

**Analytical report on 6 different cases for velocity distribution, mass flow rate and pressure distribution in pipe**  
**COMSOL Report**

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SEES 500  
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## COMSOL Simulations Analysis

In this report 6 different case studies were analyzed in detail for three different profiles which are velocity distribution, pressure distribution and mass flow rate through the pipe. In addition, both 2D and 3D analysis is done to see the problem from realistic point of view

### Case Study 1: Disturbance of 10cm x 10cm x 10xm in to the pipe

As a first case velocity distribution is checked when the disturbance was added at the initial part of the pipe. The 2 Dimensional views the velocity distribution is shown in Fig. 1 from which it can be concluded that velocity changed from 1.4 m/s to 0.3 m/s suddenly but only for 0.1 m distance but is steadily increased to 1.2 m/s after distance of 5 m and then approached to approximately 1.4 m/s after that distance. The velocity of the water remained approximately 1.4 m/s at the locations above and below the disturbance and no significant difference was seen.

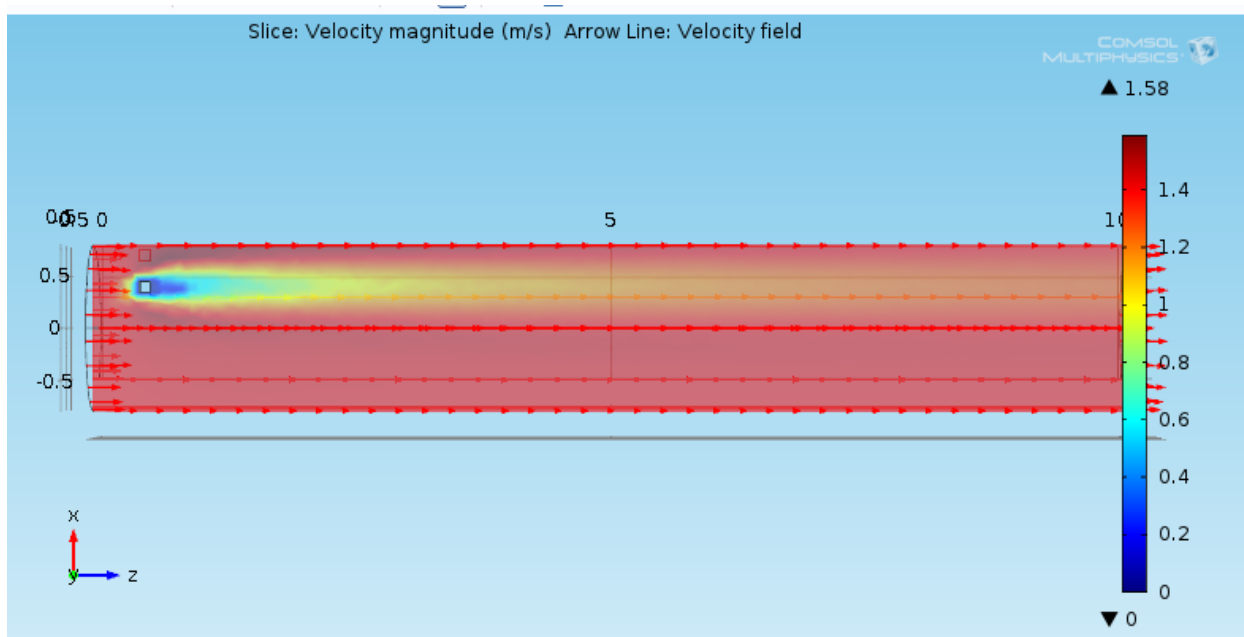


Figure 1 Velocity distribution in 2D for 10cm disturbance added in to the pipe

The 3 Dimensional view of velocity profile of the pipe is shown in Fig. 2 which shows that velocity distribution of the pipe is changed only at the location where the disturbance is added. At all other locations velocity remained approximately equal to 1.4m/s

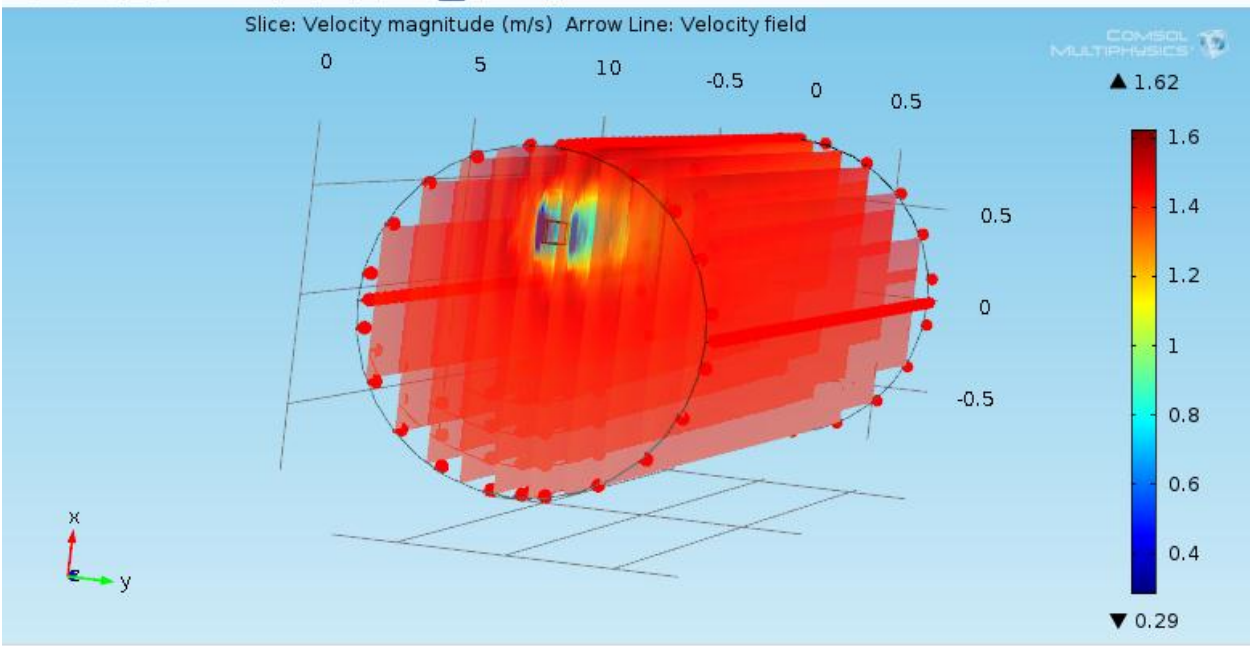


Figure 2: 3 Dimensional view of pipe when disturbance of 10cm is added in to the pipe

Fig 3 shows the mass flow rate which remained constant to 2.8 m<sup>3</sup>/s or 2.8 x 10<sup>3</sup> kg/s even disturbance was added to the pipe

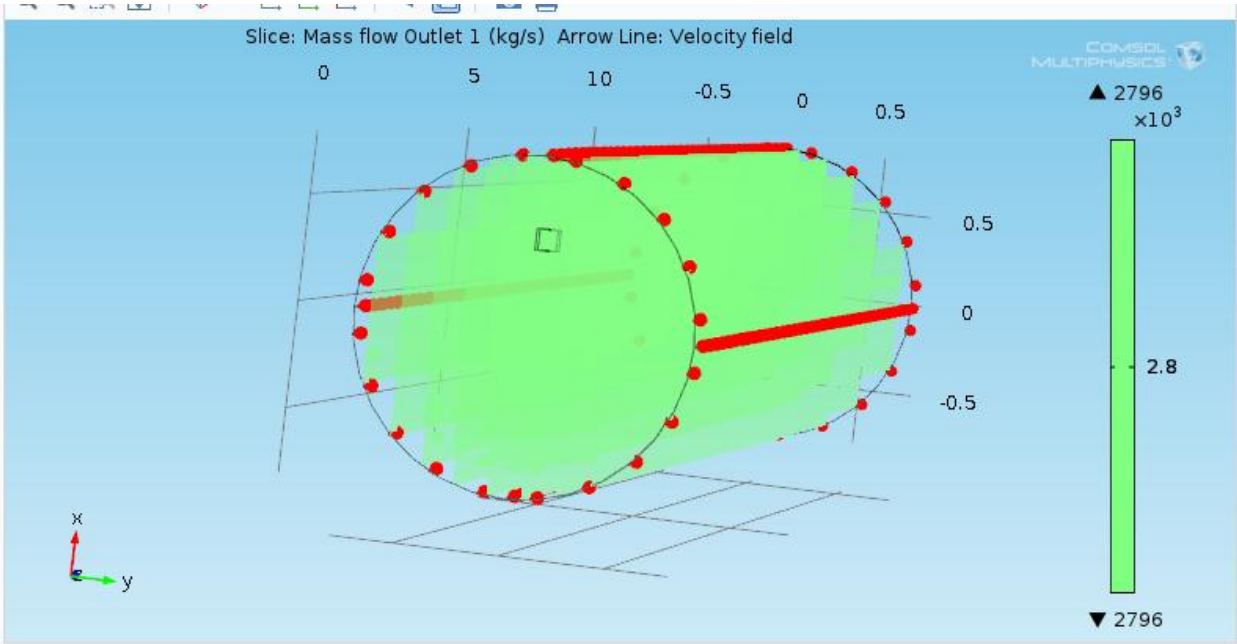


Figure 3 Mass flow rate (kg/s) for 10cm disturbance

Fig.4 shows the 2 Dimensional profile of pressure in to the pipe and sudden increase and decrease of the pressure profile is seen at the pipe where disturbance is added. On the other hand, Fig. 5 shows the pressure distribution profile of the pipe in 3 Dimensions which shows that pressure profile only changed at locations where disturbance is added.

