Pressure Loss due to Sudden Contraction in Rectangular Ducts

Jeremy VanBuren

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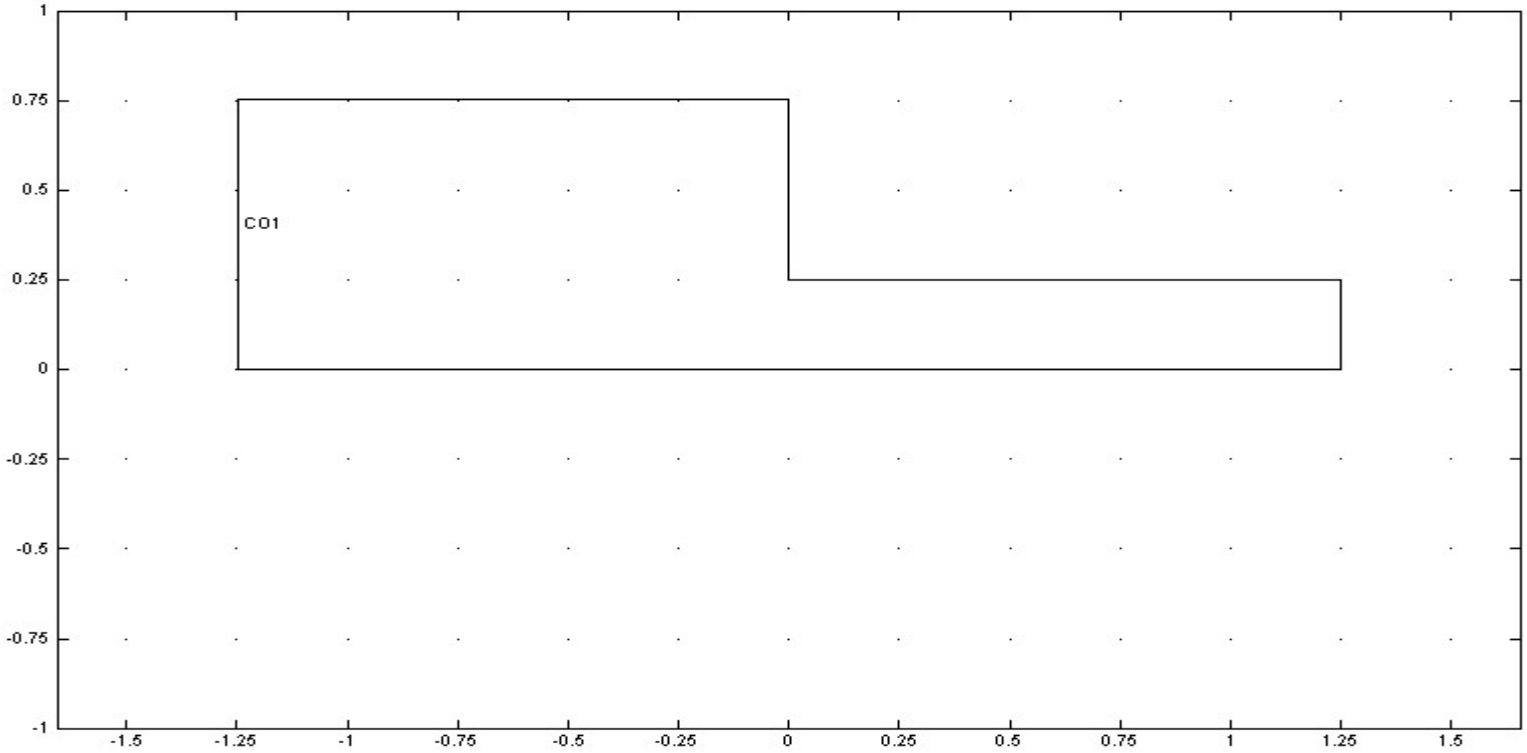
Chem E 499

Overview

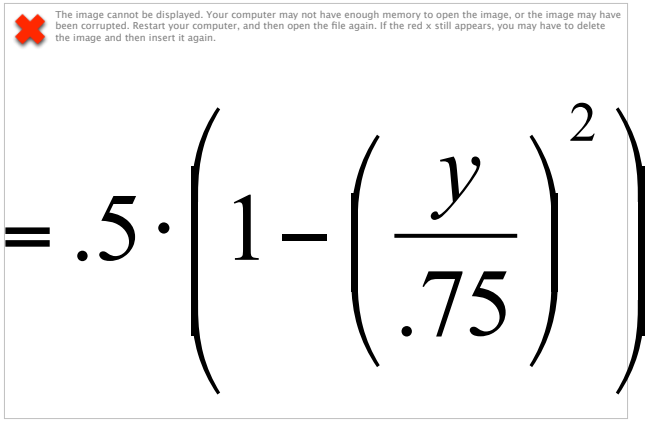
- **2 and 3 Dimensional Rectangular Ducts**
  - **Geometry**
  - **Equations Used**
  - **Boundary Conditions**
  - **Mesh Selection**
  - **Solutions**
  - **Data Trends**

