PROJECT-2

MAE:560 Applied Computational Fluid Dynamics

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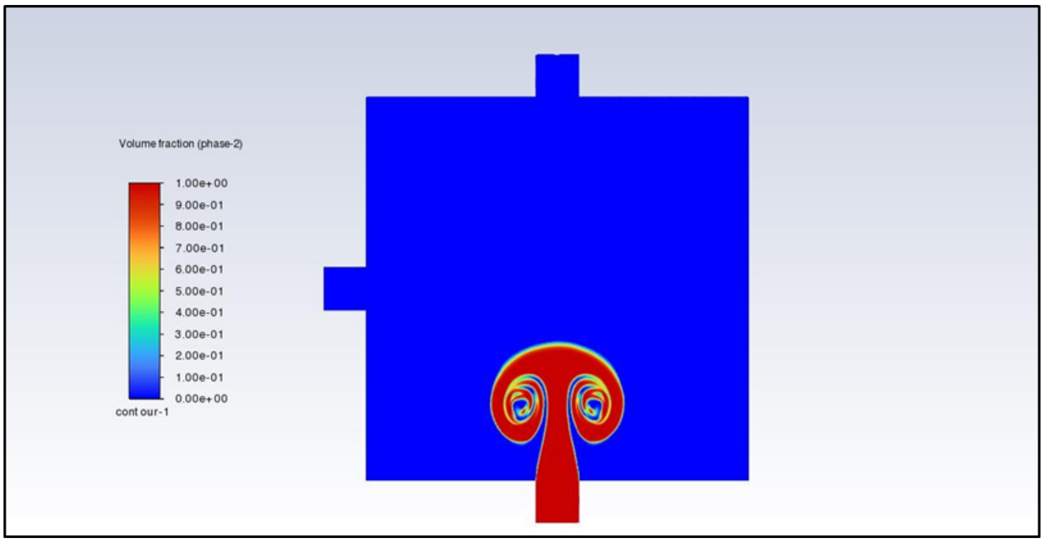
No Collaboration

TASK 1 A:-

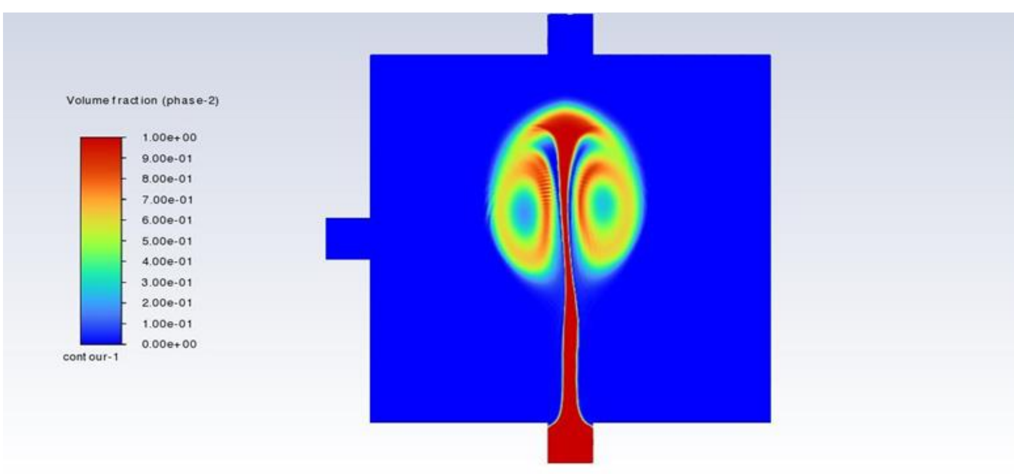
(Case A)- Inlet of left pipe closed.