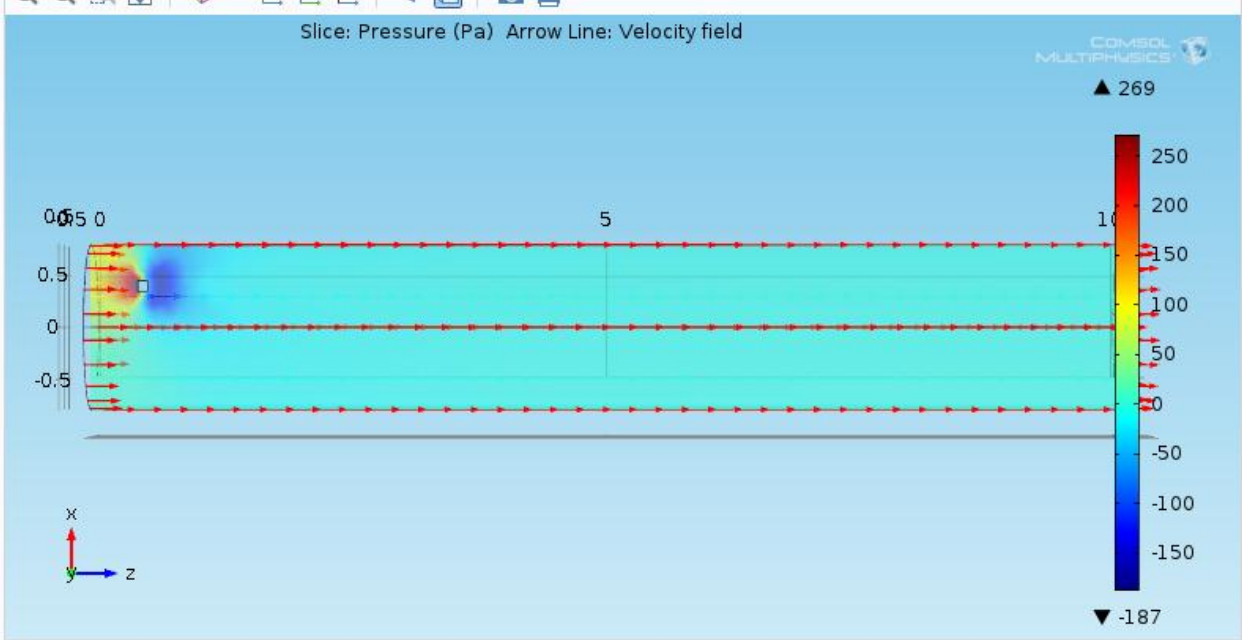


Figure 4 Pressure profile of the pipe in 2D

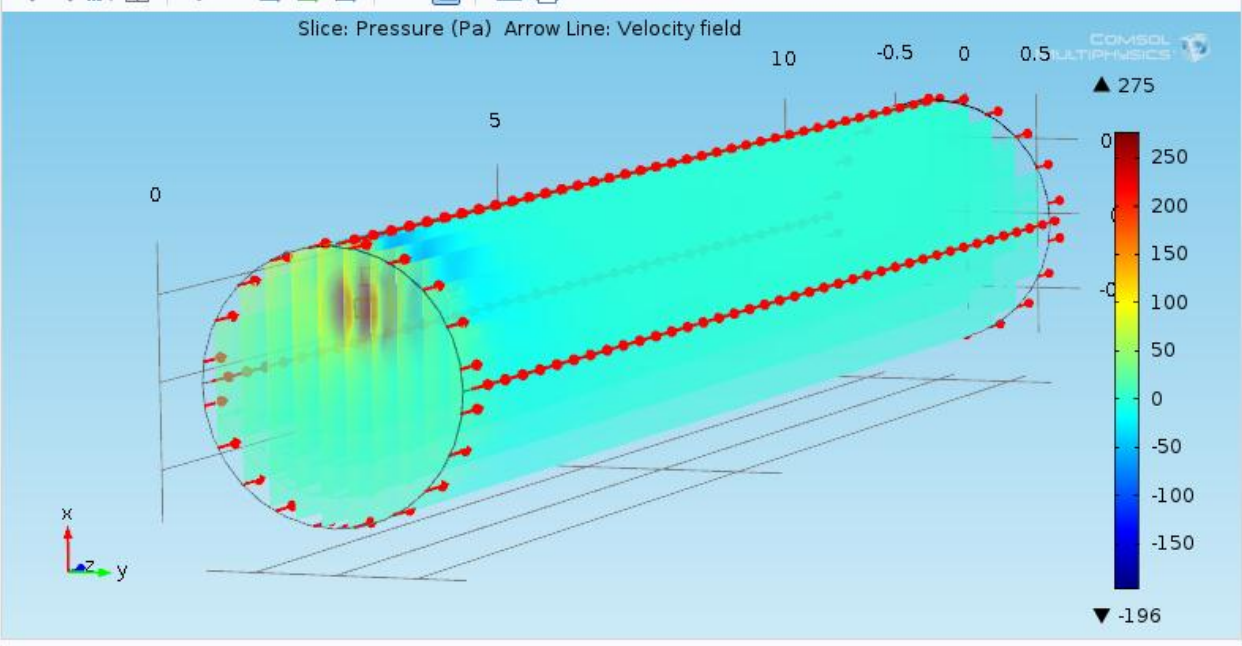


Figure 5 Pressure profile in 3D

## Case Study 2: Disturbance of 40cm x 40cm x 40xm in to the pipe

As a second case velocity distribution is checked when the disturbance was added at the initial part of the pipe. The 2 Dimensional views the velocity distribution is shown in Fig. 6 from which it can be concluded that velocity changed from 1.4 m/s to 0.3 m/s suddenly but then after 5 m distance but is steadily increased to 0.8 m/s after distance of 5 m and then approached to approximately 1 m/s after that distance. The velocity of the water remained approximately 1.2 m/s at the locations above and below the disturbance and sudden increase in velocity profile to 2 m/s was also seen at locations near to the disturbance.

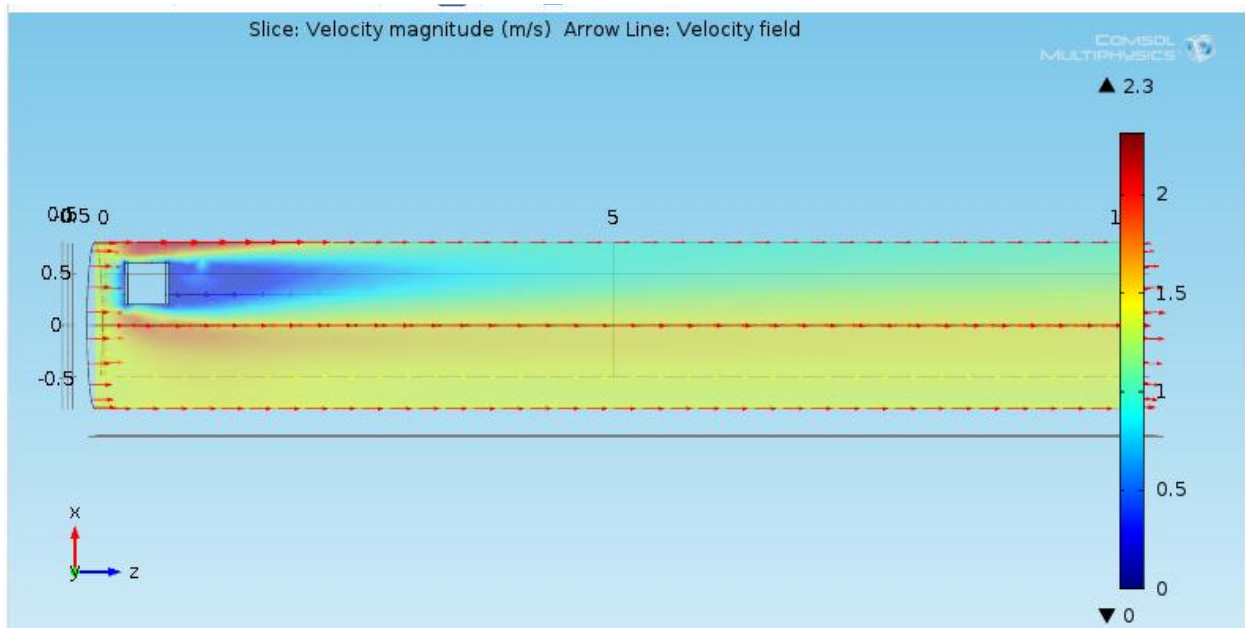


Figure 6 Velocity distribution in 2D for 40cm disturbance added in to the pipe

The 3 Dimensional view of velocity profile of the pipe is shown in Fig. 7 which shows that velocity distribution of the pipe is changed not only at the location where the disturbance is added but also at the locations near to the disturbance. The velocity distribution profile completely changed to the places near to the disturbance and impact of the disturbance remained dominant for the 10 m long pipe.

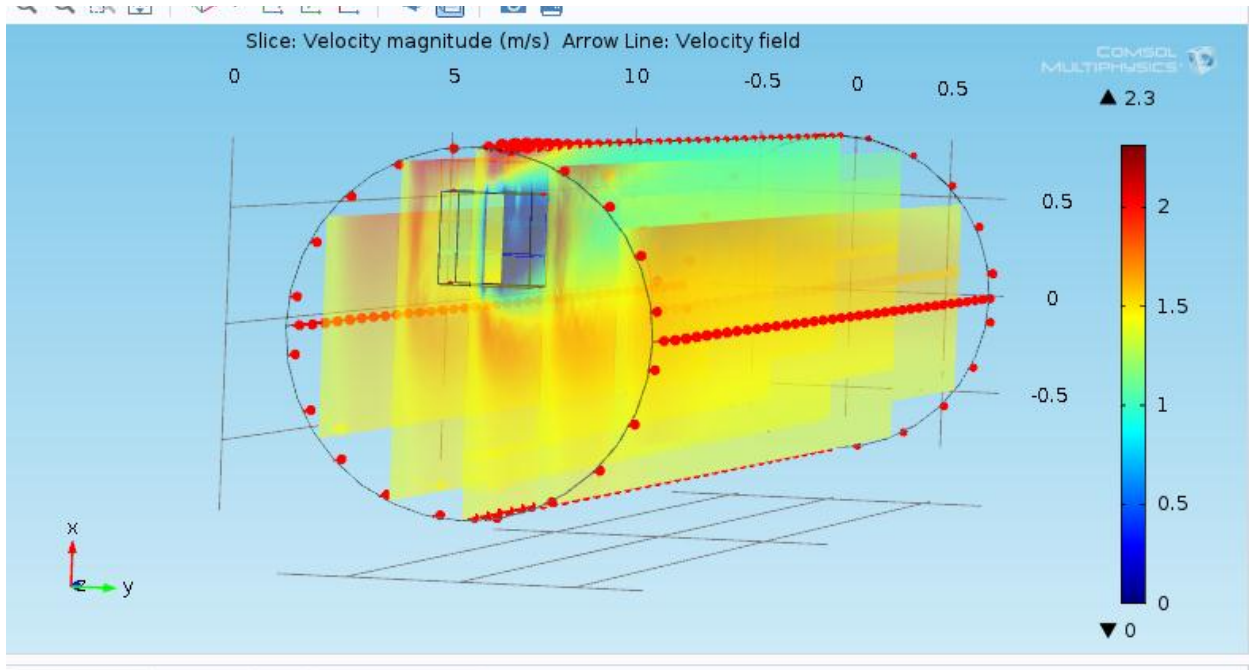


Figure 7: 3 Dimensional view of pipe when disturbance of 10cm is added in to the pipe

Fig 8 shows the mass flow rate which remained constant to  $2.8 \text{ m}^3/\text{s}$  or  $2.8 \times 10^3 \text{ kg/s}$  even disturbance of 40cm dimension was added to the pipe.