2-D, Plane Geometry



Equations Used

- Inlet velocity must be Fully Developed (Laminar Flow: Parabolic)



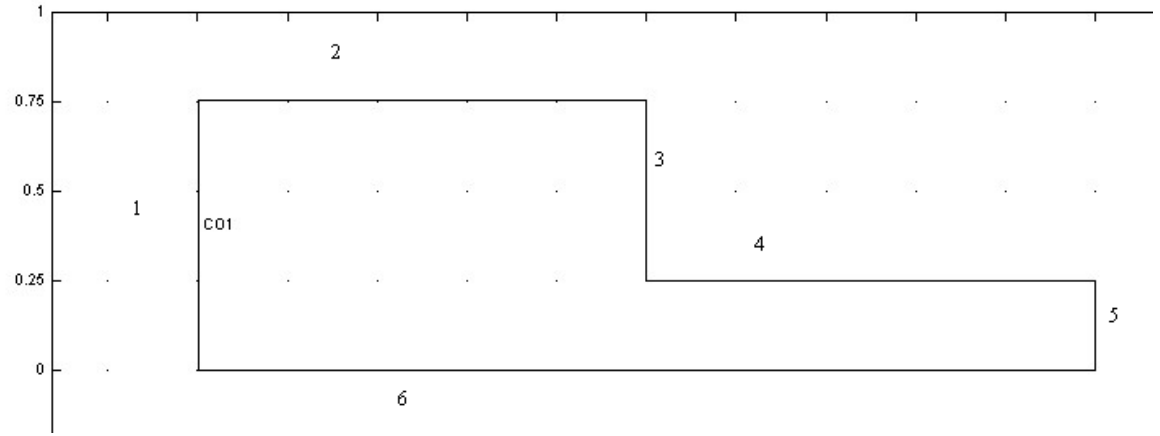
$$u = .5 \cdot \left(1 - \left(\frac{y}{.75}\right)^2\right)$$

- Pressure Drop across large and small Pipe sections

$$\Delta P = \frac{2 \cdot u_{\max} \cdot \mu \cdot L}{H^2}$$

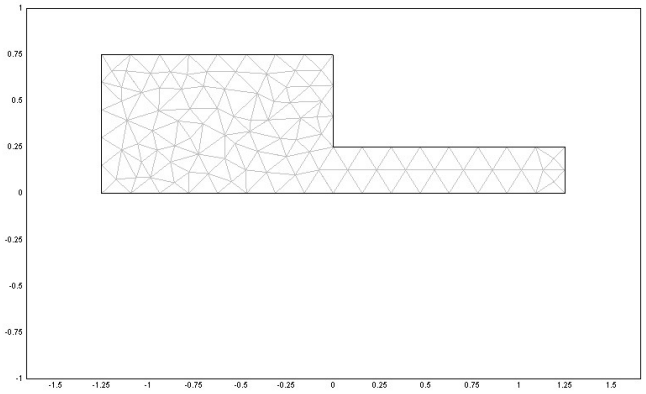
2-D, Boundary Conditions

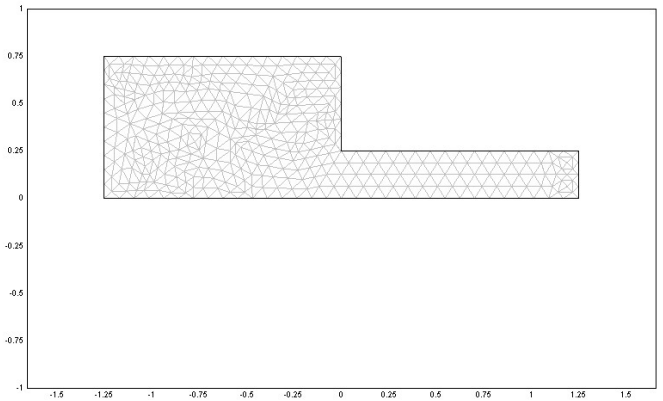
- **Inlet (1): Equation derived for velocity**
- **2,3 and 4: No Slip**
- **5: Normal Flow/Pressure**
- **Outlet(6): Slip/Symmetry**