Deliverables 1

- **Contour plots of the volume fraction of methane at t = 1s and t = 2.5 s.**



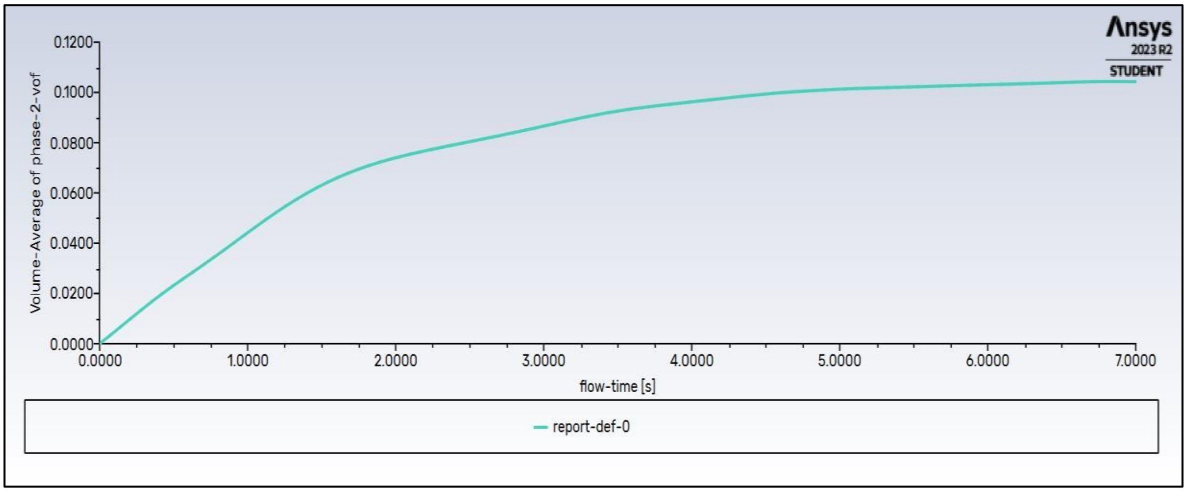
Volume Fraction of Methane at t=1s



Volume Fraction of Methane at t=2.5s

Deliverables 2

- **A plot of the D-index as a function of time, for 0 ≤ t ≤ 7 s.**

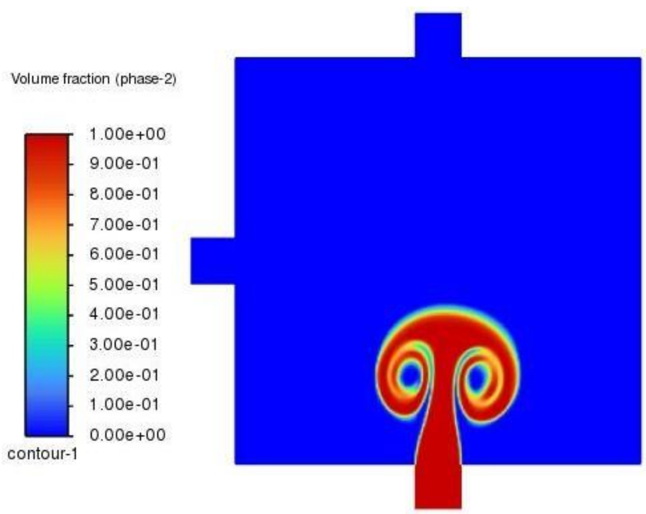


Plot for t=7s

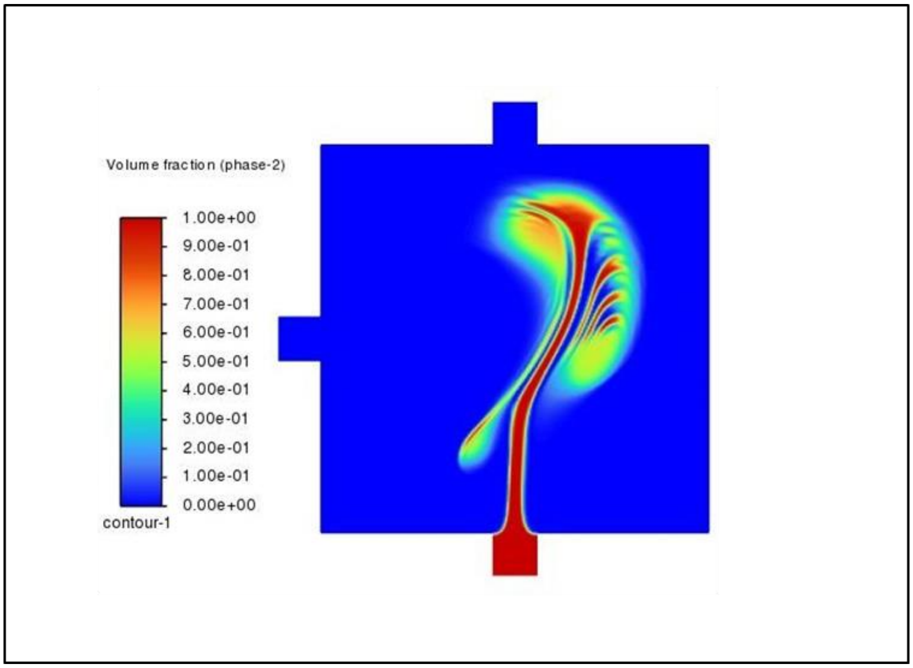
- (Case B): Inlet of left pipe provides fresh air.