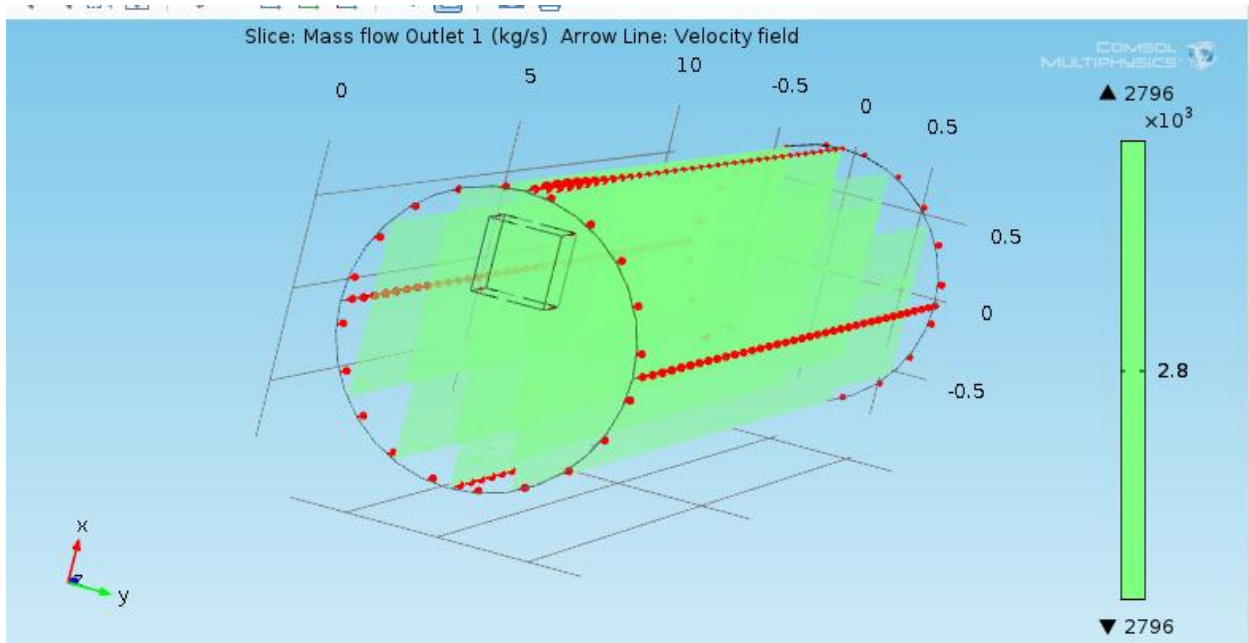


Figure 8 Mass flow rate (kg/s) for 40cm disturbance



Fig.9 shows the 2 Dimensional profile of pressure in to the pipe and sudden increase and decrease of the pressure profile is seen at the pipe where disturbance is added. On the other hand, Fig. 10 shows the pressure distribution profile of the pipe in 3 Dimensions which shows that pressure profile only changed at locations where disturbance is added.

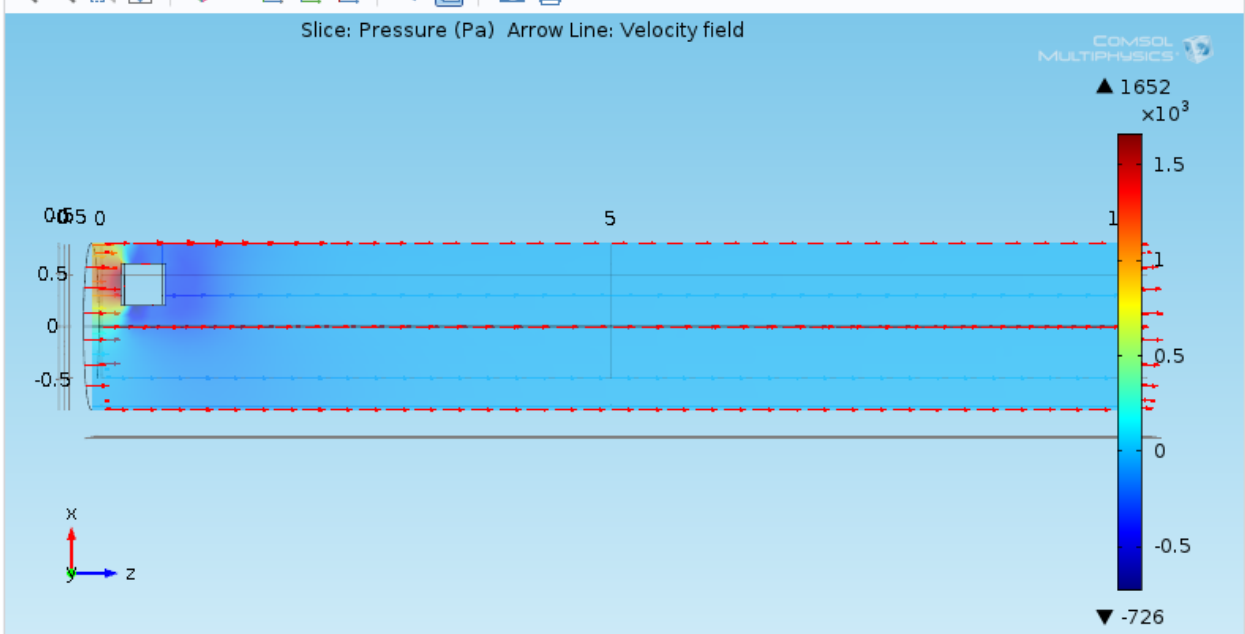


Figure 9 Pressure profile of the pipe in 2D

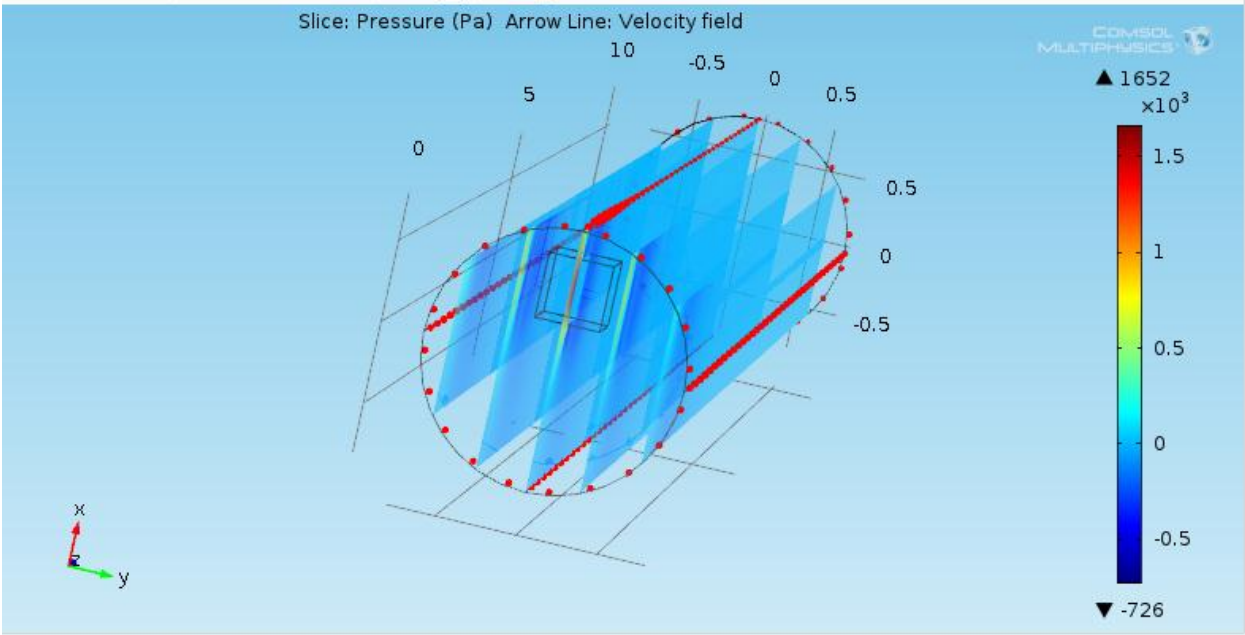


Figure 10 Pressure profile in 3D

### Case Study 3: Disturbance of 40cm x 40cm x 40cm in to the pipe at the center location of the pipe

As a third case velocity distribution is checked when the disturbance was added at the center part of the pipe. The 2 Dimensional views the velocity distribution is shown in Fig. 11 from which it can be concluded that velocity changed from 1.4 m/s to 0.3 m/s suddenly till 5 m distance but is steadily increased to 0.8 m/s after distance of 5 m and then approached to approximately 1 m/s after that distance. The velocity of the water remained approximately 1.2 m/s at the locations above and below the disturbance and sudden increase in velocity profile to 2 m/s were also seen at locations near to the disturbance.

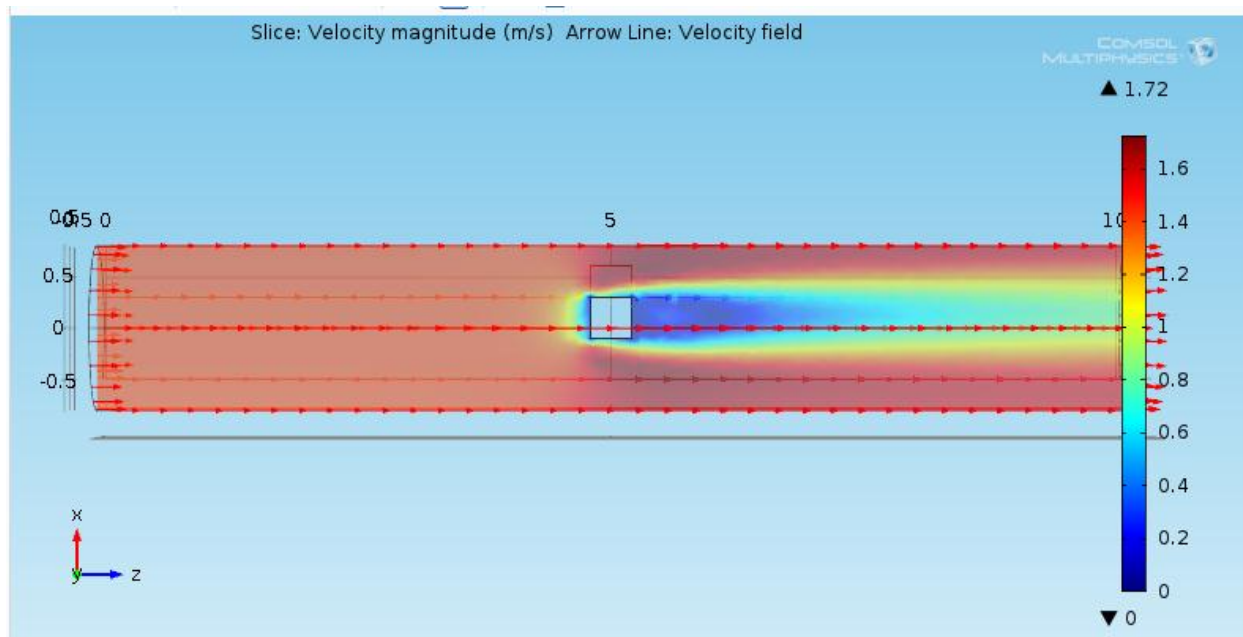


Figure 11 Velocity distribution in 2D for 40cm disturbance at center added in to the pipe

The 3 Dimensional view of velocity profile of the pipe is shown in Fig. 12 which shows that velocity distribution of the pipe is changed not only at the location where the disturbance is added but also at the locations near to the disturbance. The velocity distribution profile completely changed to the places near to the disturbance and impact of the disturbance remained dominant for the 10 m long section of the pipe.



