MAE 560

Project 2

Junghyun Choi

Name of Collaborator : Wonwung Kim	
Task 1	Discussed the result of the simulation
Task 2	Discussed the result of the simulation
Task 3	Discussed the result of the simulation
Task 4	Discussed the result of the simulation

Task 1. Natural Gas Leaking into Open Air (2-D)

(D1) Contour plots of the volume fraction of methane, y-velocity, and static pressure.

General: a transient simulation, a pressure-based solver, gravity -9.81m/s^2 in Y-direction the operating density method to mixture-averaged, a turbulence k-epsilon model, top and sides' boundaries are open with pressure outlets with zero gauge pressure (pipe is pressure inlet with 50 Pa of gauge pressure)

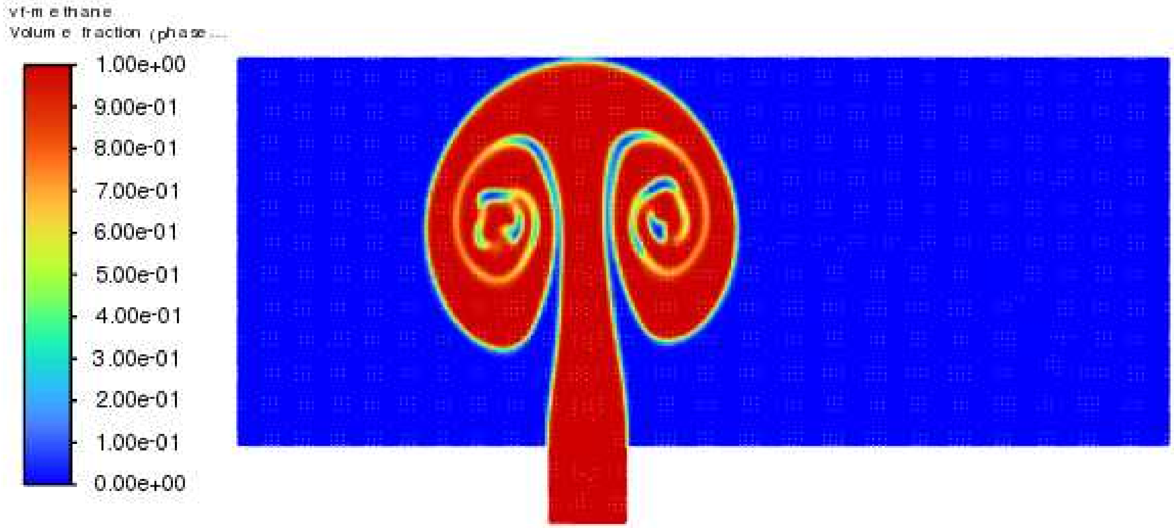


Figure 1. Volume Fraction of Methane at t = 5 s

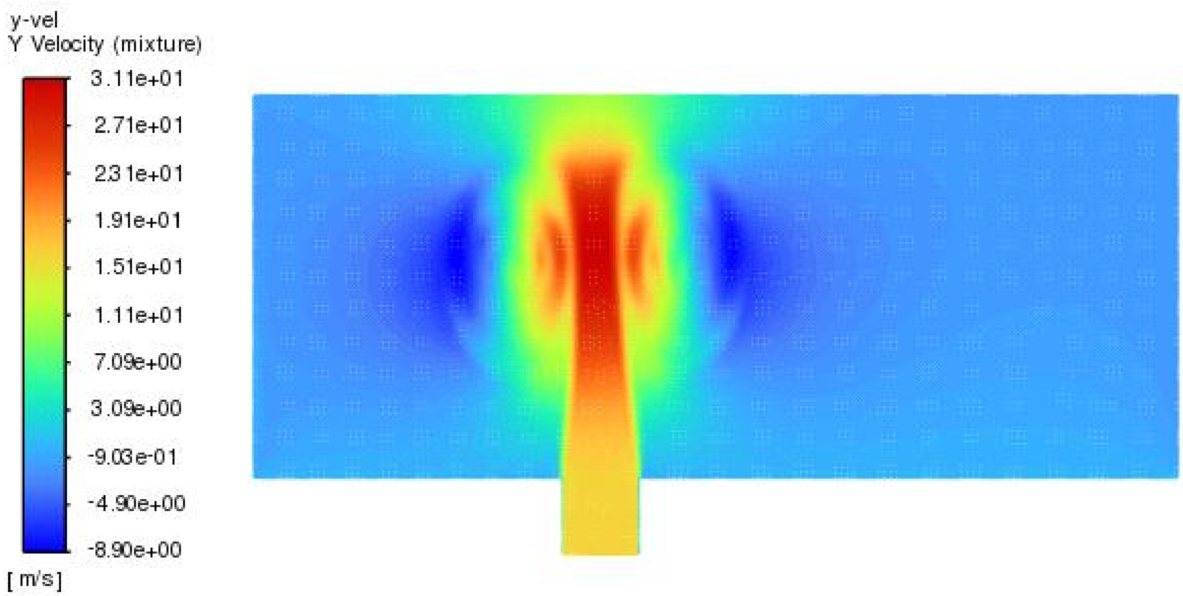