Deliverables 3: -

- **Contour plots of the volume fraction of methane at t = 1 s and t = 2.5 s.**



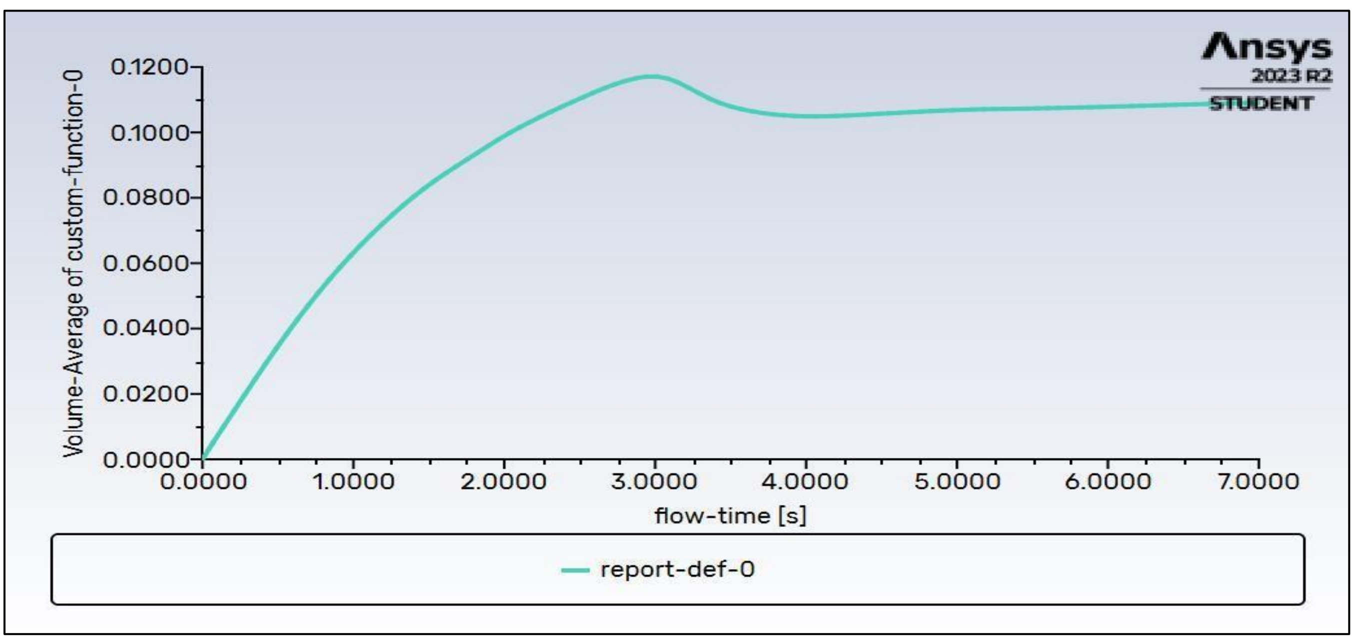
Volume Fraction of Methane at t=1s



Volume Fraction of Methane at t=2.5s

Deliverables 4

- **A plot of the D-index as a function of time, for 0 ≤ t ≤ 7 s.**

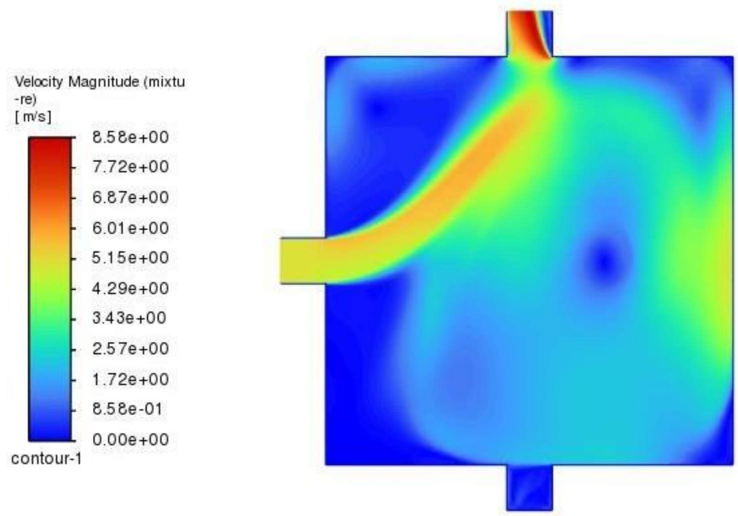


Line plot of the D-index as a function of the time at t=7s

***Does the injection of fresh air help reduce the D-index?**

There is potential difference in the values of the d-index. After a point, there is decrease in the d-index in case b. So, by using air as inlet it can be useful in decreasing d-index.

