## *Modeling Instructions*

**NEW**

In the New window, click Model Wizard.

**MODEL WIZARD**

1. In the Model Wizard window, click **2D**.
2. In the Select Physics tree, select **Fluid Flow>Single-Phase Flow>Laminar Flow (spf).**
3. Click **Add**.
4. In the Select Physics tree, select **Chemical Species Transport>Transport of Diluted Species (tds).**
5. Click **Add**.
6. Click **Study**.
7. In the Select Study tree, select **General Studies>Stationary**.
8. Click **Done**

**GLOBAL DEFINITIONS**

*Parameters 1*

1. In the Model Builder window, under Global Definitions click **Parameters 1**.
2. In the Settings window for Parameters, locate the Parameters section.
3. In the table, enter the following settings:

| Name | Expression | Value | Description |
|---|---|---|---|
| Dg | 6.7e-10[m^2/s] | 6.7E-10 $m^2/s$ | Diffusion coefficient of glucose |
| Dia | 2.54 [mm] | 2.54E-3 m | Diameters of inlets and outlet |
| C0 | 5.56 [mM] | 5.56 $mol/m^3$ | Concentration of glucose |
| Q1 | 100e-6 [L/min] | 1.6667E-9 $m^3/s$ | Flow rate of inlet 1 (buffer) |
| QR | 1 | 1 | Flow ratio Q1/Q2 (Q2= glucose) |
| LC | 65 [mm] | 0.065 m | Channel length |
| WC | 12 [mm] | 0.012 m | Channel width |
| rho | 1 [kg/L] | 1000 $kg/m^3$ | Density of water |

**GEOMETRY 1**

1. Change Length unit to: **mm**

*Rectangle 1 (r1)*

1. In the Geometry toolbar, click **Rectangle**.
2. In the Settings window for Rectangle, locate the Size and Shape section.
3. In the Width text field, type: **WC**.
4. In the Height text field, type: **LC**.
5. In the Settings window for Rectangle, locate the Position section.
6. In the x text field, type: **-WC/2**.
7. In the y text field, type: **-22[mm]**.
8. Click **Build Selected**.

*Fillet 1 (fil1)*

1. In the Geometry toolbar, click **Fillet**.
2. Select the four corners of the rectangle (*r1*- 1, 2, 3, 4)
3. In the Radius text field, type: **6 [mm]**
4. Click **Build Selected**.

*Circle 1 (c1)*

1. In the Geometry toolbar, click **Circle**.
2. In the Settings window for Circle, locate the Size and Shape section.
3. In the Radius text field, type: **Dia/2**.
4. In the Settings window for Circle, locate the Position section.
5. In the y text field, type: **-12[mm]**.
6. Click **Build Selected**.

*Circle 2 (c2)*

1. In the Geometry toolbar, click **Circle**.
2. In the Settings window for Circle, locate the Size and Shape section.
3. In the Radius text field, type: **Dia/2**.
4. Click **Build Selected**.

*Circle 3 (c3)*

1. In the Geometry toolbar, click **Circle**.
2. In the Settings window for Circle, locate the Size and Shape section.
3. In the Radius text field, type: **Dia/2**.
4. In the Settings window for Circle, locate the Position section.
5. In the y text field, type: **33[mm]**.
6. Click **Build Selected**.

*Difference 1 (dif1)*

1. In the Geometry toolbar, click **Booleans and Partitions** and choose **Difference**.
2. Select the object fil1 only.
3. In the Settings window for Difference, locate the Difference section.
4. Find the Objects to subtract subsection. Select the Activate Selection toggle button.
5. Select the objects c1, c2, and c3.
6. In the Geometry toolbar, click **Build All.**

*Line Segment 1 (ls1)*

1. In the Model Builder window, under Component 1 (comp1) right-click Geometry 1 and choose **Line Segment**.
2. In the Settings window for Line Segment, locate the Starting Point section.
3. For specify, select: **Coordinates**.
4. In the x text field, type: **-WC/2**.
5. In the y test field, type: **19 [mm]**.