Figure 2. Contour of y-velocity at t = 5 s

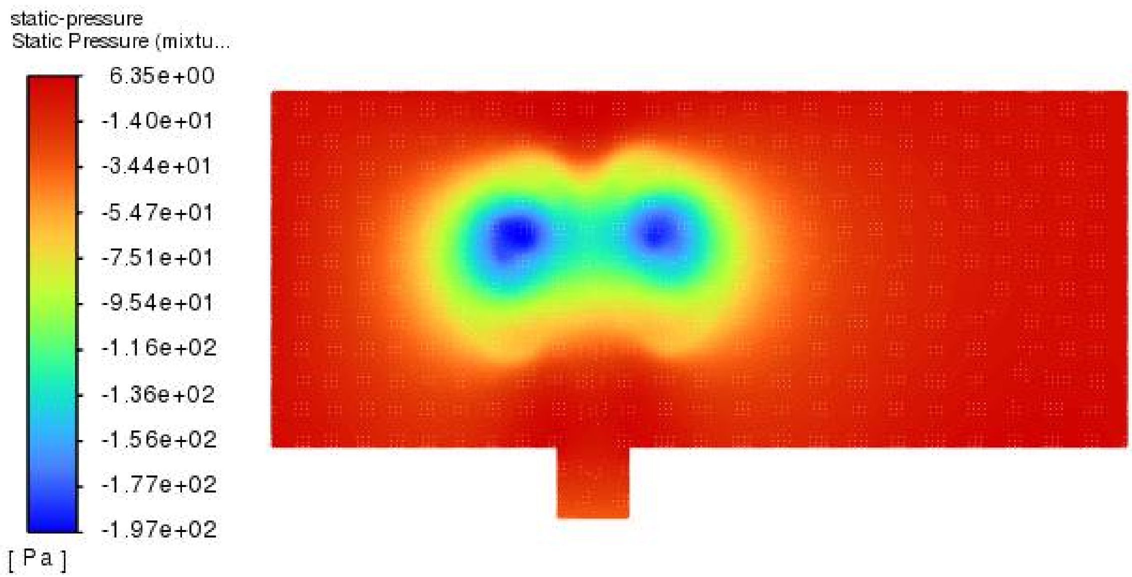


Figure 3. Contour of Static Pressure at t = 5 s

(D2) A contour plot of the volume fraction of methane at t = 5 s.

The boundary condition of the left side is a velocity inlet with velocity profile set to $u = 0.8\,y - 0.032\,y^2$ [m/s]

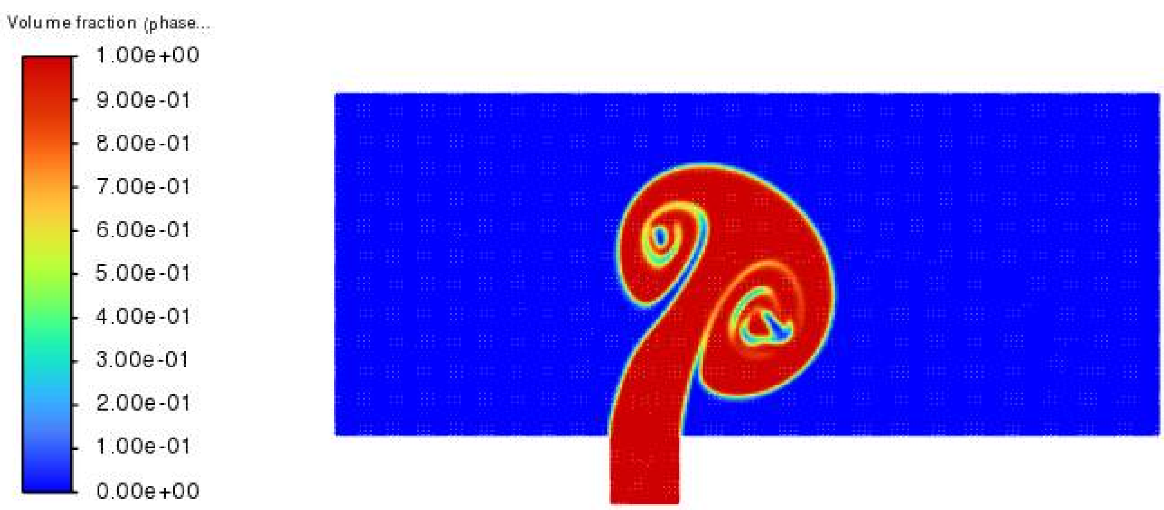


Figure 4. Volume Fraction of Methane at t = 5 s

(D3) Describe the mesh resolution (element size) and time step size used in the simulations in (a) and (b).

Element size: 0.2m (Number of elements: 38k)

Time step size: 0.01s with 10 max Iterations

Task 2. A Falling Water Droplet (2-D)

(D4) Contour plots of the volume fraction of water at t = 0.2 s, 0.25 s, and 0.3 s.

A square bucket is open to air at the top with the other three sides being walls.