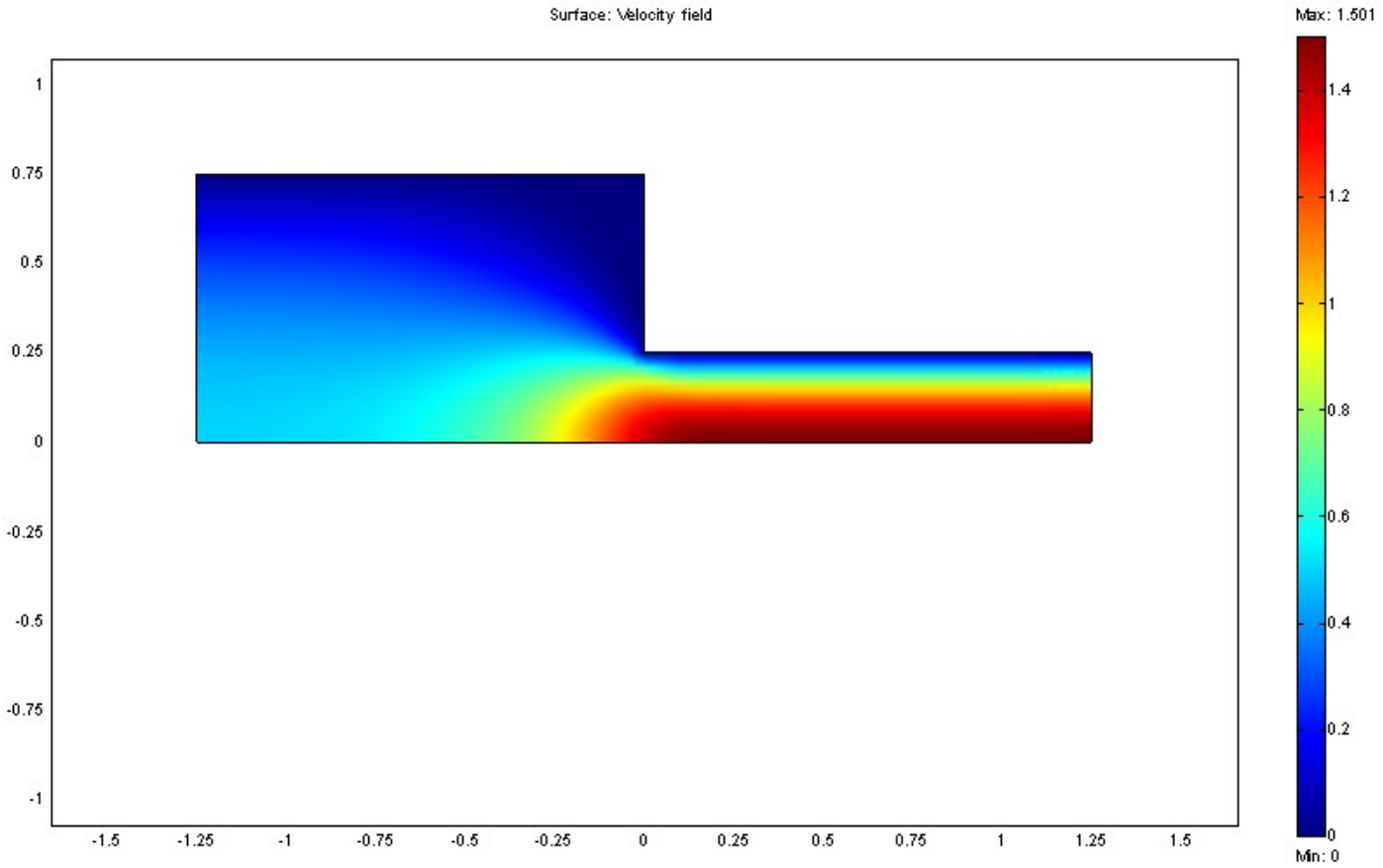
Mesh Selection

- Re = .001
- Mesh 1: 183 elements
  - 1.485 % difference from 3
- Mesh 2(chosen): 732 elements
  - .566 % difference from 3
- Mesh 3: 2928 elements