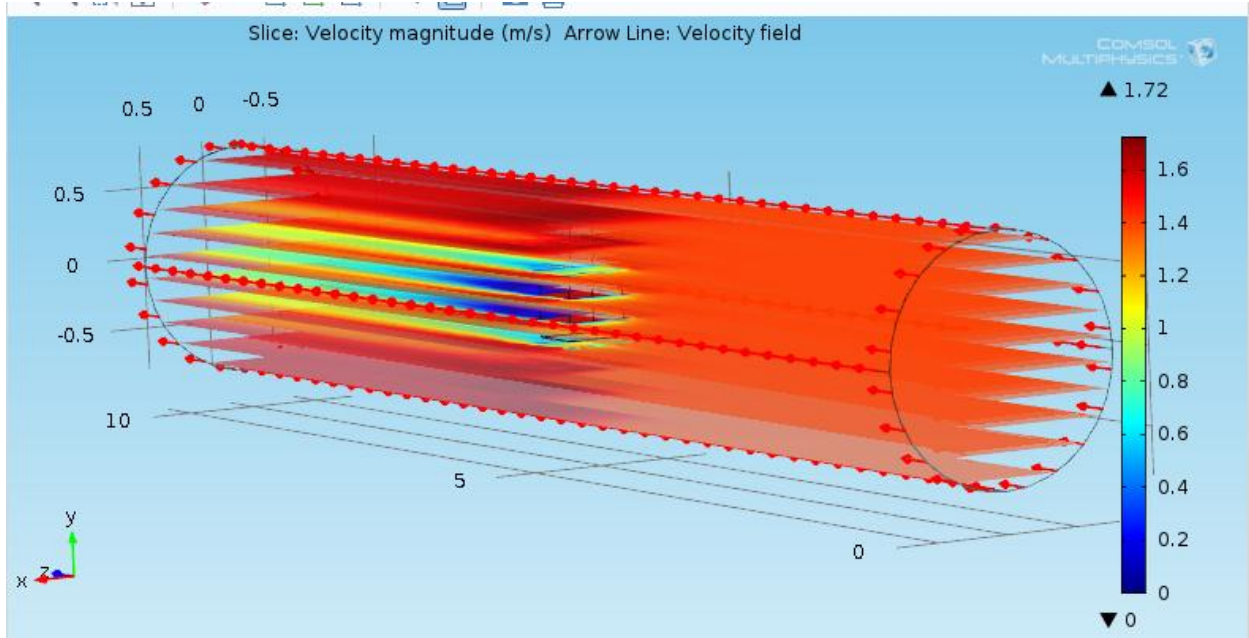


Figure 12. 3 Dimensional view of pipe when disturbance of 40cm is added in to the center of the pipe.

Fig 13 shows the mass flow rate which remained constant to  $2.8 \text{ m}^3/\text{s}$  or  $2.8 \times 10^3 \text{ kg/s}$  even disturbance of 40cm dimension was added to the pipe.

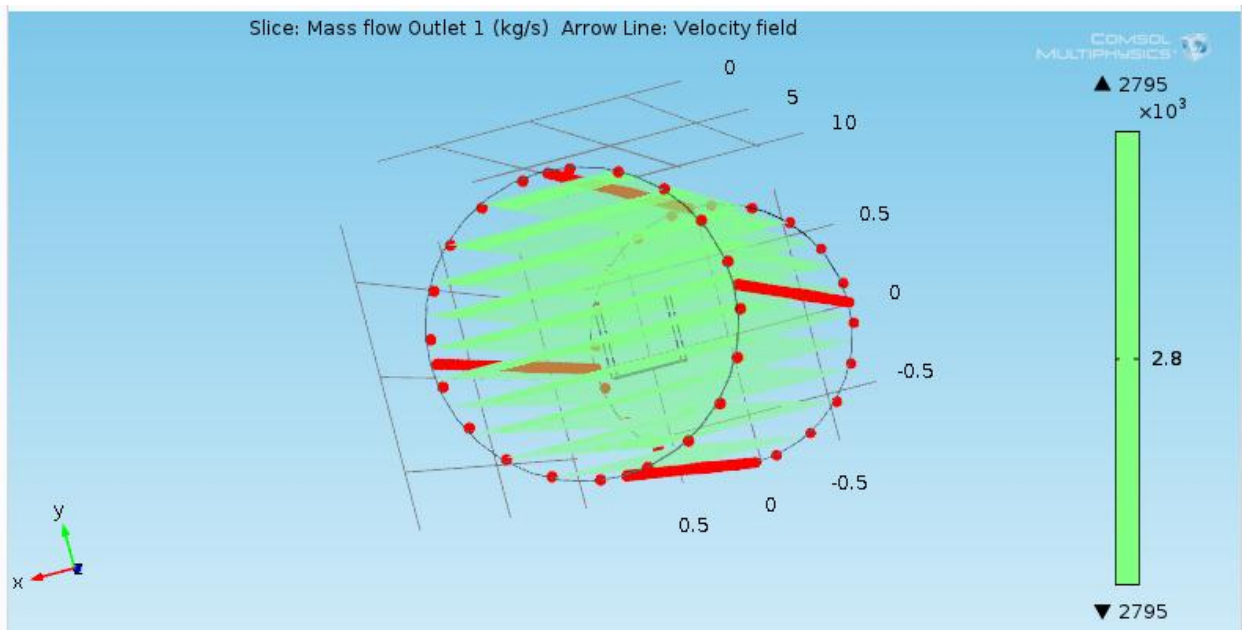


Figure 13 Mass flow rate (kg/s) for 40cm disturbance

Fig.14 shows the 2 Dimensional profile of pressure in to the pipe and sudden increase and decrease of the pressure profile is seen at the pipe where disturbance is added. On the other hand, Fig. 15 shows the pressure distribution profile of the pipe in 3 Dimensions which shows that pressure profile only changed at locations where disturbance is added.

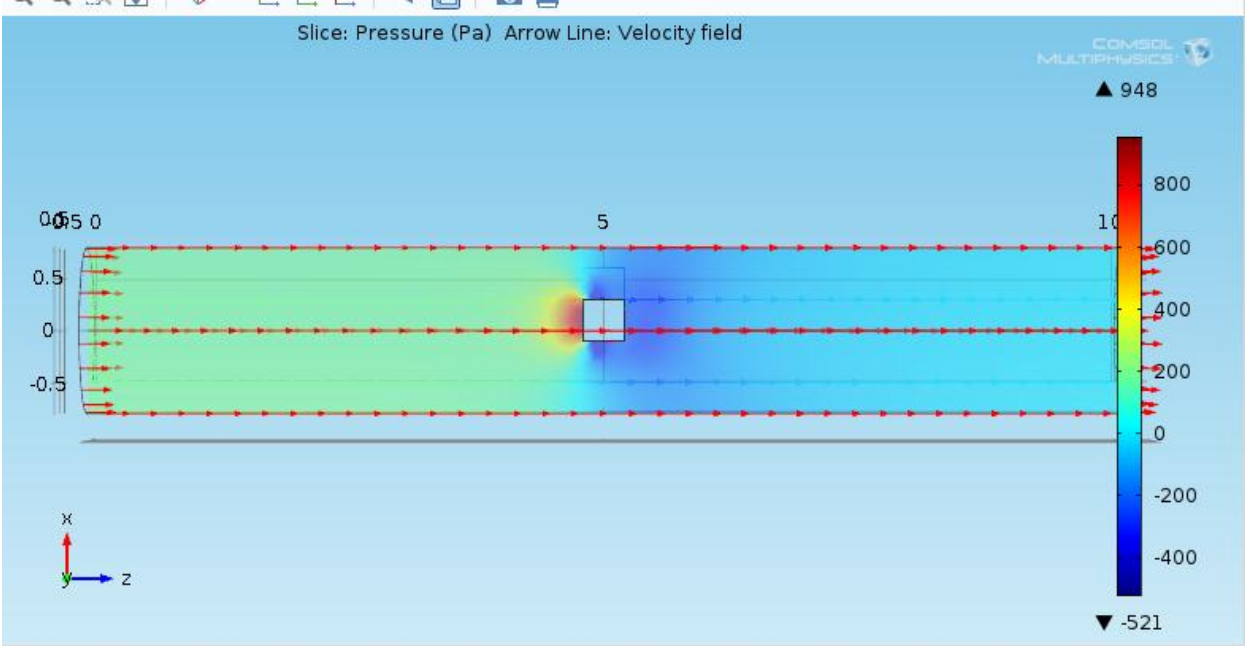


Figure 14 Pressure profile of the pipe in 2D

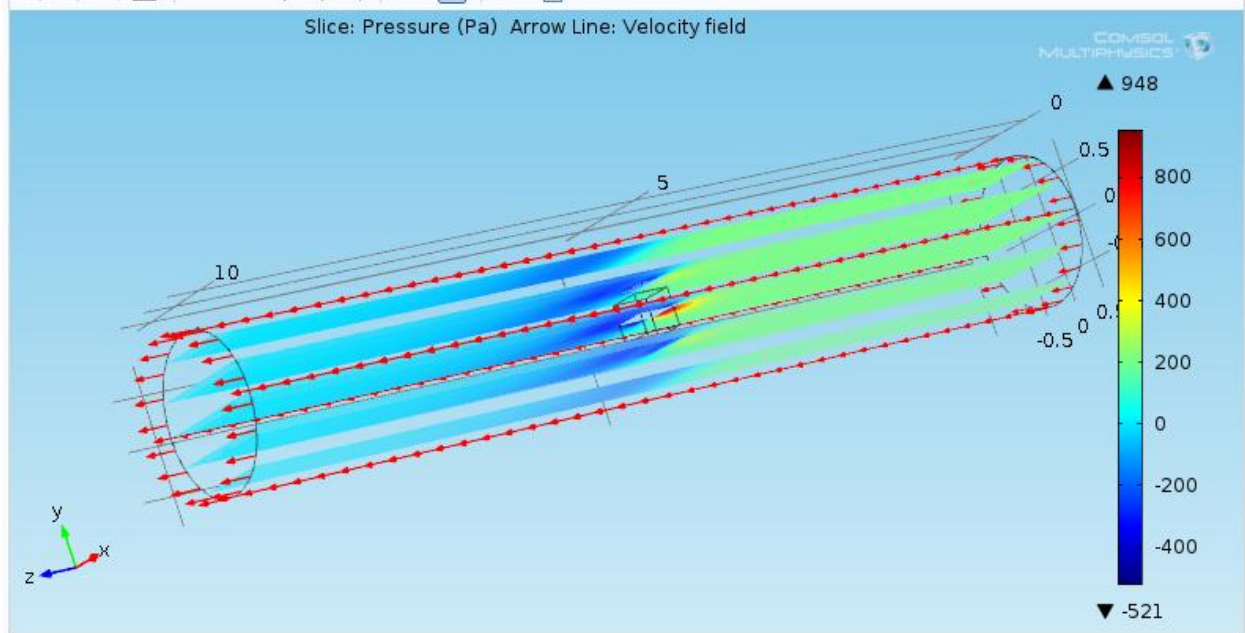


Figure 15 Pressure profile in 3D

**Case Study 4: Disturbance of 60cm x 60cm in to the pipe**

As a fourth case velocity distribution is checked when the disturbance was added at the initial part of the pipe. The 2 Dimensional views the velocity distribution is shown in Fig. 16 from which it can be concluded that velocity changed from 1.4 m/s to 0.3 m/s suddenly but then after 5 m distance but is steadily increased to 0.8 m/s after distance of 5 m and then approached to approximately 1 m/s after that distance. The velocity of the water remained approximately 1.2 m/s at the locations above and below the disturbance and sudden increase in velocity profile to 2 m/s were also seen at locations near to the disturbance.