Deliverables 5:-



Velocity Magnitude of the mixture at t=7s

Deliverables 6:-

Same for both Case A and Case B

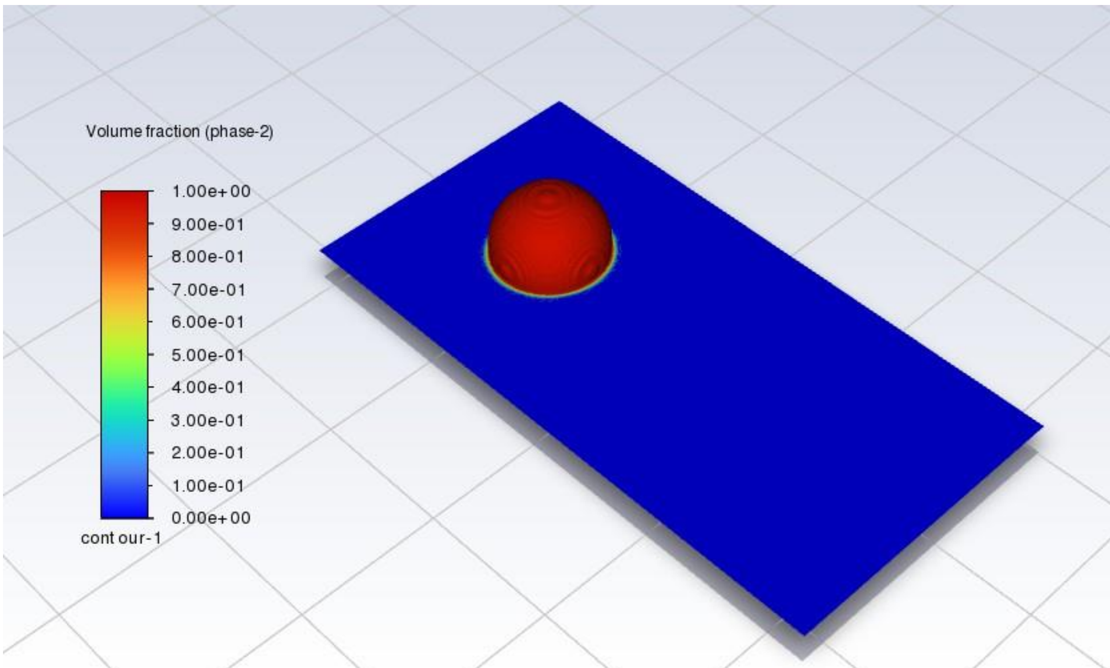
a. **Mesh resolution:** 30 cm
b. **Time step size:** 0.01 sec
c. **Maximum number of iterations per time step:** 20