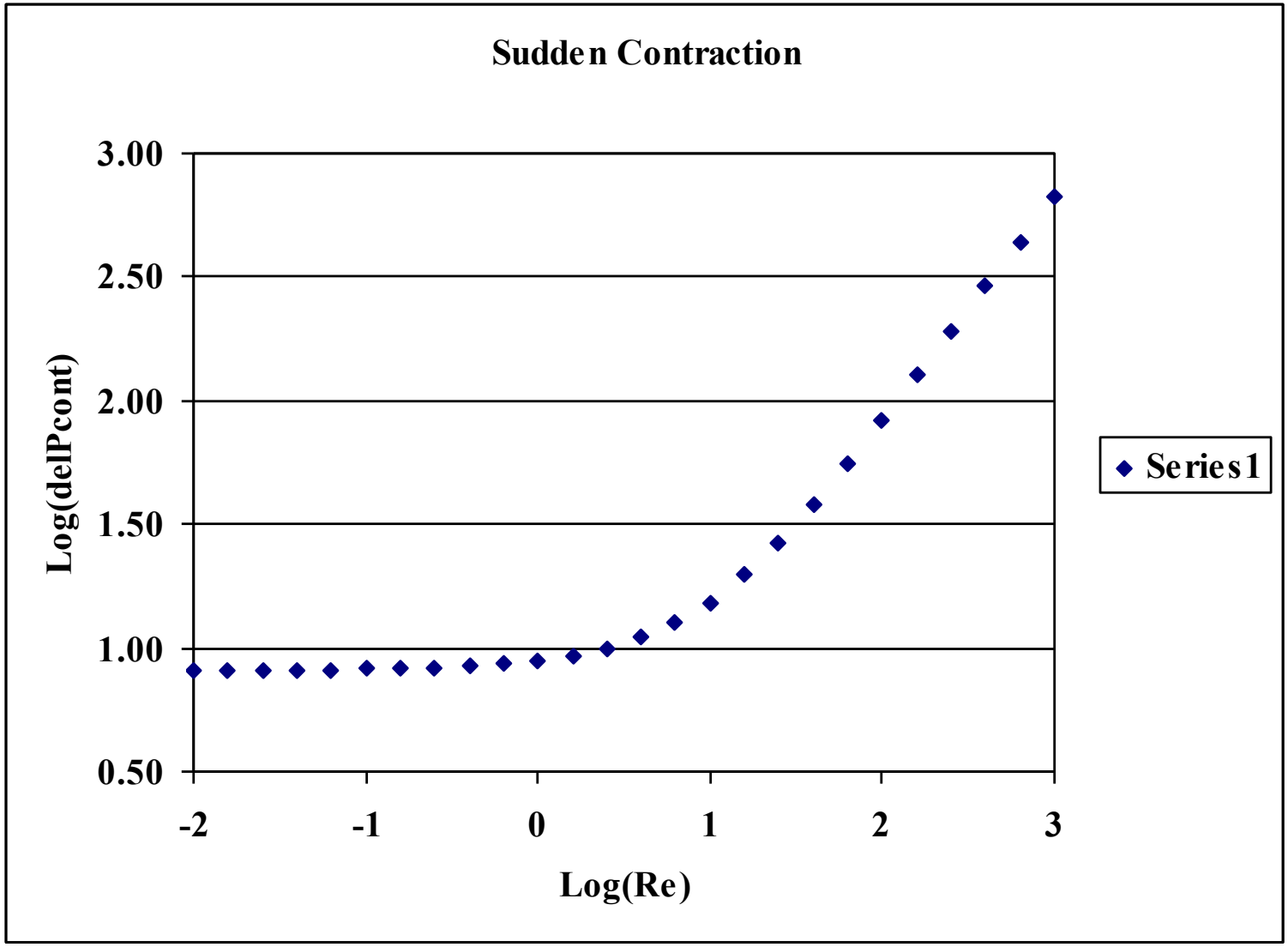




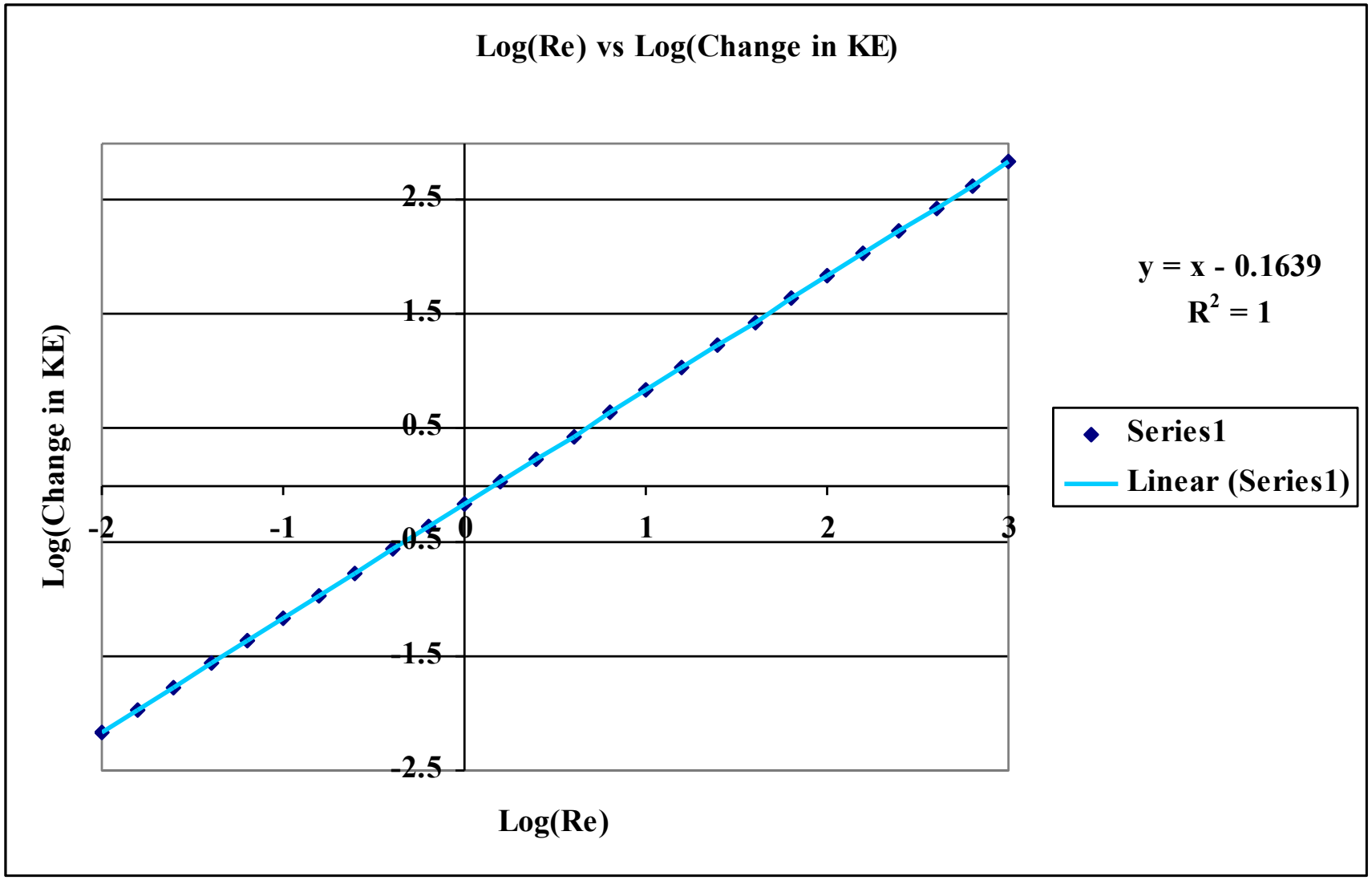
Solution


Surface: Velocity field
Max: 1.501
Min: 0
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
-1.5
-1.25
-1
-0.75
-0.5
-0.25
0
0.25
0.5
0.75
1
1.25
1.5
1.4
1.2
1
0.8
0.6
0.4
0.2
0