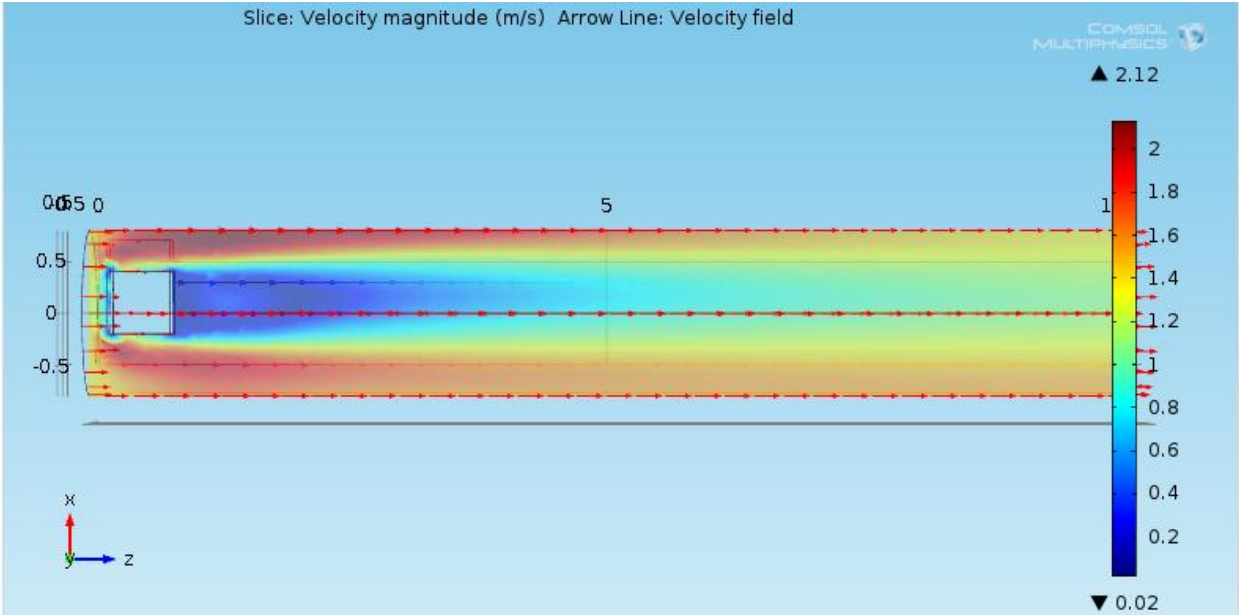


Figure 16 Velocity distribution in 2D for 60cm disturbance added in to the pipe

The 3 Dimensional view of velocity profile of the pipe is shown in Fig. 17 which shows that velocity distribution of the pipe is changed not only at the location where the disturbance is added but also at the locations near to the disturbance. The velocity distribution profile completely changed to the places near to the disturbance and impact of the disturbance remained dominant for the 10 m long section of the pipe.

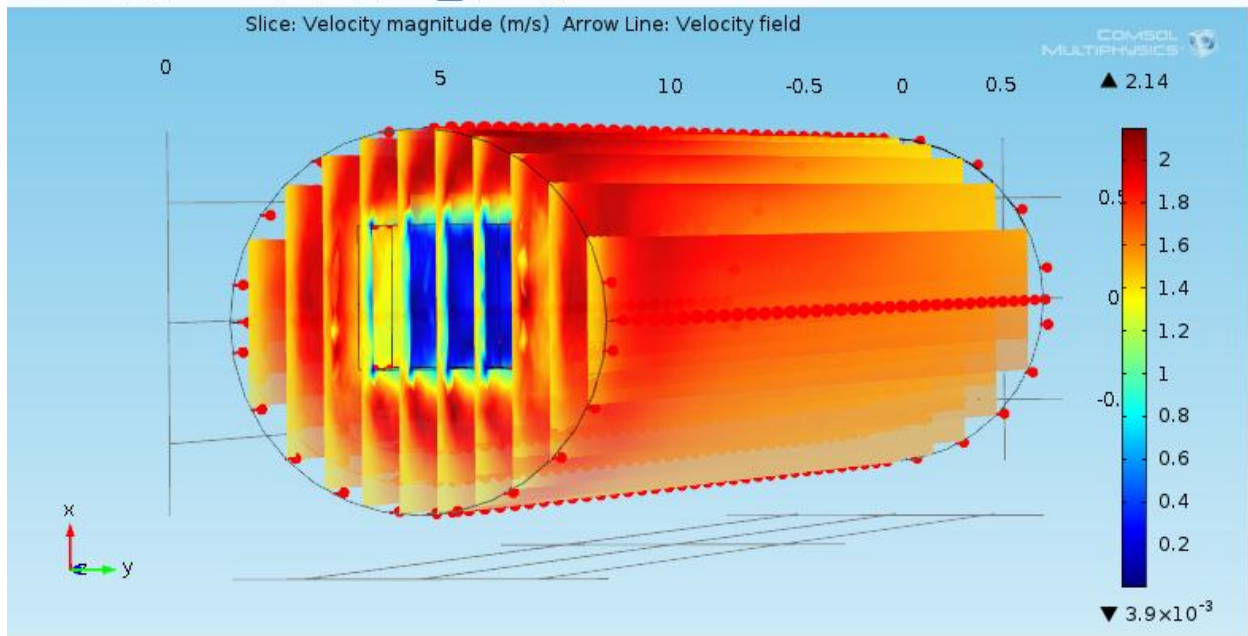


Figure 17: 3 Dimensional view of pipe when disturbance of 60cm is added in to the pipe

Fig .18 shows the slight decrease in mass flow rate form  $2.8 \text{ m}^3/\text{s}$  to  $2.79 \text{ m}^3/\text{s}$  or  $2.79 \times 10^3 \text{ kg/s}$  even disturbance of 60cm dimension was added to the pipe.

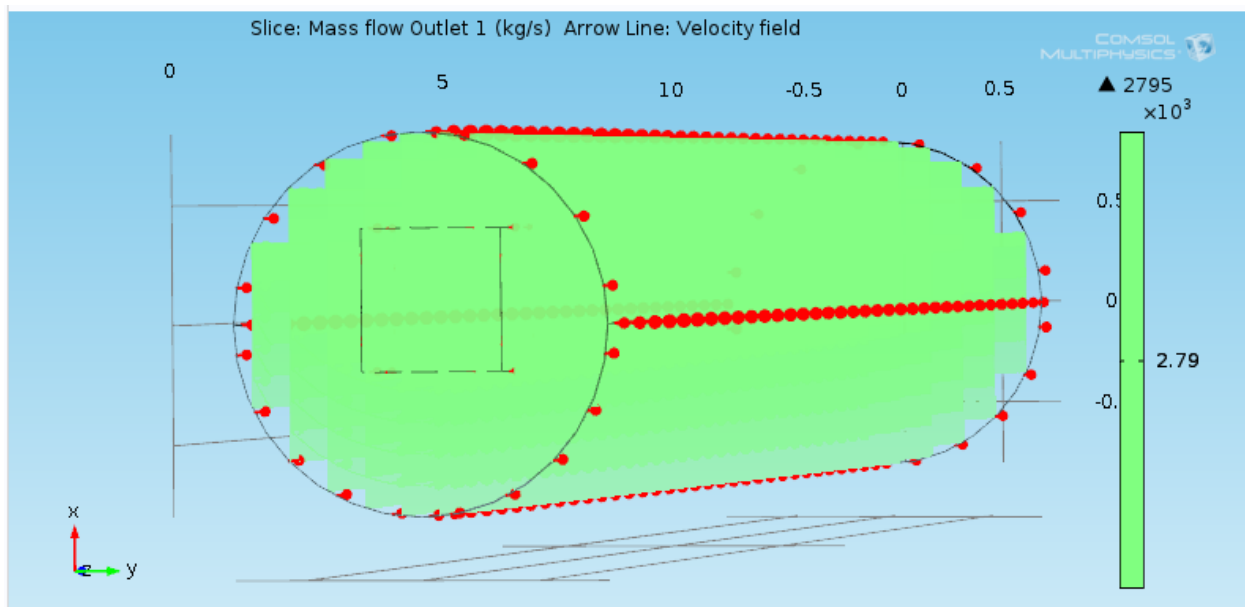


Figure 18 Mass flow rate (kg/s) for 60cm disturbance

Fig.19 shows the 2 Dimensional profile of pressure in to the pipe and sudden increase and decrease of the pressure profile is seen at the pipe where disturbance is added. On the other hand, Fig. 20 shows the pressure distribution profile of the pipe in 3 Dimensions which shows that pressure profile only changed at locations where disturbance is added.