6. In the Settings window for Line Segment, locate the Endpoint section.
7. For specify, select: **Coordinates**.
8. In the x text field, type: **WC/2**.
9. In the y test field, type: **19 [mm]**.
10. In the Geometry toolbar, click **Build All.**

**MATERIALS**

*Material 1 (mat1)*

1. In the Model Builder window, under Component 1 (comp1) right-click Materials and choose **Add Material from Library**.
2. In the Add Material tree, select **Liquids and Gases>Liquids>Water.**
3. Click + **Add to Component**.

**LAMINAR FLOW (SPF)**

*Inlet 1*

1. In the Model Builder window, under Component 1 (comp1) right-click Laminar Flow (spf) and choose **Inlet**.
2. Select Boundaries 8, 9, 15, and 16.
3. In the Settings window for Inlet, locate the Boundary Condition section and select **Mass flow**.
4. In the normal mass flow rate text field, type: **Q1*rho**.
5. In the channel thickness text field, type: **0.1 [mm]**.

*Inlet 2*

1. In the Model Builder window, under Component 1 (comp1) right-click Laminar Flow (spf) and choose **Inlet**.
2. Select Boundaries 10, 11, 17, and 18.
3. In the Settings window for Inlet, locate the Boundary Condition section and select **Mass flow**.
4. In the normal mass flow rate text field, type: **Q1*rho/QR**.
5. In the channel thickness text field, type: **0.1 [mm]**.

*Outlet 1*

1. In the Model Builder window, under Component 1 (comp1) right-click Laminar Flow (spf) and choose **Outlet**.
2. Select Boundaries 12, 13, 19, and 20.

**TRANSPORT OF DILUTED SPECIES (TDS)**

*Transport Properties*

1. In the Settings window for Transport Properties, locate the Convection section.
2. Under Velocity field, change **u** to: **Velocity field (spf)**.
3. In the Settings window for Transport Properties, locate the Diffusion section.
4. Change material to: **Water (mat1)**.
5. In the diffusion coefficient text field, type: **Dg**.

*Inflow 1*

1. In the Model Builder window, under Component 1 (comp1) right-click Transport of diluted Species (tds) and choose **Inflow**.
2. Select Boundaries 8, 9, 15, and 16.

*Inflow 2*

1. In the Model Builder window, under Component 1 (comp1) right-click Transport of diluted Species (tds) and choose **Inflow**.
2. Select Boundaries 10, 11, 17, and 18.
3. In the Settings window for Inlet, locate the Concentration section.
4. In the $c_{0,c}$ text field, type: **C0**.

*Outflow 1*

1. In the Model Builder window, under Component 1 (comp1) right-click Transport of diluted Species (tds) and choose **Outflow**.
2. Select Boundaries 12, 13, 19, and 20.

**MESH 1**

1. In the Model Builder window, under Component 1 (comp1) click **Mesh 1**.
2. In the Settings window for Mesh, locate the Physics-Controlled Mesh section.
3. From the Element size list, choose **Fine**.
4. Click **Build All**.

**STUDY 1**

*Parametric Sweep*

1. In the Model Builder window, right-click Study 1 and choose **Parametric Sweep**.
2. In the Settings window for Parametric Sweep, locate the Study Settings section.
3. Right-click Parameter name in the table, and select **Add**.
4. Select **QR (flow ratio Q1/Q2 (Q2 = glucose))**.
5. In the text field under Parameter value list in the table, type: **1, 2, 4**.
6. Click on **Compute**.

**RESULTS**

*Velocity (spf)*

Add a **Streamline** node, to generate streamlines on top of the 2D velocity color map.