Surface tension turned on with the coefficient of the database

The boundary of the top is a pressure outlet with zero gauge pressure

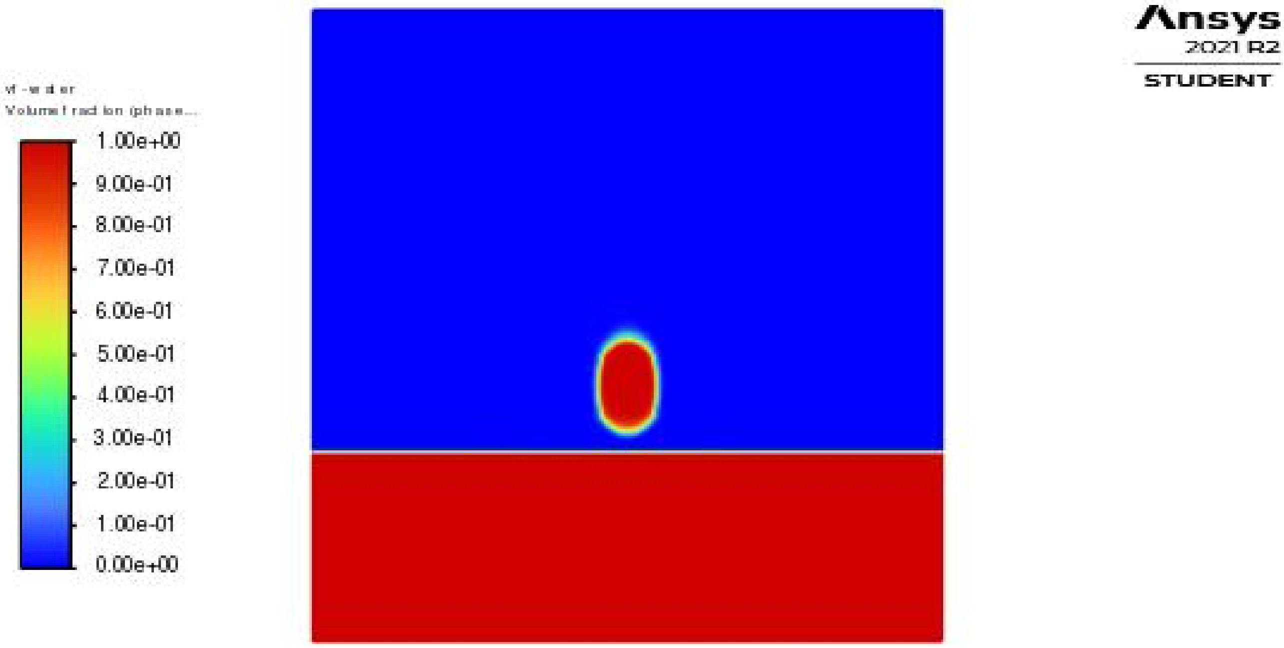


Figure 5. Volume Fraction of Water at t = 0.2 s

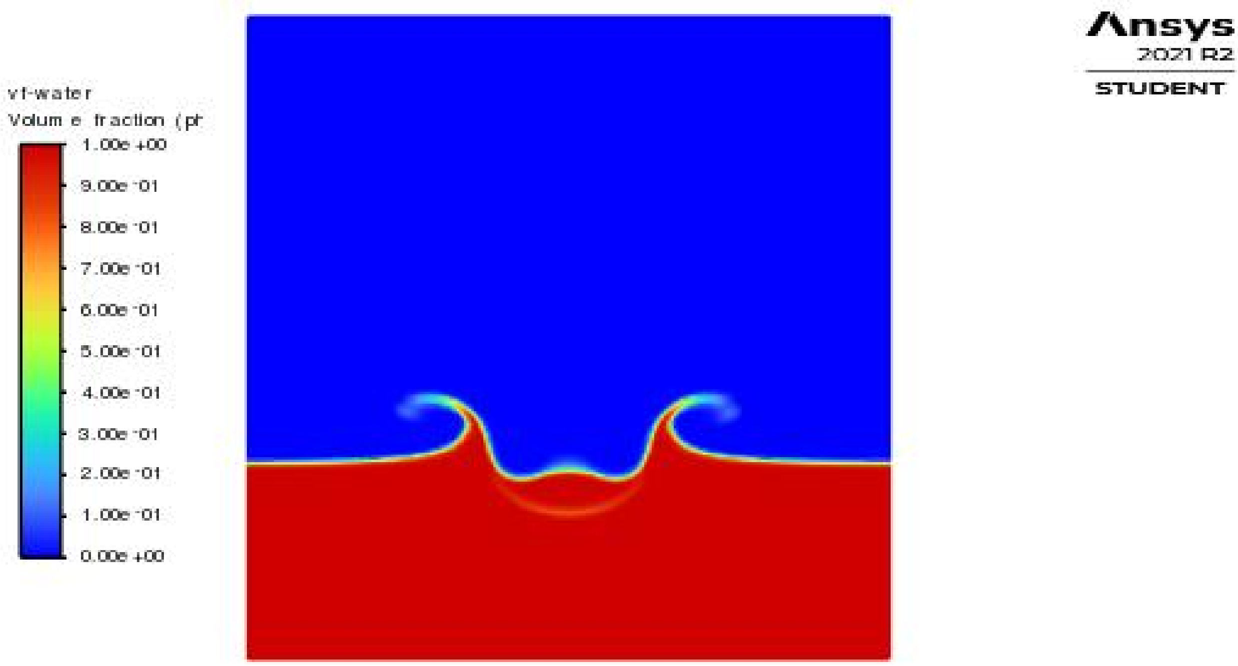


Figure 6. Volume Fraction of Water at t = 0.25 s

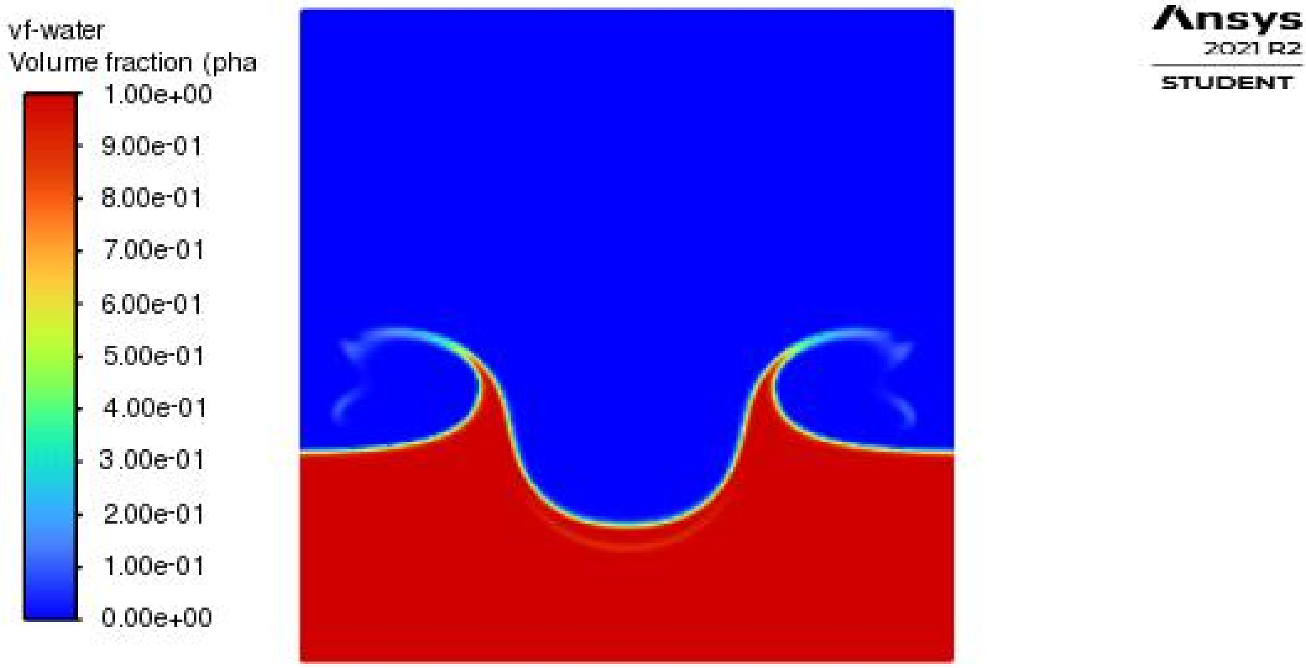


Figure 7. Volume Fraction of Water at t = 0.3 s

(D5) A description of the mesh resolution and time step size used in the simulation.