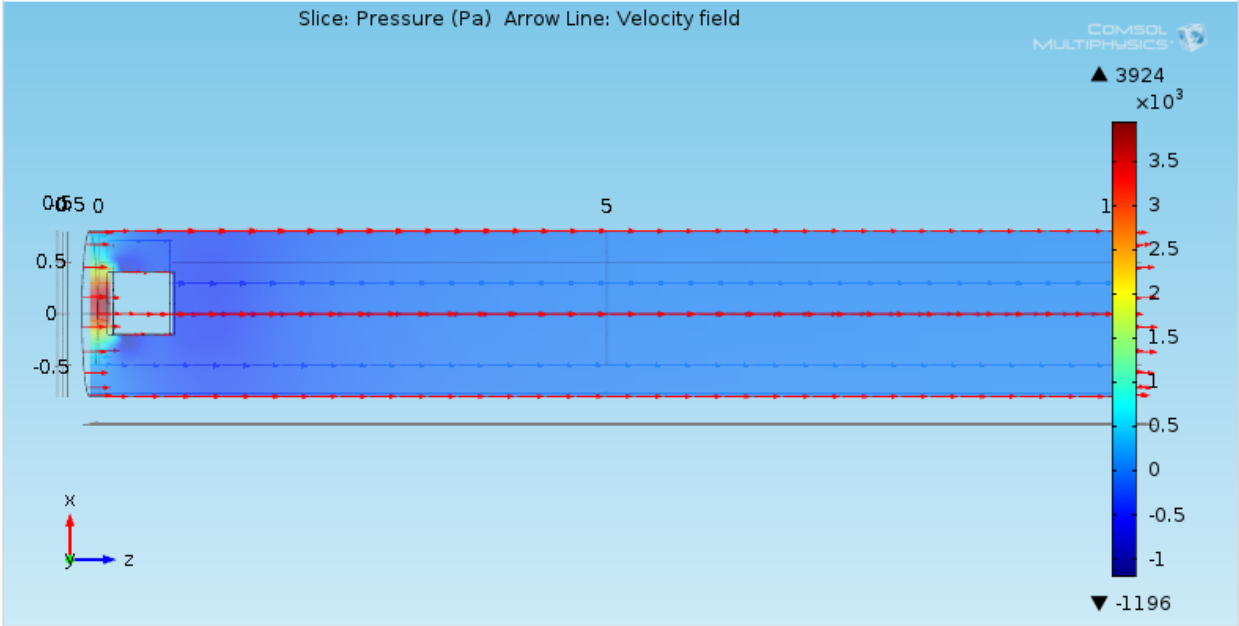


Figure 19 Pressure profile of the pipe in 2D

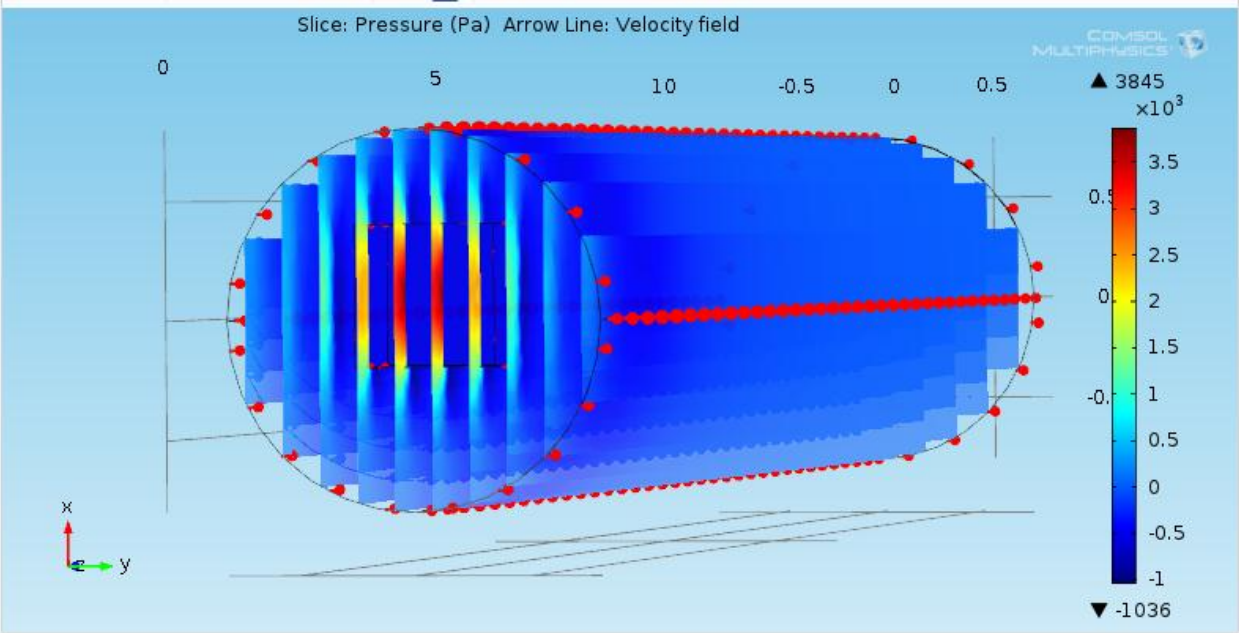


Figure 20 Pressure profile of the pipe in 3D



### Case Study 5: Disturbance of 25cm x 25cm x 25cm in to the pipe at the center location of the pipe

As a fifth case velocity distribution is checked when the disturbance was added at the initial part of the pipe. The 2 Dimensional views the velocity distribution is shown in Fig. 21 from which it can be concluded that velocity changed from 1.4 m/s to 0.3 m/s suddenly but then after 8 m distance but is steadily increased to 0.8 m/s after distance of 8 m and then approached to approximately 1 m/s after that distance. The velocity of the water remained approximately 1.2 m/s at the locations above and below the disturbance and sudden increase in velocity profile to 2 m/s were also seen at locations near to the disturbance.

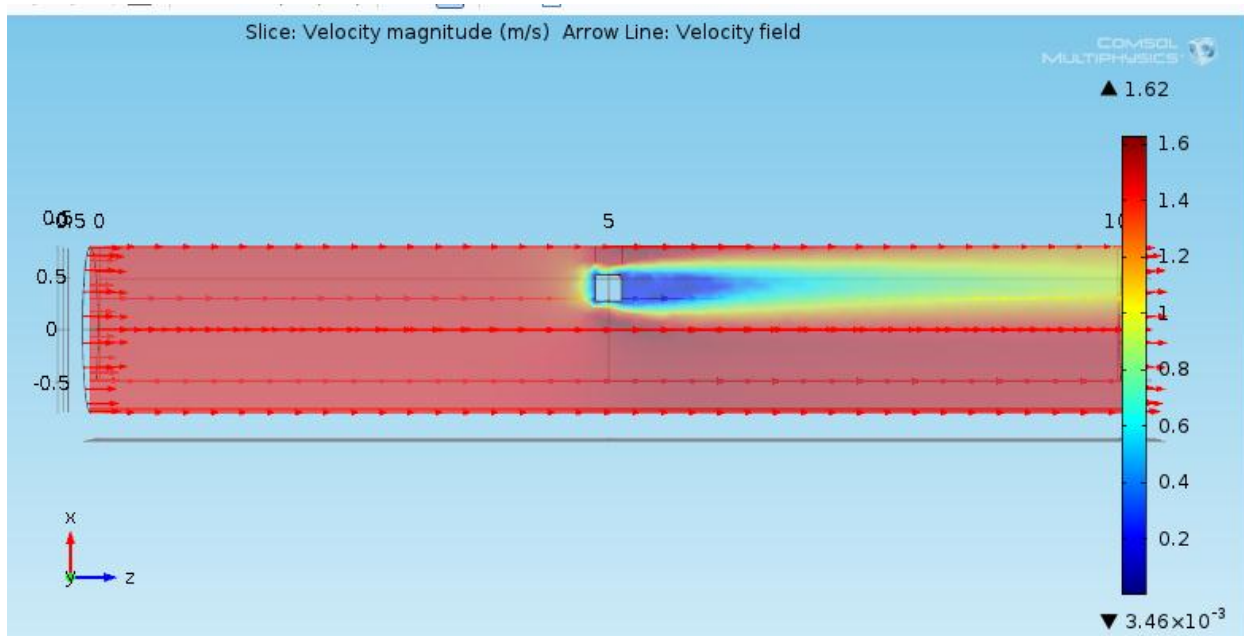


Figure 21 Velocity distribution in 2D for 25cm disturbance added in to the pipe

The 3 Dimensional view of velocity profile of the pipe is shown in Fig. 22 which shows that velocity distribution of the pipe is changed not only at the location where the disturbance is added but also at the locations near to the disturbance. The velocity distribution profile completely changed to the places near to the disturbance and impact of the disturbance remained dominant for the 10 m long section of the pipe.



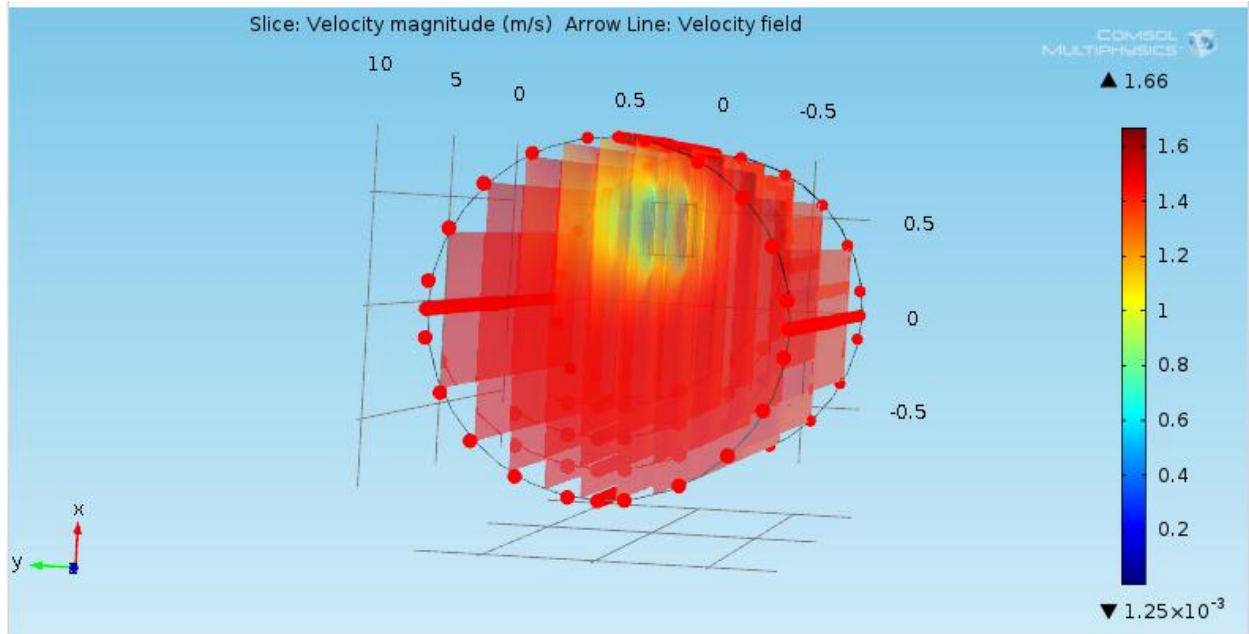


Figure 22 : 3 Dimensional view of pipe when disturbance of 25cm is added in to the pipe

Fig 23 shows the mass flow rate which remained constant to  $2.8 \text{ m}^3/\text{s}$  or  $2.8 \times 10^3 \text{ kg/s}$  even disturbance of 40cm dimension was added to the pipe.