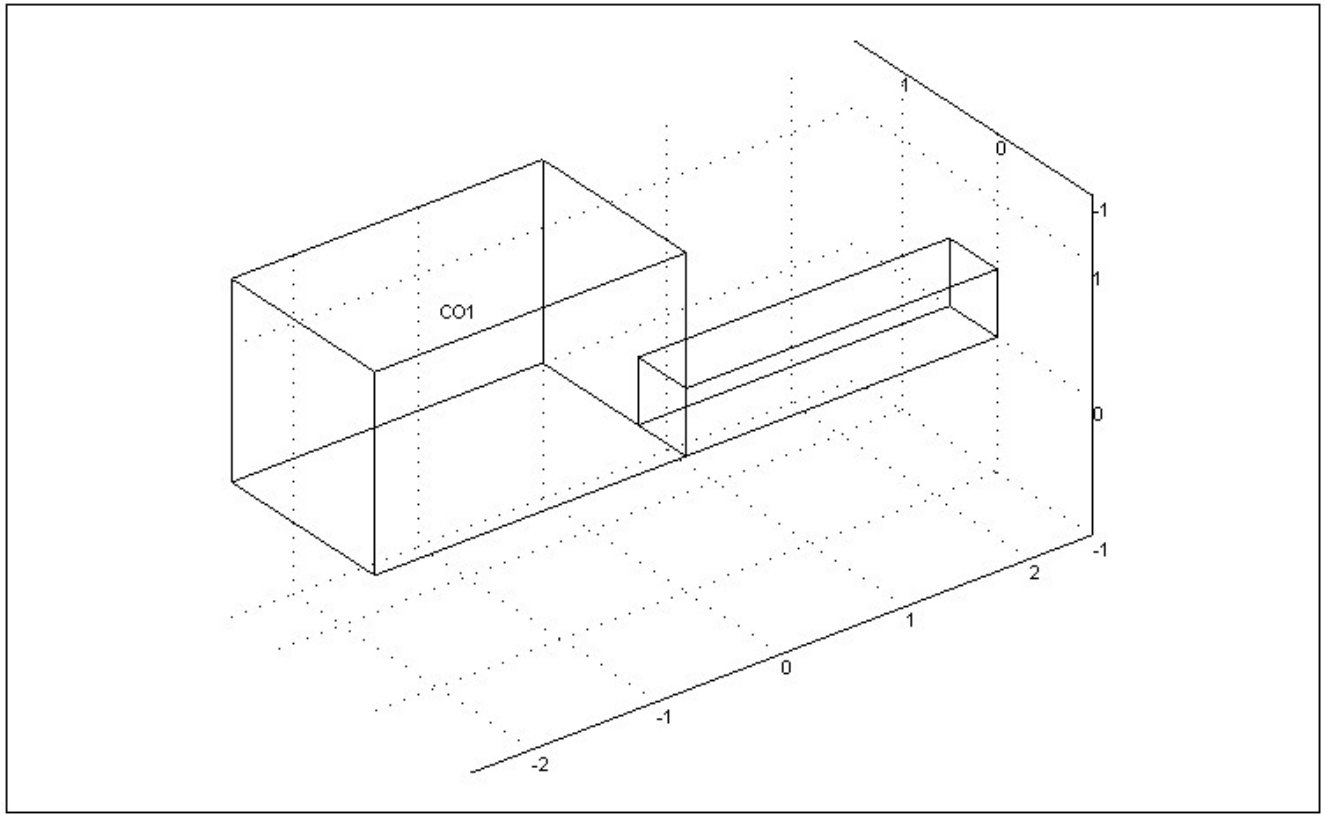
Range of Reynolds Numbers



Change in Kinetic Energy

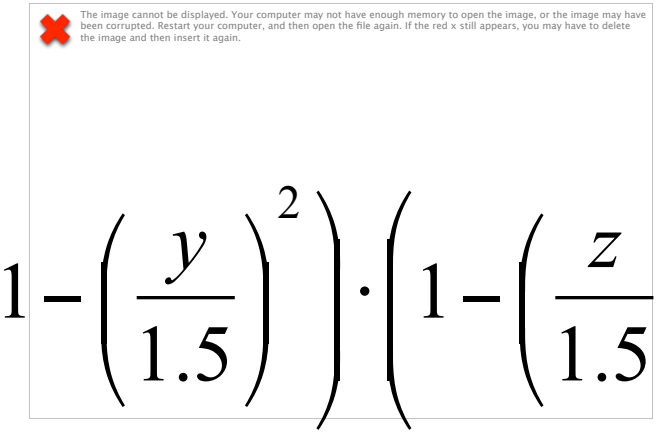


3-D Geometry



Equations Used

- Inlet velocity must be Fully Developed (Laminar Flow: Parabolic)



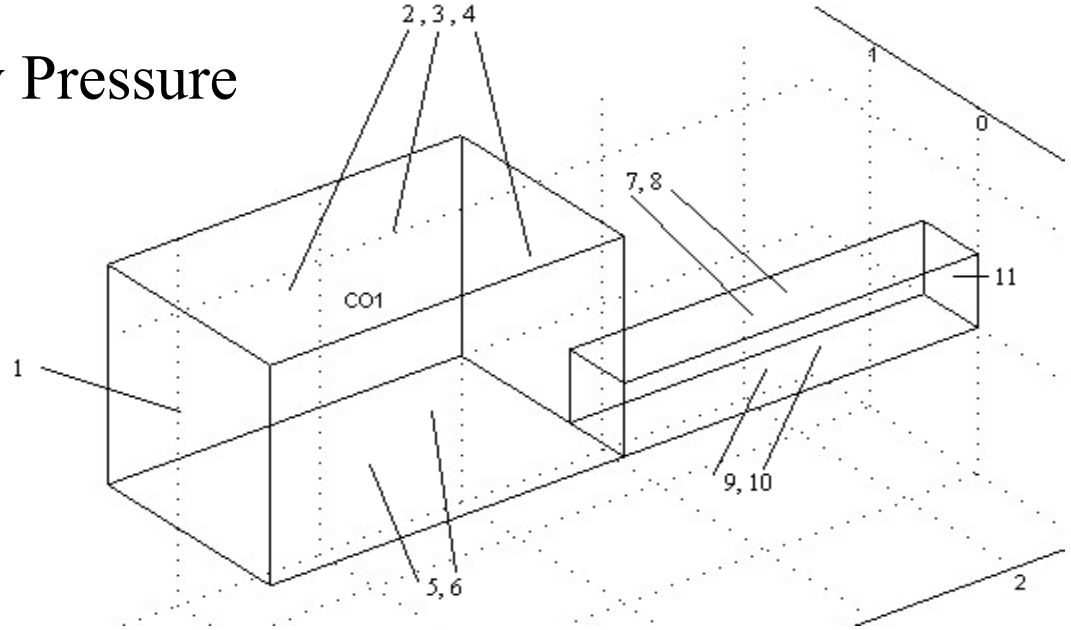
$$u = .25 \cdot \left(1 - \left(\frac{y}{1.5}\right)^2\right) \cdot \left(1 - \left(\frac{z}{1.5}\right)^2\right)$$