Element size: 0.25cm (Number of elements: 40k)

Time step size: 0.001s with 20 max Iterations

Task 3. Engine Oil Droplet on Inclined Plate(3-D)

(D6) A description of the computational domain, boundary conditions, mesh resolution, and time step size used in the simulation.

Computational domain: 8x12x3cm(The domain of 10x15x5cm was made at first, however, due to the mesh resolution limitation and the computational cost it was reconsidered then adjusted a bit based on the first simulation.)

Boundary conditions: All sides(except the bottom as a wall) are open as a pressure outlet with zero gauge pressure(backflow of water set to zero)

Mesh Resolution: element size 0.001m (Number of elements: 288k)

Time step size: 0.001s with 15 max Iterations

(D7) Three plots in the fashion of Fig. 3b that show the 3-D shape of the blob of engine oil at t = 0, 0.05 s, and 0.1 s.

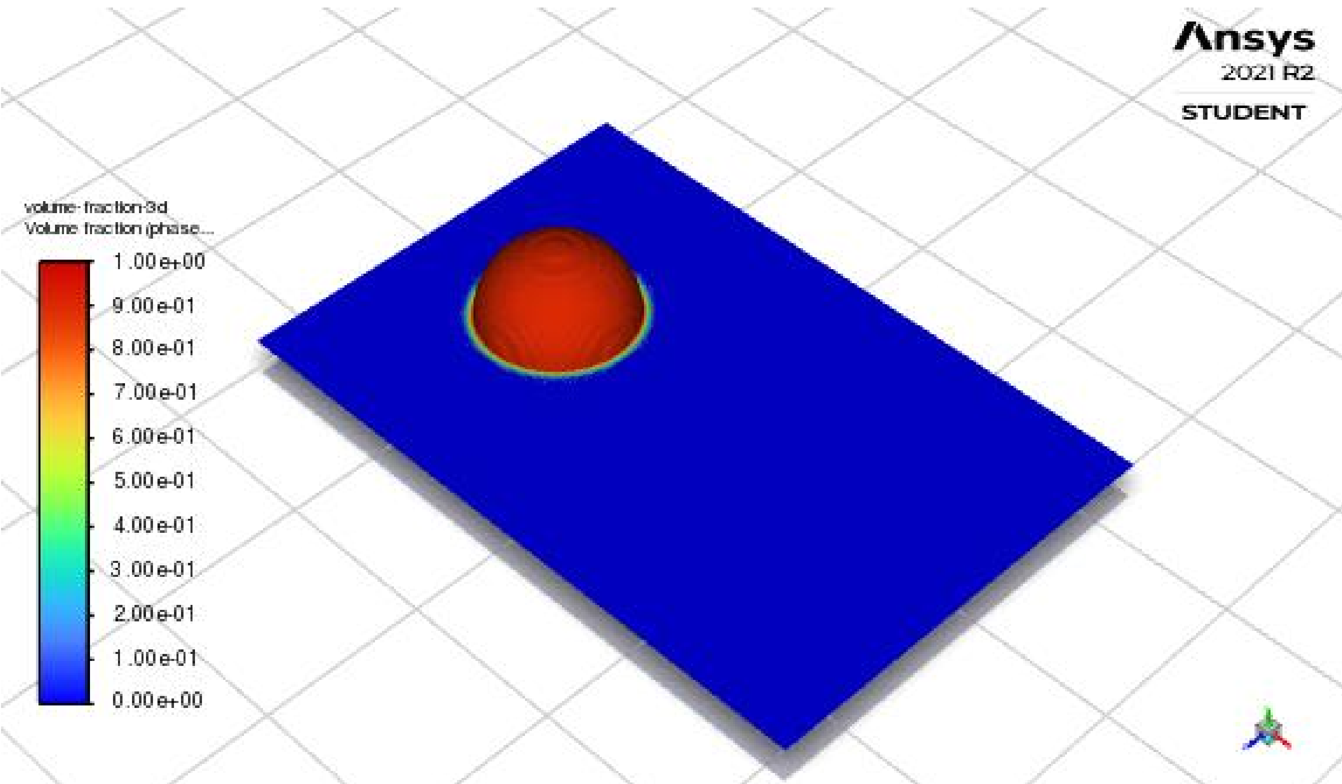


Figure 8. Iso-Surface (VF = 0.9) of Engine Oil at t = 0 s

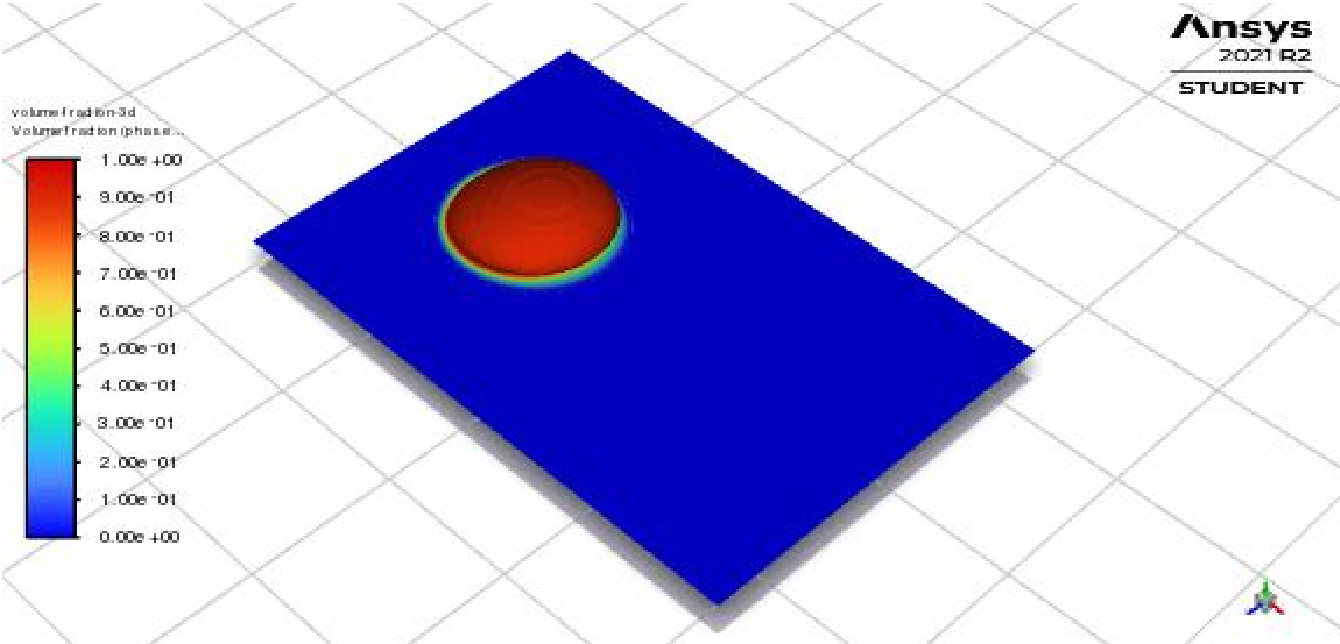


Figure 9. Iso-Surface (VF = 0.9) of Engine Oil at t = 0.05 s

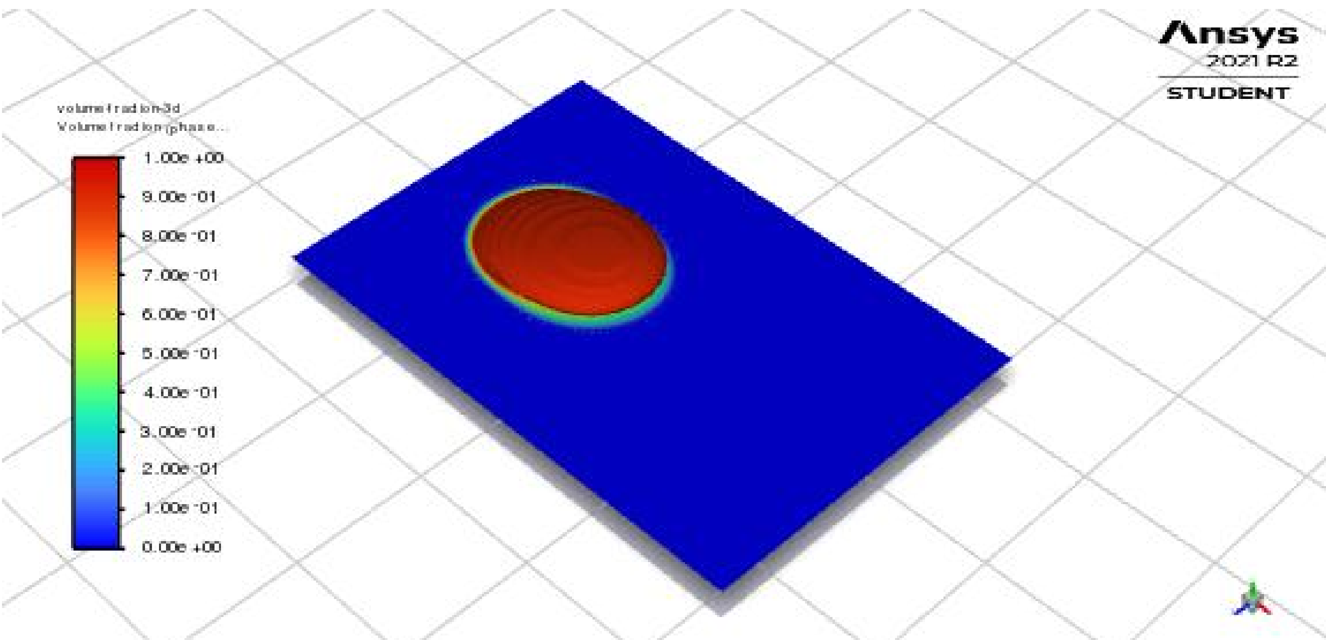


Figure 10. Iso-Surface (VF = 0.9) of Engine Oil at t = 0.1 s

(D8) Three contour plots of the volume fraction of engine oil on the plane of symmetry, at t = 0, 0.05 s, and 0.1 s.