Task 2

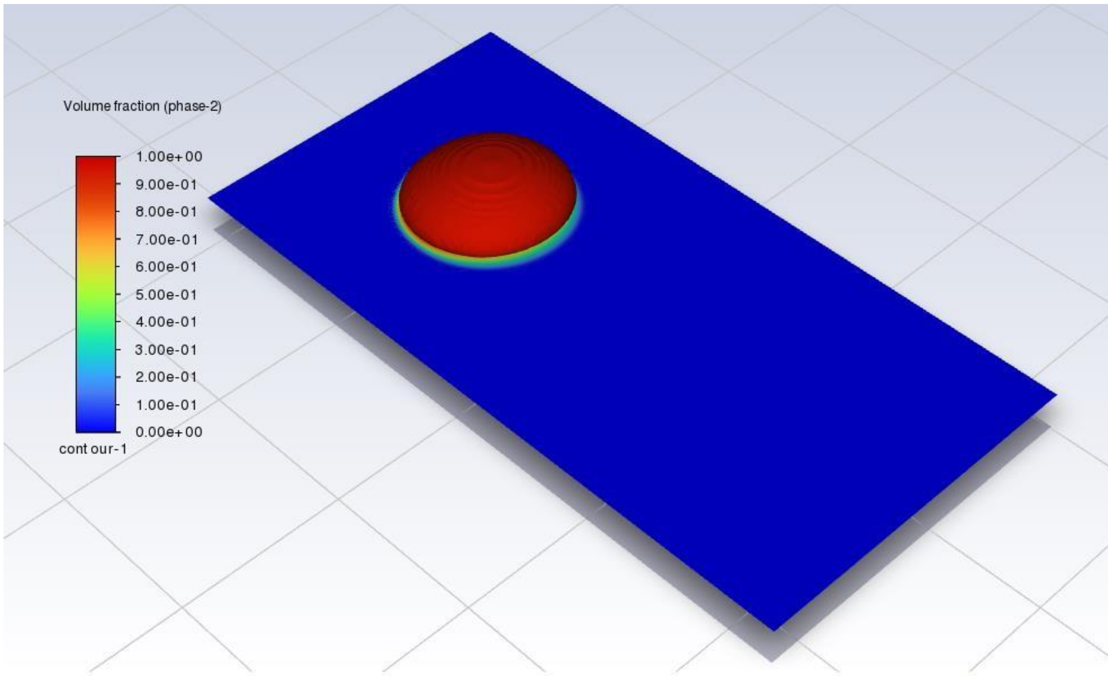
Case A- Use engine oil as the liquid

Deliverables 7

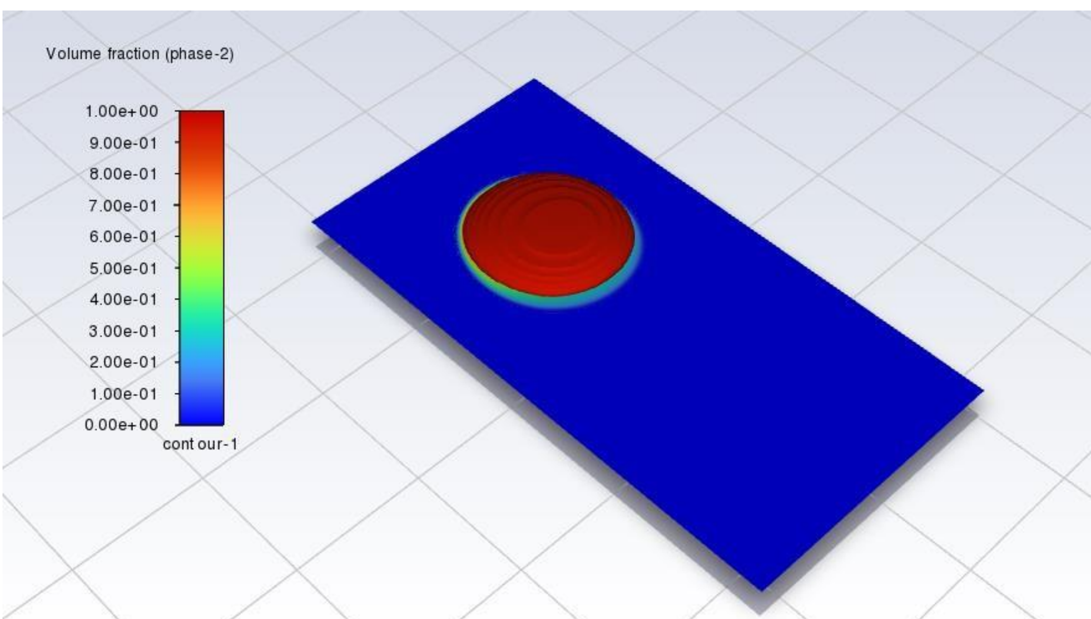
- **Isometric view of the iso-surface and the bottom plate of the blob of engine oil at t = 0, 0.05 s, and 0.1s.**