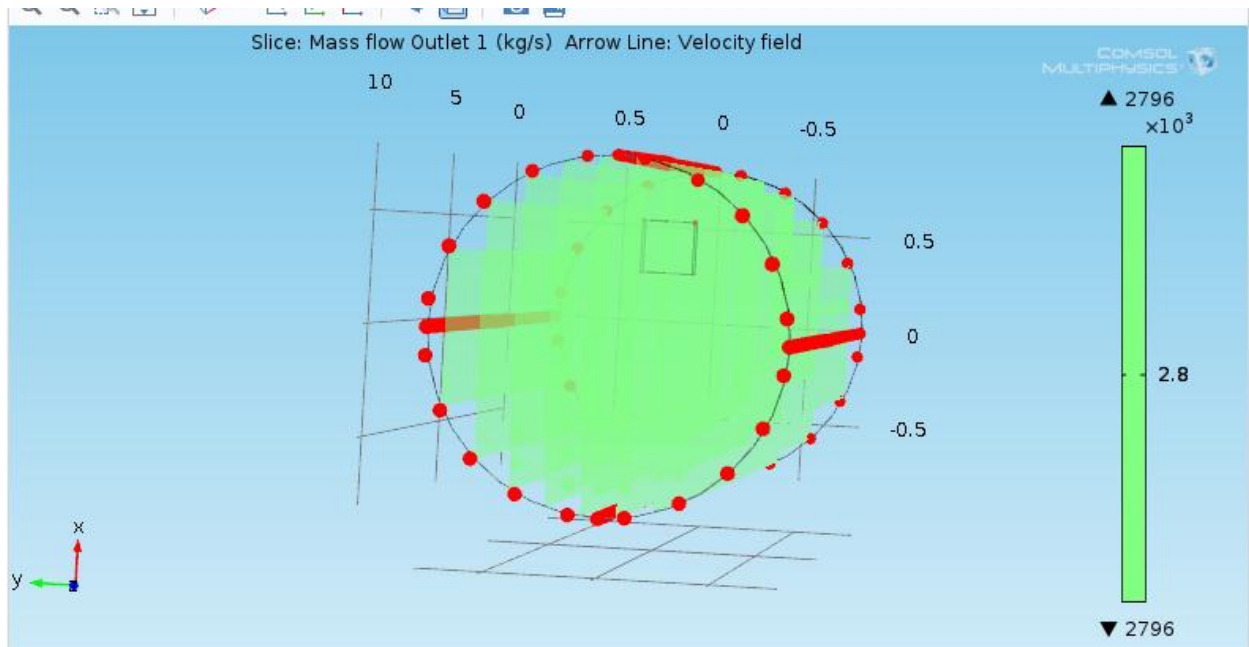


Figure 23 Mass flow rate (kg/s) for 25cm disturbance

Fig.24 shows the 2 Dimensional profile of pressure in to the pipe and sudden increase and decrease of the pressure profile is seen at the pipe where disturbance is added. On the other hand, Fig. 25 shows the pressure distribution profile of the pipe in 3 Dimensions which shows that pressure profile only changed at locations where disturbance is added.

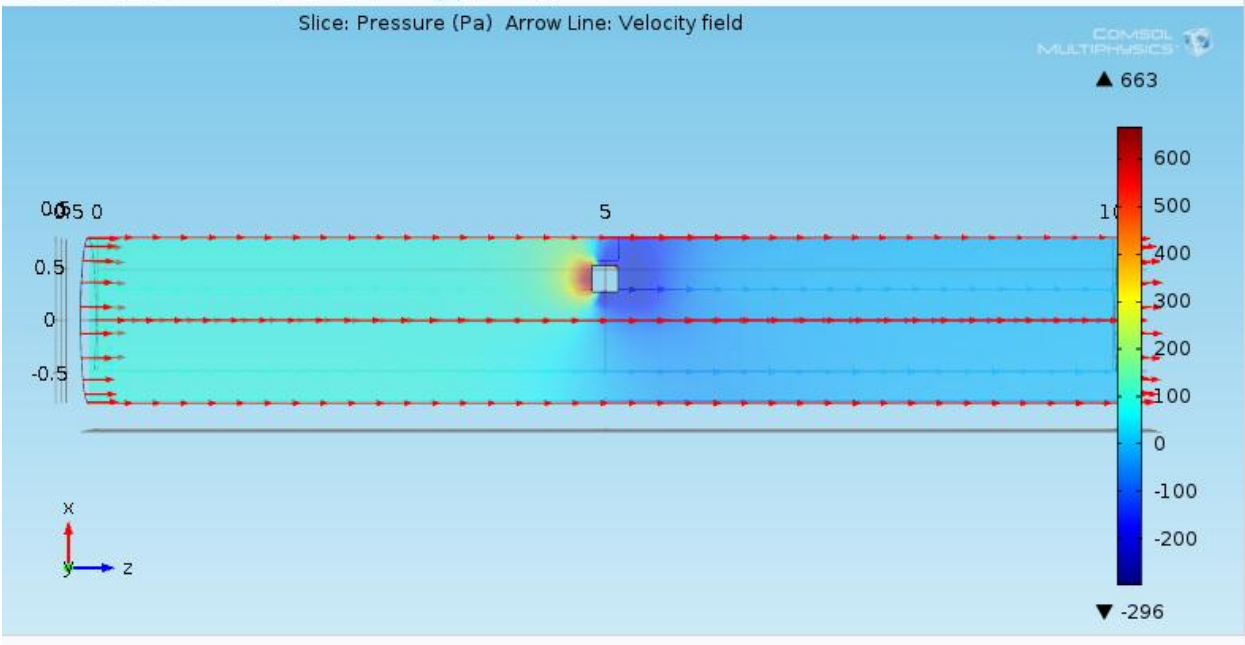


Figure 24 Pressure profile of the pipe in 2D

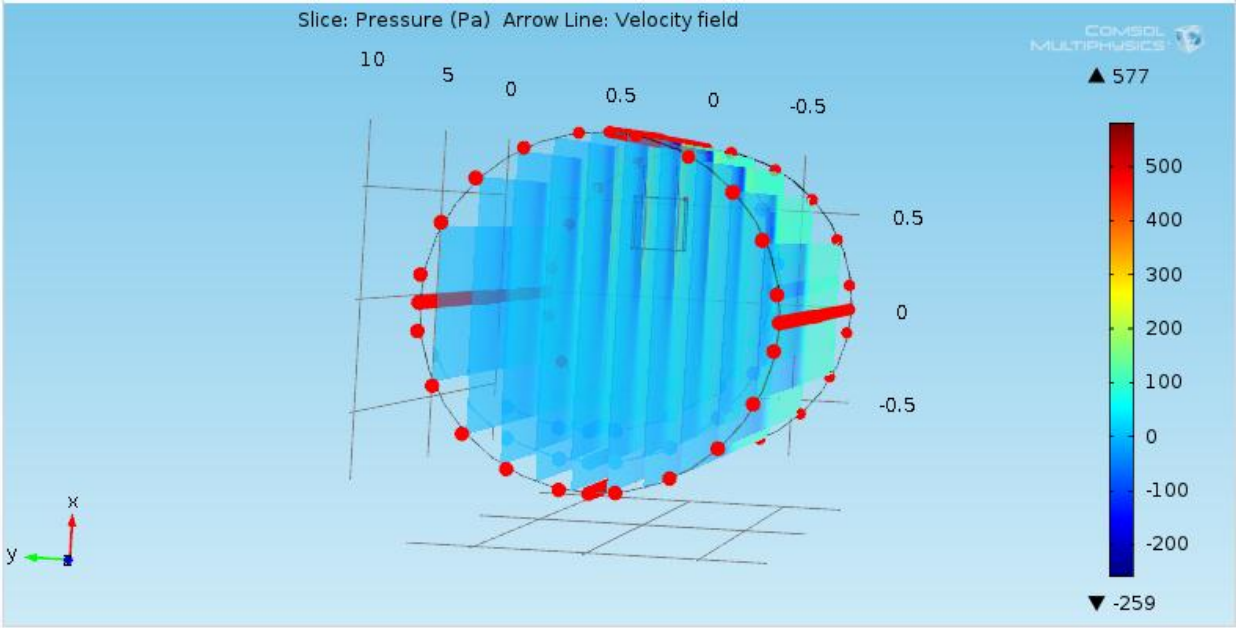


Figure 25 Pressure profile of the pipe in 3D

### Case Study 6: Two Disturbances of 30cm x 30cm x 30cm in to the pipe at different locations of the pipe for 15 m long section of the pipe

In sixth case velocity distribution is checked when the two disturbances were added at the different locations of the pipe. The 2 Dimensional views the velocity distribution is shown in Fig. 26 from which it can be concluded that velocity changed from 1.4 m/s to 0.3 m/s suddenly but then after 5 m distance but is steadily increased to 0.8 m/s after distance of 5 m and then approached to approximately 1 m/s after that distance. For the other disturbance, velocity changed from 1.4 m/s to 0.3 m/s suddenly but then after 10 m distance but is steadily increased to 0.8 m/s after distance of 10 m and then approached to approximately 1 m/s after that distance. The velocity of the water remained approximately 1.2 m/s at the locations above and below the disturbance and sudden increase in velocity profile to 2 m/s were also seen at locations near to the disturbance.

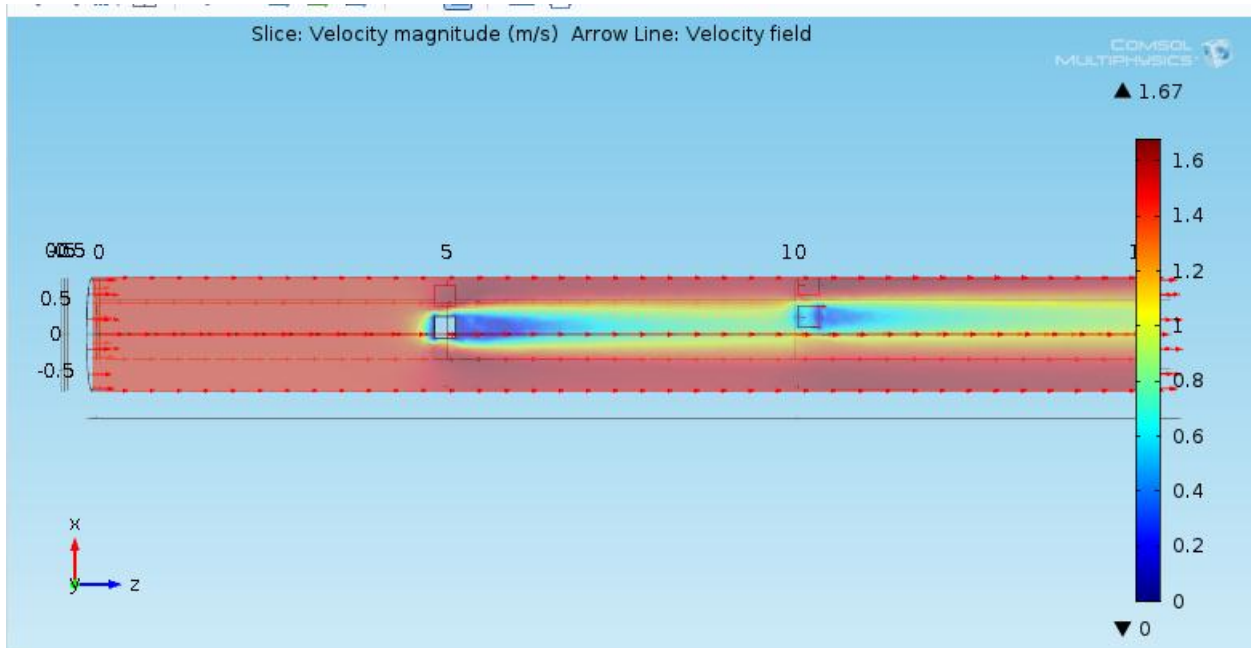


Figure 26 Velocity distribution in 2D for two 30cm disturbances added in to the different locations of the pipe

The 3 Dimensional view of velocity profile of the pipe is shown in Fig. 27 which shows that velocity distribution of the pipe is changed not only at the location where the disturbance is added but also at the locations near to the disturbance. The velocity distribution profile completely changed to the places near to the disturbance and impact of the disturbance remained dominant for the 15 m long section of the pipe.