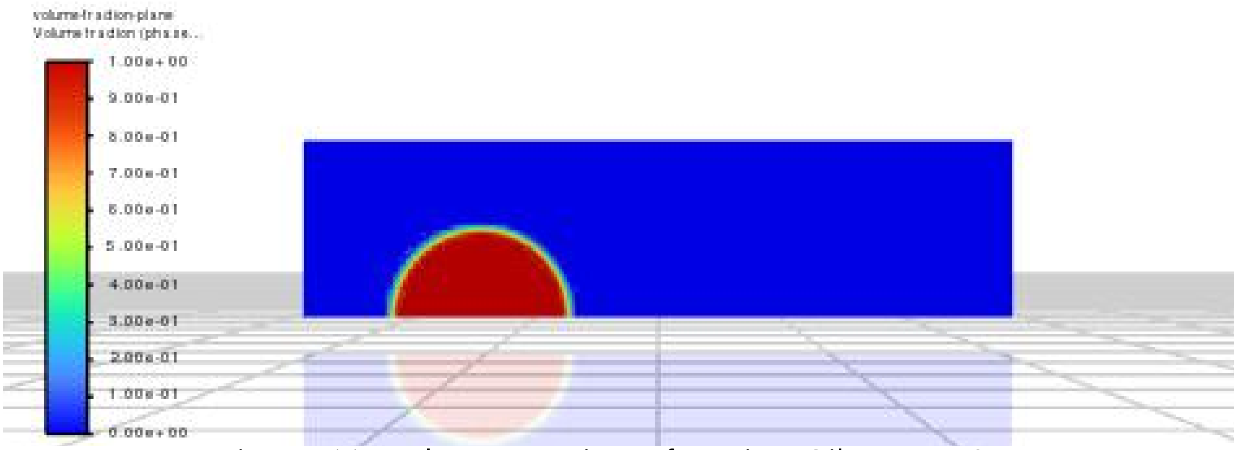


Figure 11. Volume Fraction of Engine Oil at t = 0 s

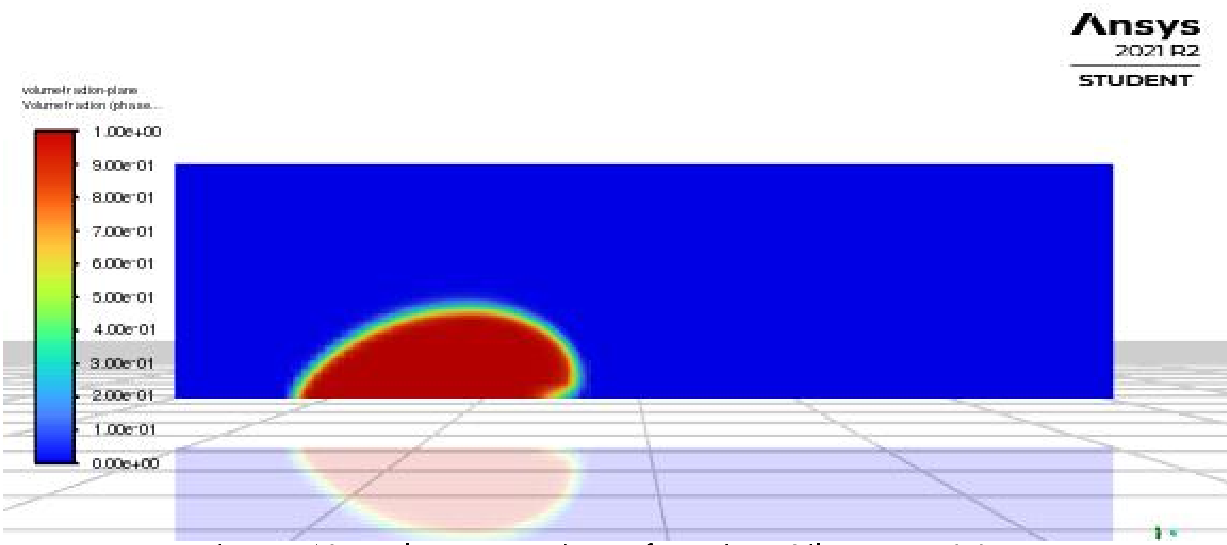


Figure 12. Volume Fraction of Engine Oil at t = 0.05 s

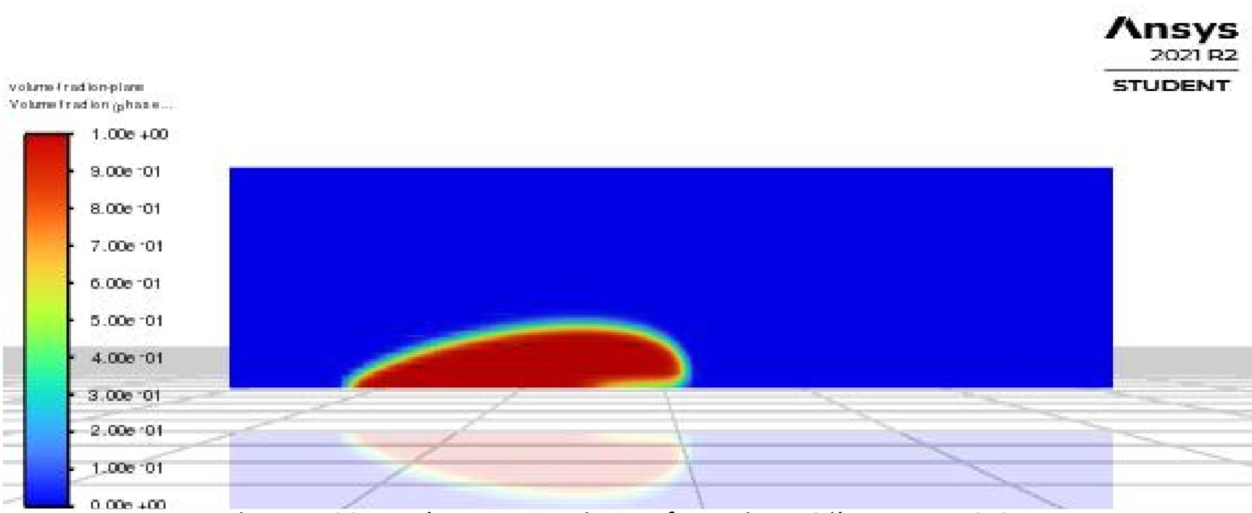


Figure 13. Volume Fraction of Engine Oil at t = 0.1 s

Task 4. Water in U-shaped pipe (3-D)

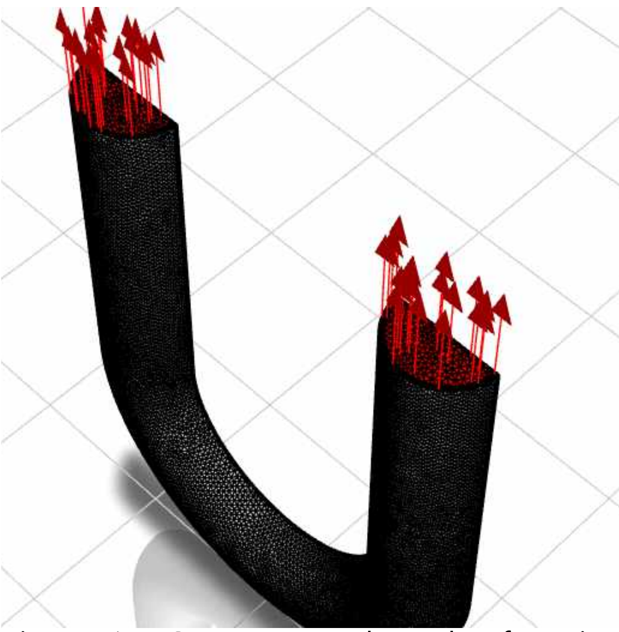
(D9) A description of the boundary conditions you choose for the two top openings that allow Fluent to properly simulate the oscillation.