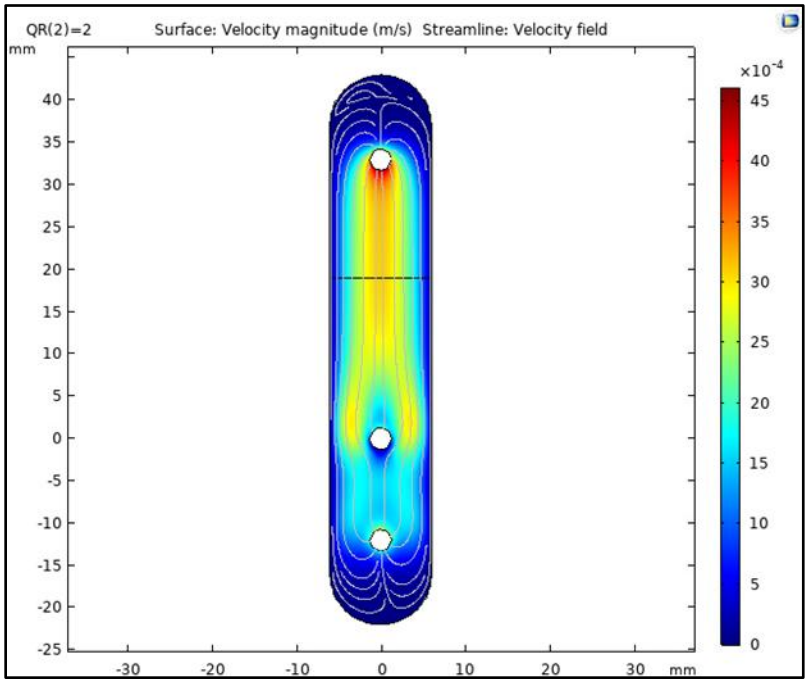
1. In the Velocity (spf) toolbar, click **Streamline**.
2. In the Settings window for Streamline, locate the Streamline Positioning section.
3. For positioning, select: **Uniform density**.
4. In the Separating distance text field, type: **0.025**.
5. In the Settings window for Streamline, locate the Coloring and Style section.
6. For Color, select: **Gray**.
7. Click **Plot**.

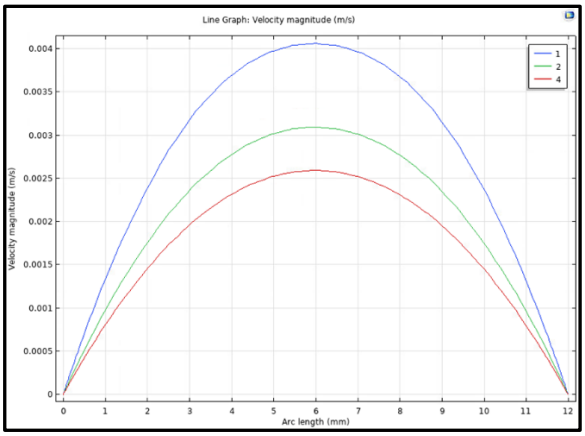
*Velocity (1D)*

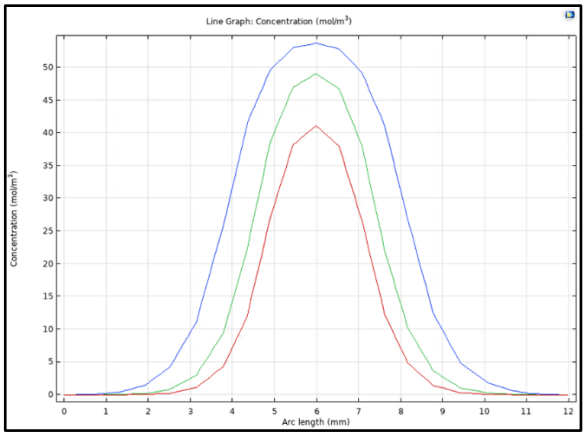
1. In the Results toolbar, click **Add Plot Group**, and select **1D Plot Group**.
2. In the Label text field, type: **Velocity**.
3. In the Velocity toolbar, click **Line Graph**.
4. Select Boundary 3 (long horizontal line at 19 mm).
5. In the Settings window for Line Graph, locate the Legends section.
6. Check Show Legends.
7. Click **Plot**.

*Concentration (1D)*

1. In the Results toolbar, click **Add Plot Group**, and select **1D Plot Group**.
2. In the Label text field, type: **Concentration**.
3. In the Velocity toolbar, click **Line Graph**.
4. Select Boundary 3 (long horizontal line at 19 mm).
5. In the Settings window for Line Graph, locate the y-Axis Data section.
6. In the Expression text field, type: **c**.
7. In the Settings window for Line Graph, locate the Legends section.
8. Check Show Legends.
9. Click **Plot**.




Line Graph: Velocity magnitude (m/s)
Velocity magnitude (m/s)
Arc length (mm)
1
2
4


Line Graph: Concentration (mol/m³)
Concentration (mol/m³)
Arc length (mm)