used for Incompressible, laminar flow of Newtonian fluid

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Pressure Boundary Conditions

- **Inlet: fixedPressure**

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Pressure Boundary Conditions

- **Inlet: fixedPressure**

Pressure Boundary Conditions

- **Inlet: fixedPressure**
- **Outlet: fixedPressure**

Pressure Boundary Conditions

- **Inlet: fixedPressure**
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Pressure Boundary Conditions

- **Inlet: fixedPressure**
- **Outlet: fixedPressure**
- **Walls: ZeroGradient**

Velocity Boundary Conditions

- **Inlet: pressureInletVelocity**

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Velocity Boundary Conditions

- **Inlet: pressureInletVelocity**

Velocity Boundary Conditions

- **Inlet: pressureInletVelocity**
- **Outlet: zeroGradient**

Velocity Boundary Conditions

- **Inlet: pressureInletVelocity**
- **Outlet: zeroGradient**

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Velocity Boundary Conditions

- **Inlet: pressureInletVelocity**
- **Outlet: zeroGradient**
- **Walls: fixedValue**

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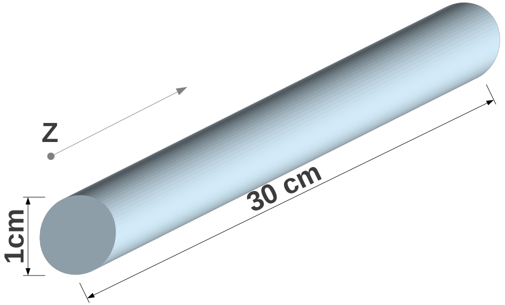
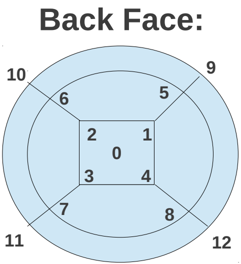
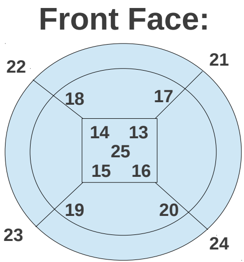
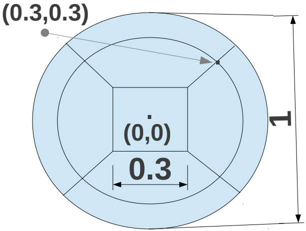
3D Pipe



Blocking Strategy







DIMENSIONS
(in cm)

Summary

- To create and mesh a 3D pipe geometry.

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Summary

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Summary

- To create and mesh a 3D pipe geometry.
- To simulate Hagen-Poiseuille flow for a fixed pressure ratio.
- To visualize the velocity results in paraFoam.

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Assignment

- Change the geometry parameters such as length and diameter.

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Assignment

- **Change the geometry parameters such as length and diameter.**

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Assignment

- Change the geometry parameters such as length and diameter.
- Change the corresponding pressure ratio.

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Assignment

- **Change the geometry parameters such as length and diameter.**
- **Change the corresponding pressure ratio.**

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Assignment

- Change the geometry parameters such as length and diameter.
- Change the corresponding pressure ratio.
- Use the fluid of different viscosity.

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About the Spoken Tutorial Project

- **Watch the video available at http://spoken-tutorial.org/What_is_a_Spoken_Tutorial**
- **It summarises the Spoken Tutorial project**

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Spoken Tutorial Workshops

The Spoken Tutorial Project Team

- **Conducts workshops using spoken tutorials**
- **Gives certificates to those who pass an online test**
- **For more details, please write to contact@spoken-tutorial.org**

Forum to answer questions

- **Do you have questions on THIS Spoken Tutorial?**
- **Choose the minute and second where you have the question.**
- **Explain your question briefly.**
- **Someone from the FOSSEE team will answer them. Please visit http://forums.spoken-tutorial.org/**

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Forum to answer questions

- Questions not related to the Spoken Tutorial?
- Do you have general / technical questions on the Software?
- Please visit the FOSSEE Forum http://forums.fossee.in/
- Choose the Software and post your question.

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Lab Migration Project

- **We coordinate migration from commercial CFD software like ANSYS to OpenFOAM**
- **We conduct free Workshops and provide solutions to CFD Problem Statements in OpenFOAM**

For more details, please visit this site:

http://cfd.fossee.in/

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Case Study Project

- **The FOSSEE team coordinates solving past, current or new CFD projects using OpenFOAM**
- **We give honorarium and certificate to those who do this**

For more details, please visit this site:

http://cfd.fossee.in/

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Acknowledgements

- **Spoken Tutorial Project is a part of the Talk to a Teacher project**
- **It is supported by the National Mission on Education through ICT, MHRD, Government of India**
- **More information on this Mission is available at http://spoken-tutorial.org/NMEICT-Intro**

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