Geometry: symmetry half pipe

Boundary conditions: Top sides are open as a pressure outlet with zero gauge pressure(backflow of water set to zero)

Mesh Resolution: element size 0.003m (Number of elements: 260k)

Time step size: 0.002s with 15 max Iterations



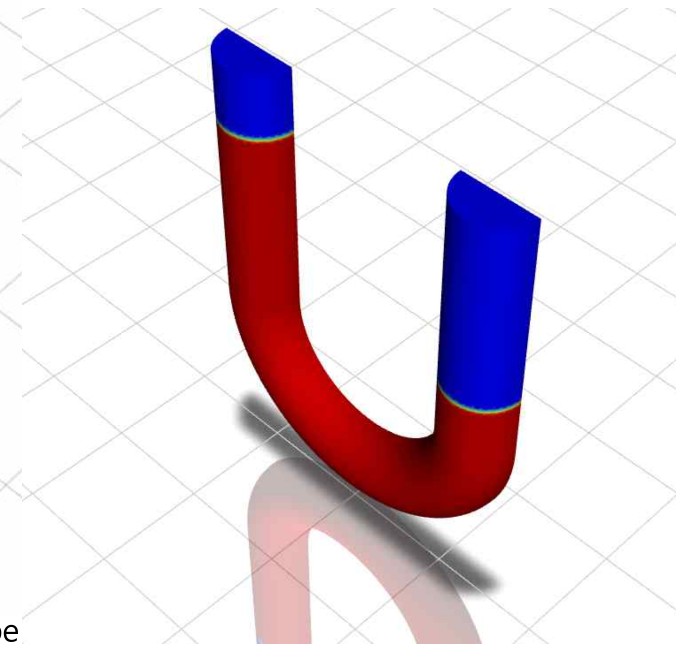


Figure 14. Geometry and Mesh of U-Pipe

(D10) A plot of h as a function of time. Determine the approximate period of the oscillation.

Period of the oscillation: 1.018 s

The first circle is t_1(≈¼ of oscillation) at 0.254 s

Due to mass flow rate m = ρVA, it needs to be divided by ρ_{air} and the area of the half pipe to obtain the value of the velocity of water level.

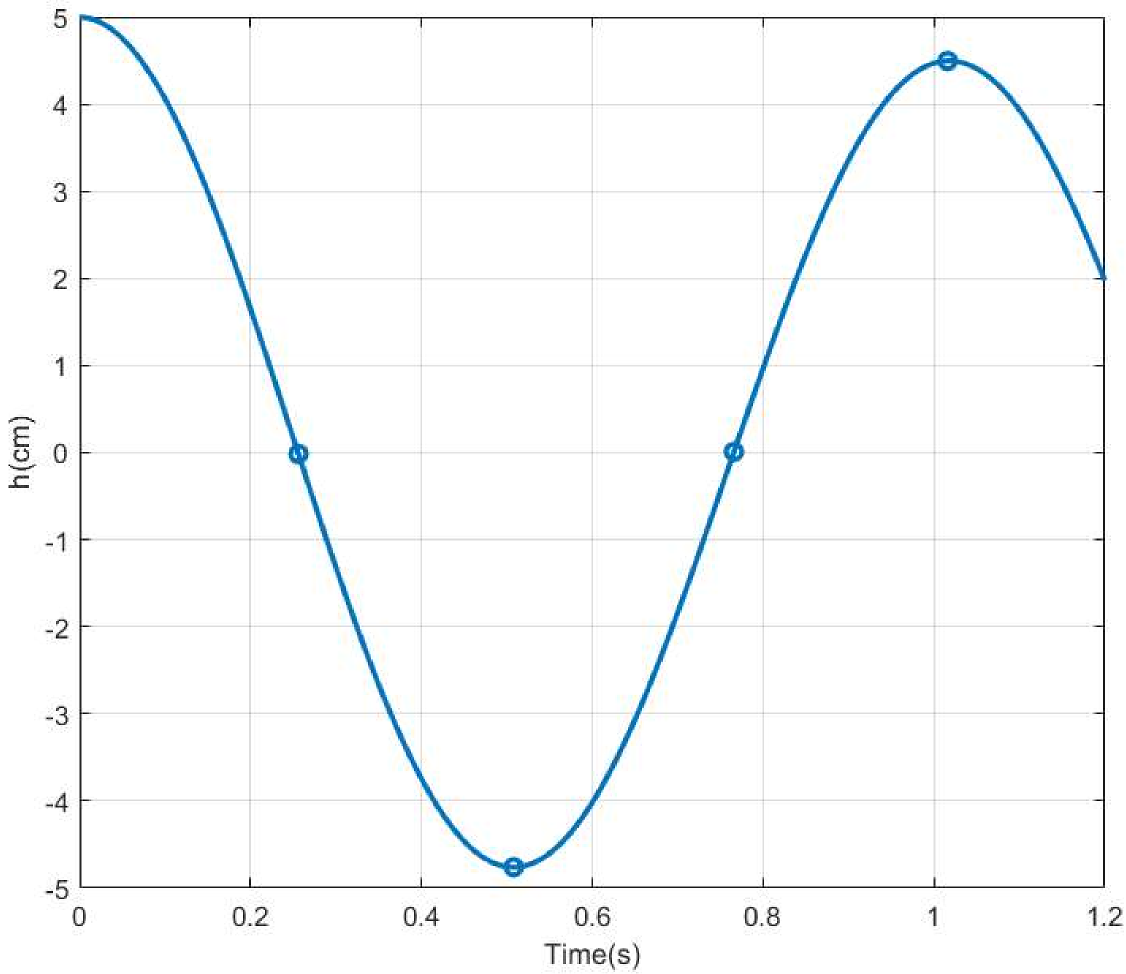


Figure 15. Line Plot of h(Water Level) as Function of Time

(D11) Let t1 be the time when the water levels of the left and right legs first become equal. Make contour plots of the x-velocity and y-velocity on the plane of symmetry at t = t1.