- Pressure Drop across large and small Pipe sections

$$\Delta P = \frac{u \cdot \mu \cdot 28.45 \cdot L}{H^2}$$

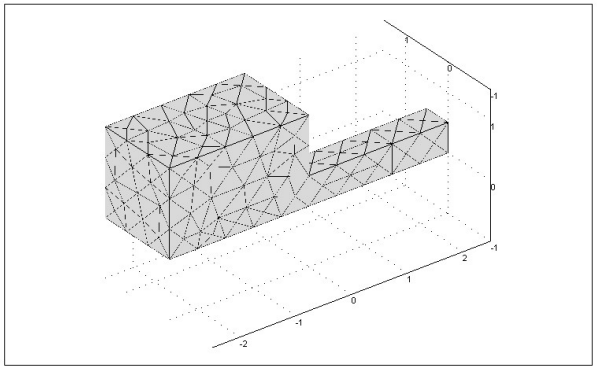
3-D, Boundary Conditions

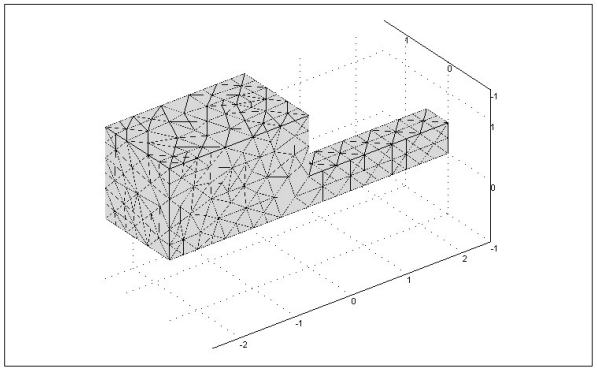
- Inlet(1): Equation derived for Velocity
- 2,3,4,7,8: No slip
- 5,6,9 and 10: Slip/Symmetry
- 11: Normal Flow Pressure



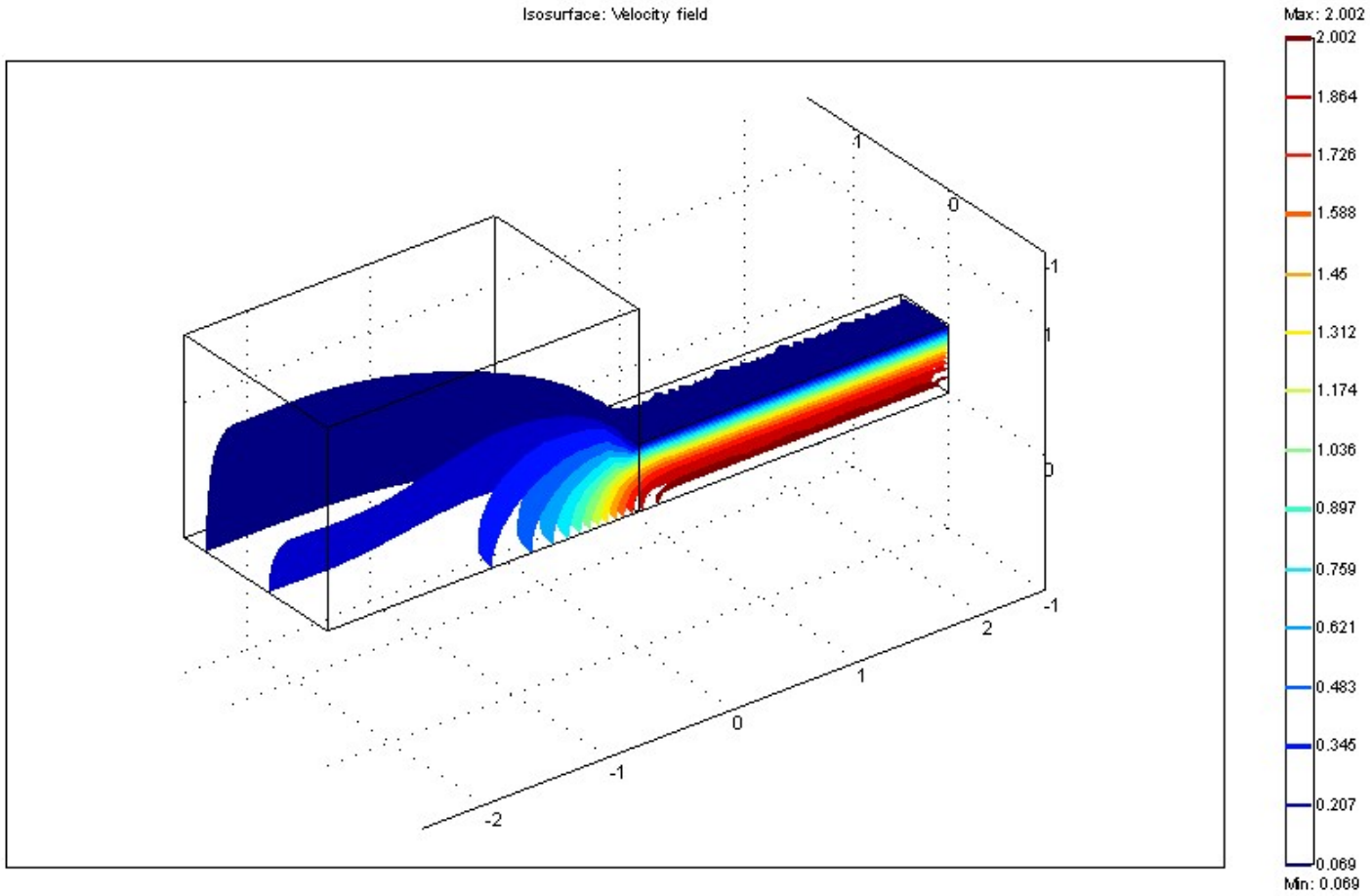
Mesh Selection

- Re = .001
- Mesh 1: 961elements
  - .637 % difference from 3
- Mesh 2: 3295 elements
  - Chosen mesh, Percent difference is small at low Re but increases dramatically as Re increases.