Blob of engine oil at t=0s



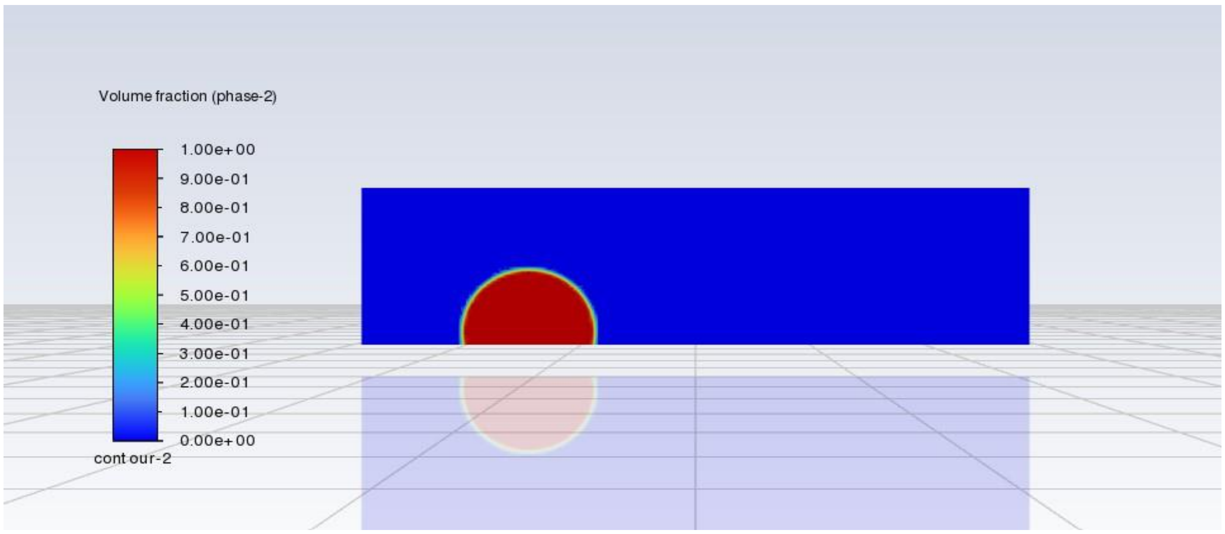
Blob of engine oil at t=0.05s



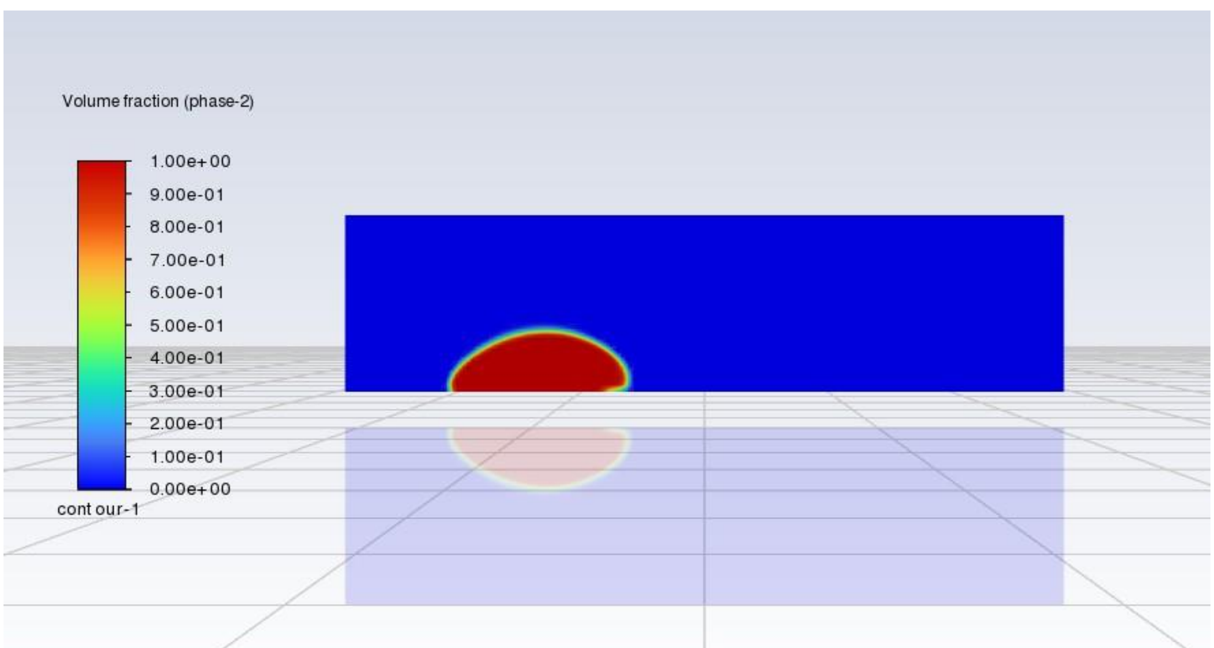
Blob of engine oil at t=0.1s

Deliverables 8

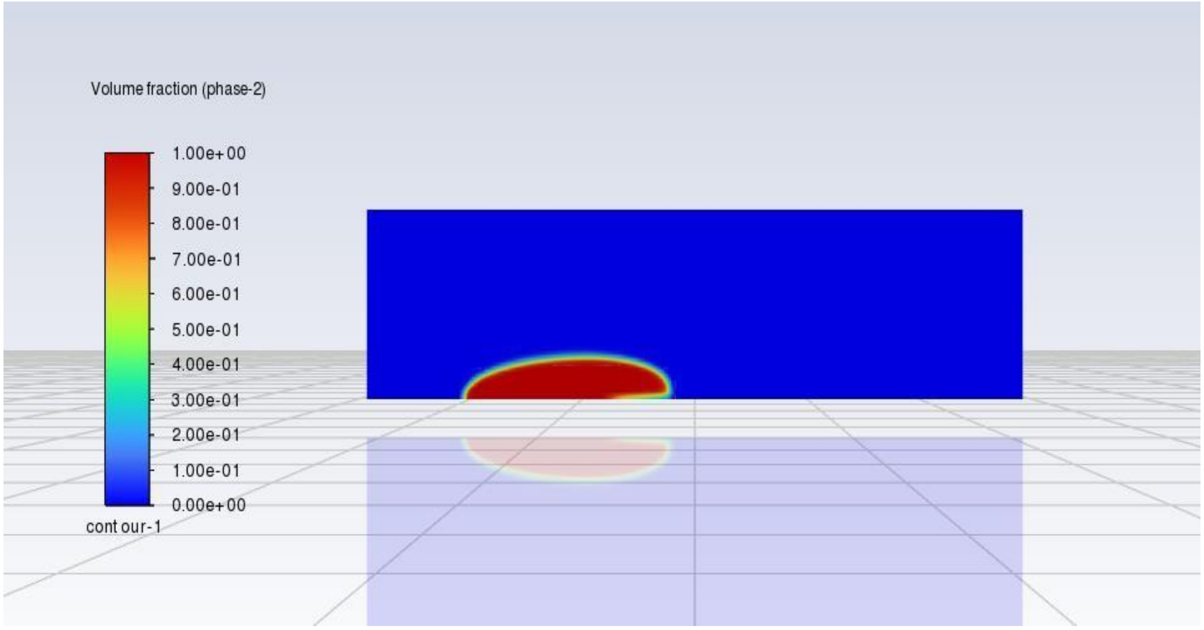
- **Three contour plots of the volume fraction of engine oil on the plane of symmetry, at t = 0, 0.05 s, and 0.1 s.**