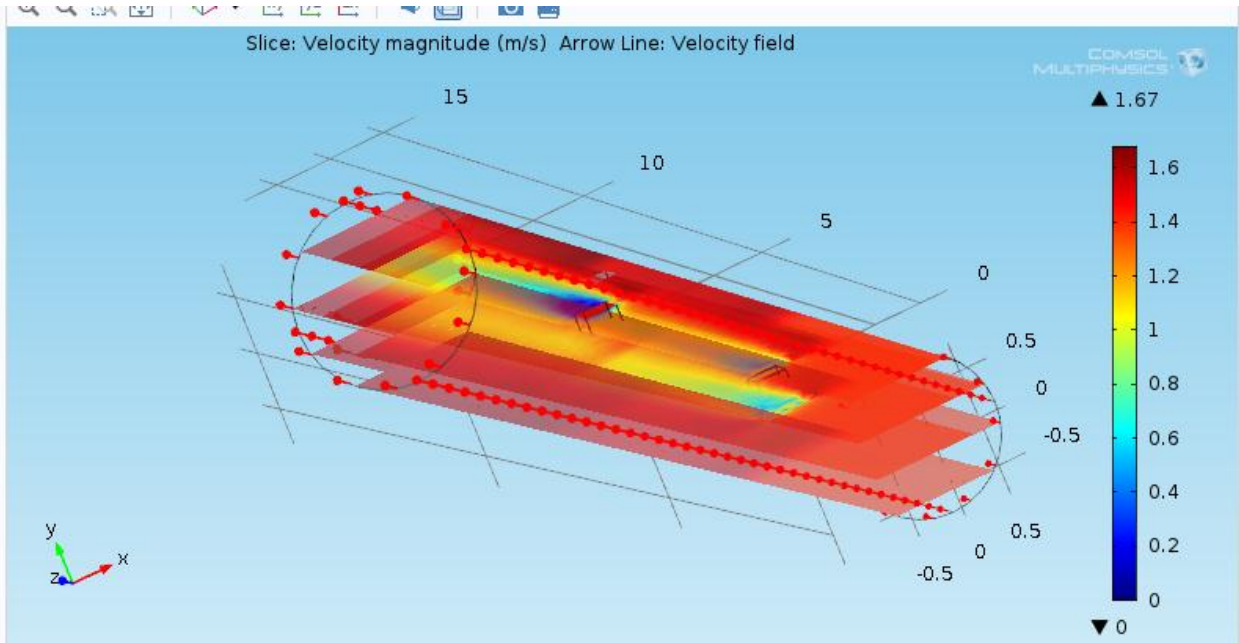


Figure 27 3 Dimensional view of pipe when two disturbances of 30cm is added in to the pipe

Fig .28 shows the slight decrease in mass flow rate form  $2.8 \text{ m}^3/\text{s}$  to  $2.79 \text{ m}^3/\text{s}$  or  $2.79 \times 10^3 \text{ kg/s}$  when two disturbances of 30cm dimension was added to the pipe.

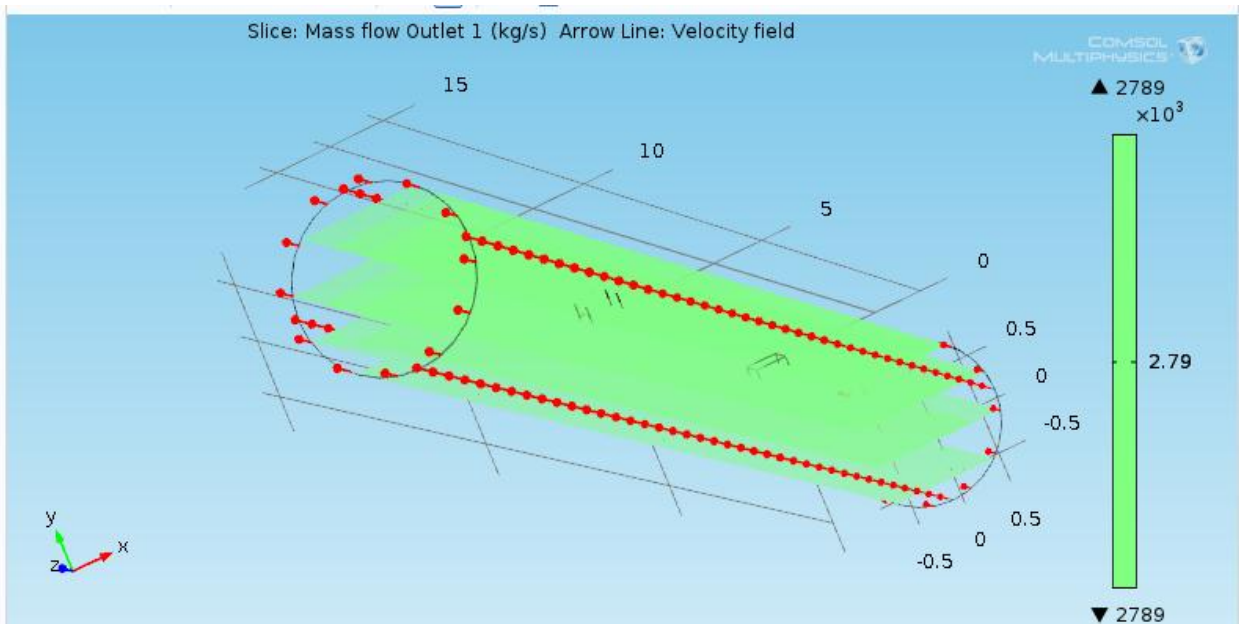


Figure 28 Mass flow rate (kg/s) for 30cm disturbances

Fig.29 shows the 3 Dimensional profile of pressure in to the pipe and sudden increase and decrease of the pressure profile is seen at the pipe where disturbance is added. On the other hand, Fig. 30 shows the pressure distribution profile of the pipe in 2 Dimensions which shows that pressure profile only changed at locations where disturbance is added.

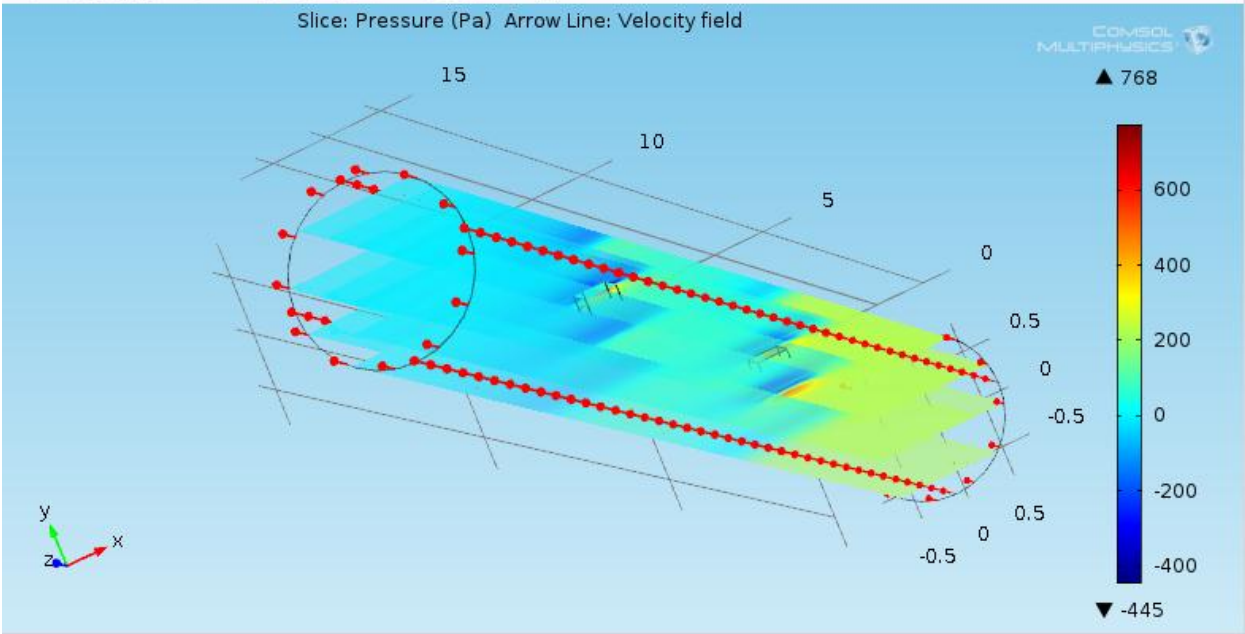


Figure 29 Pressure profile of the pipe in 3D

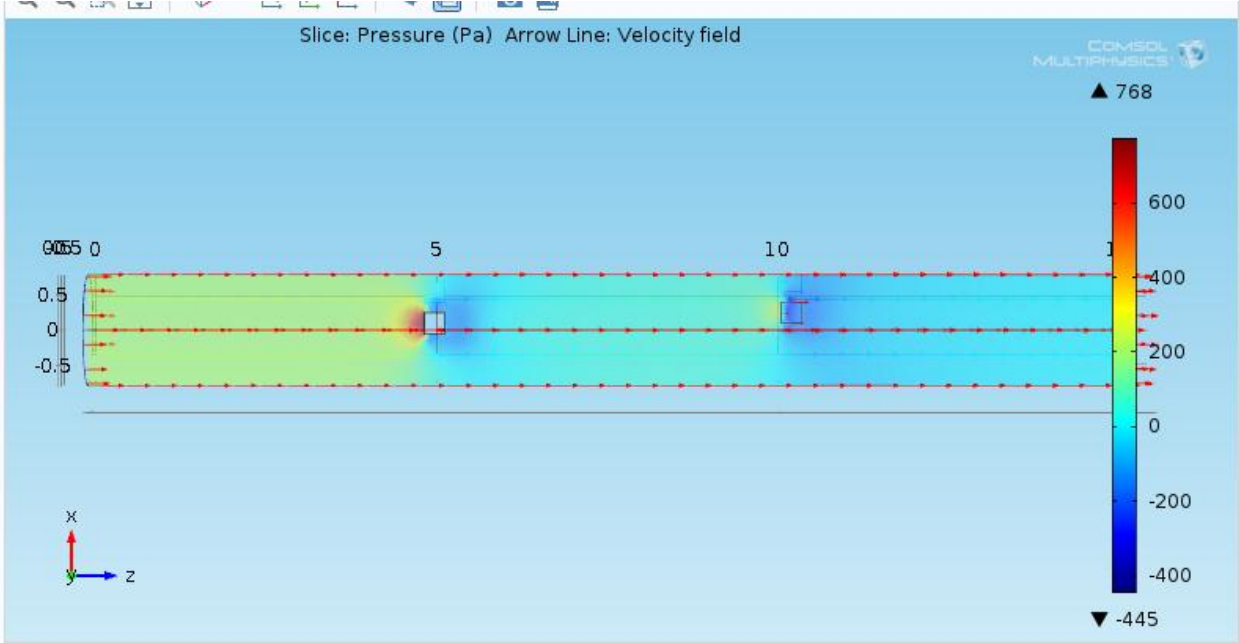


Figure 30 Pressure profile of the pipe in 2D