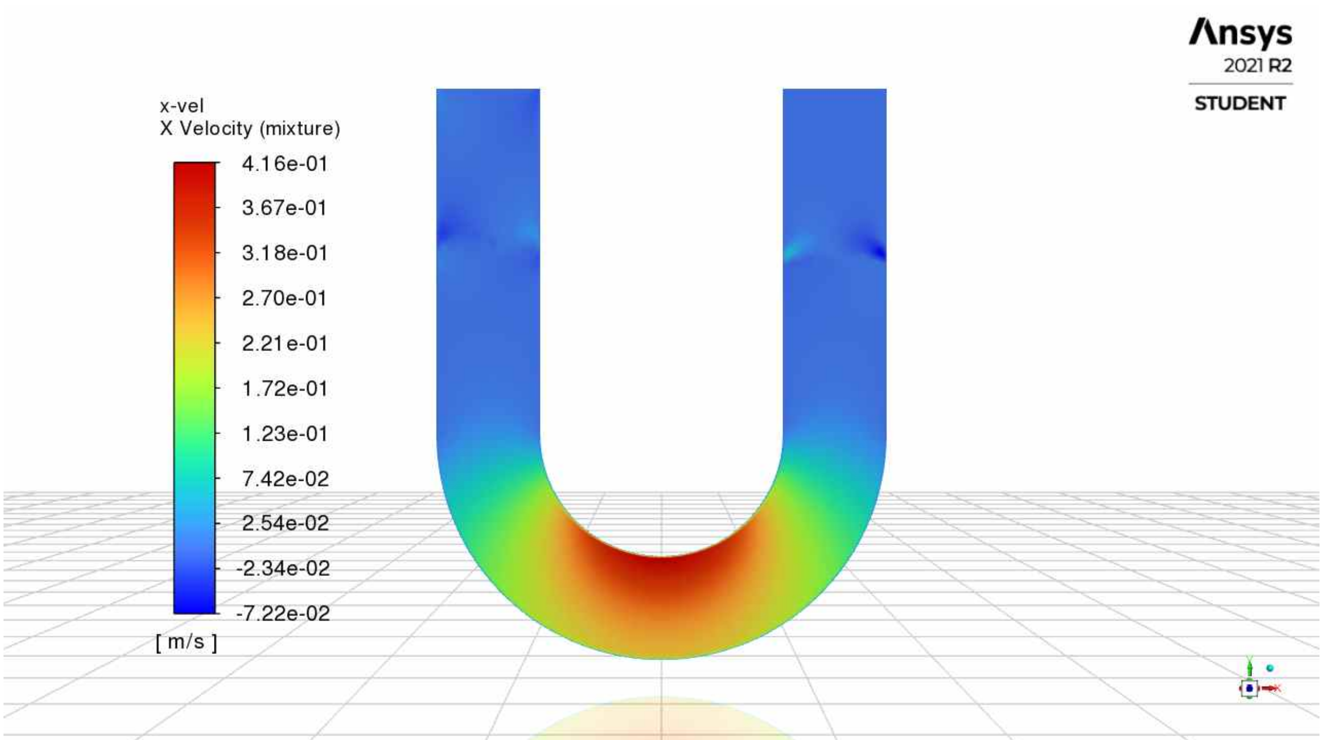


Figure 16. Contour Plot of X-Velocity at t_1(≈¼ of oscillation) = 0.254 s

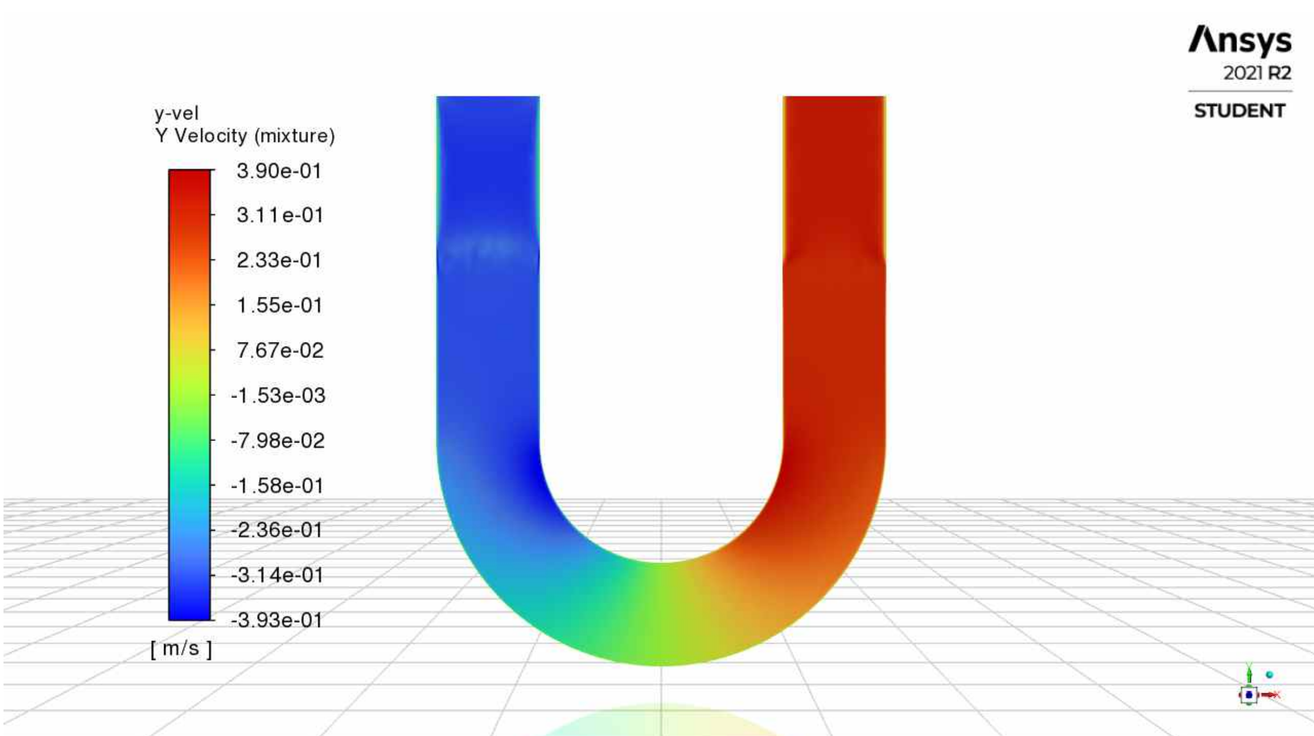


Figure 17. Contour Plot of Y-Velocity at t_1(≈¼ of oscillation) = 0.254 s