Contour of VOF of engine oil at t= 0s



Contour of VOF of engine oil at t= 0.05s

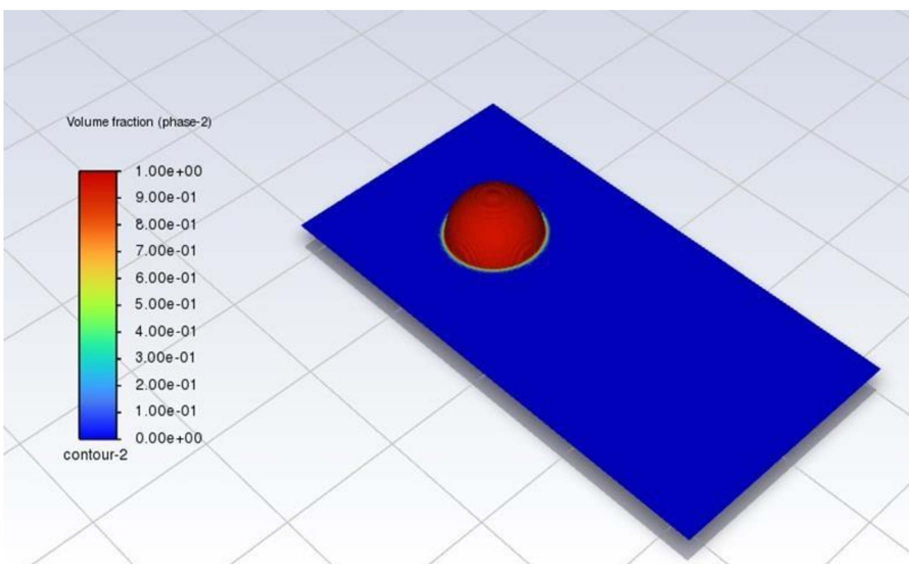


Contour of VOF of engine oil at t= 0.1s

(Case B) - Use mercury as the liquid.

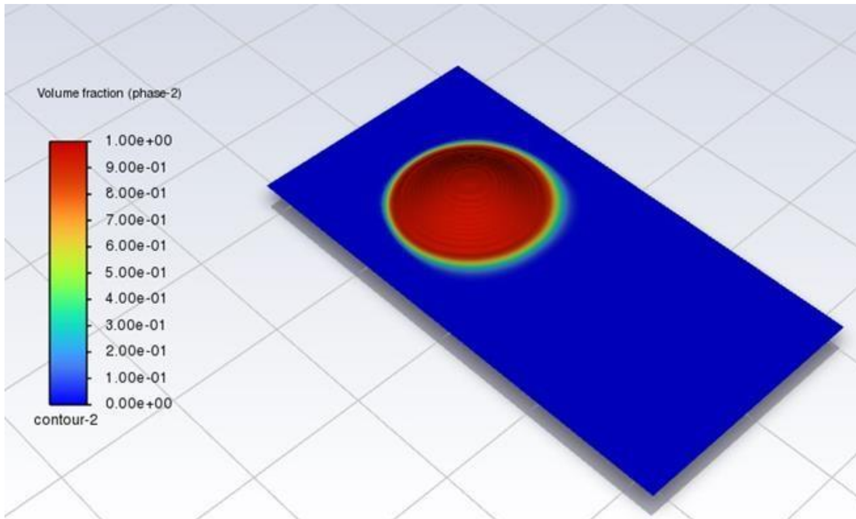
Deliverables 9 :-

- **Three plots of 3-D shape of the blob of mercury at t = 0, 0.05 s, and 0.1 s.**