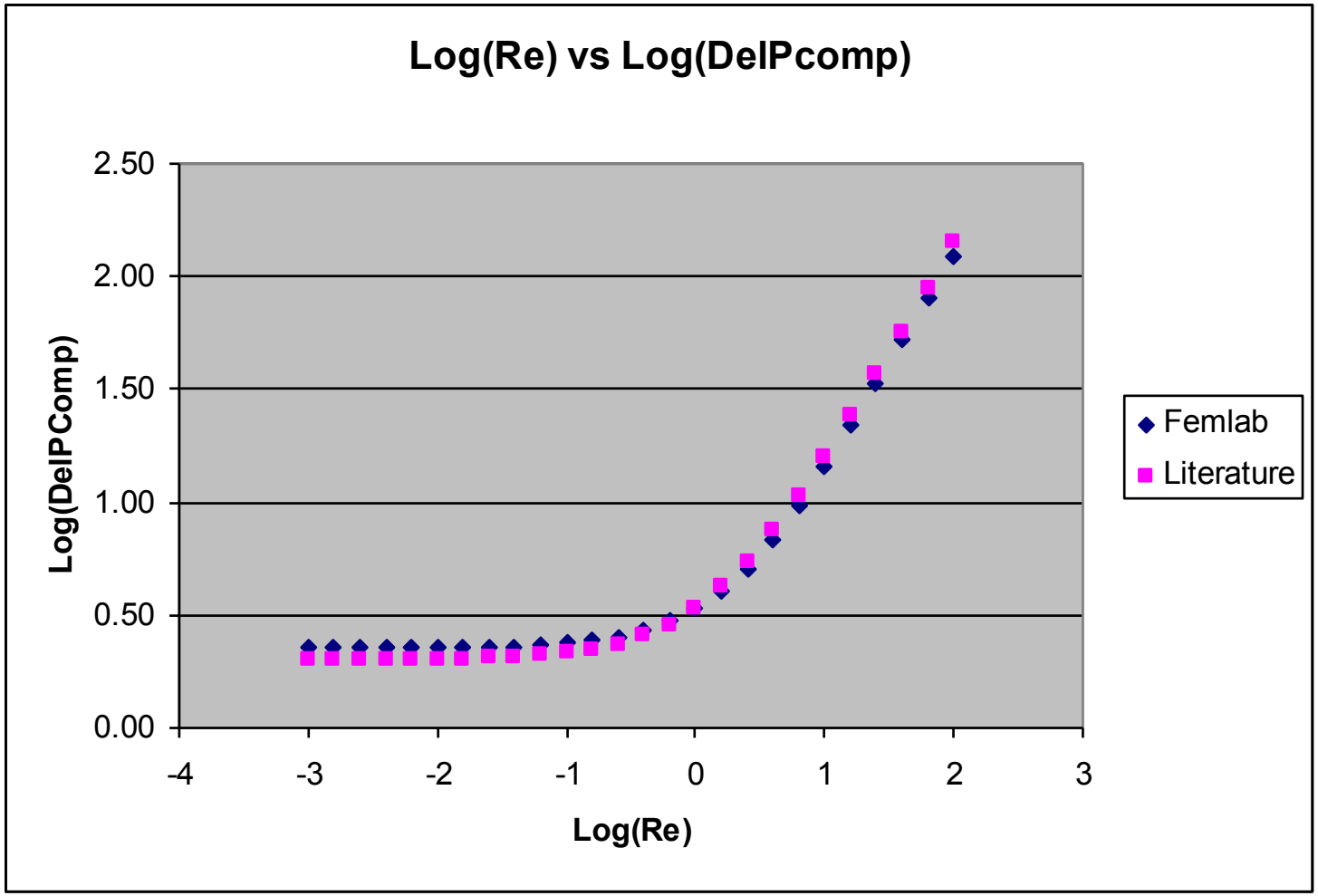




Solution


Isosurface: Velocity field
Max: 2.002
2.002
1.864
1.726
1.588
1.45
1.312
1.174
1.036
0.897
0.759
0.621
0.483
0.345
0.207
0.069
Min: 0.069
1
0
-1
1
0
-1
2
1
0
-1
-2

Range of Reynolds Numbers



Conclusions

- Femlab supports currently accepted Literature values that can be obtained from Perrys.
- At this time I would have no suggestions for improvement of the equations in Perrys as the experimentally obtained values show very close agreement to the literature values.

Change in Kinetic Energy