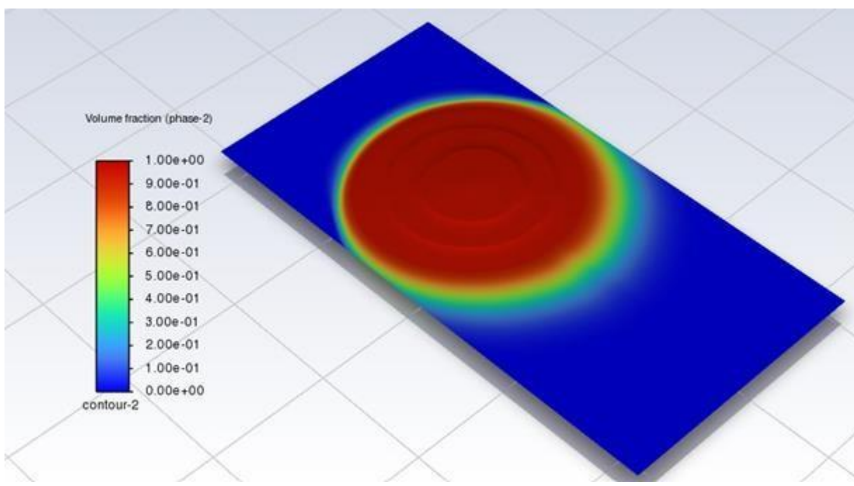


Blob of Mercury at t=0s

Blob of Mercury at t=0.05s

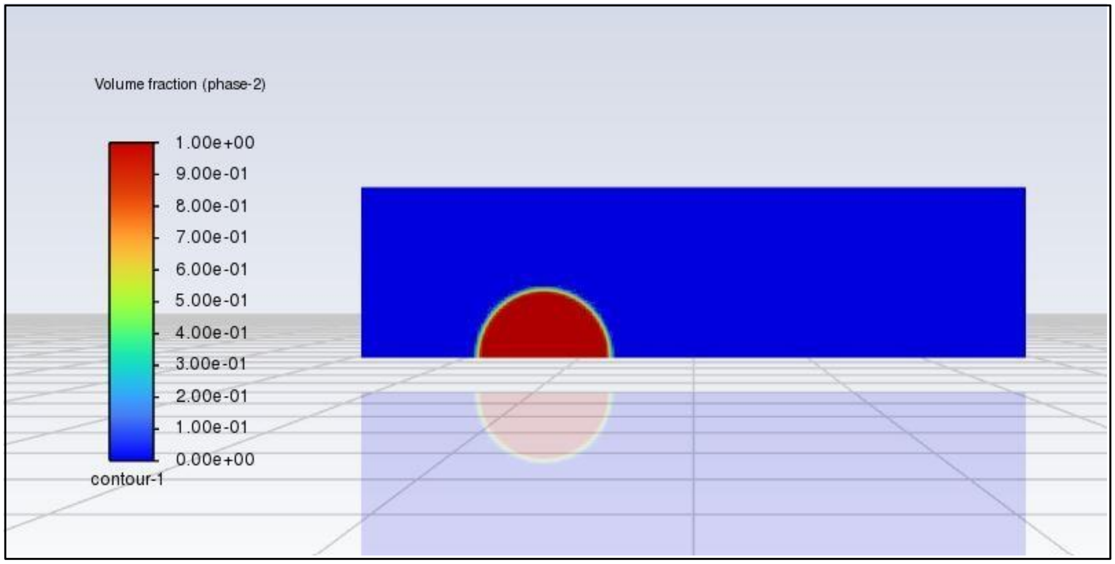


Blob of Mercury at t=0.1s

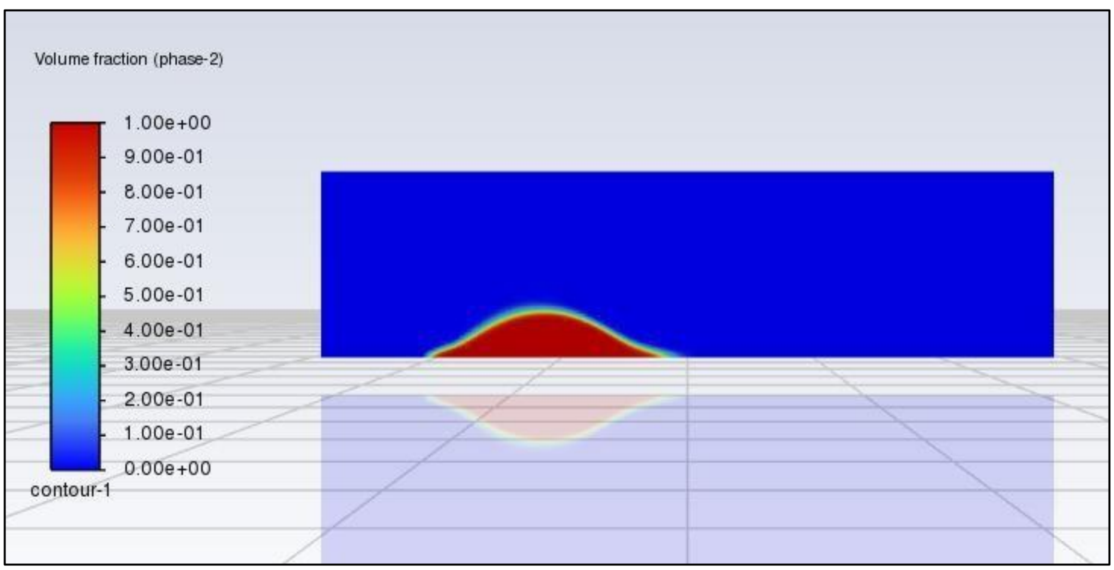


Deliverables 10

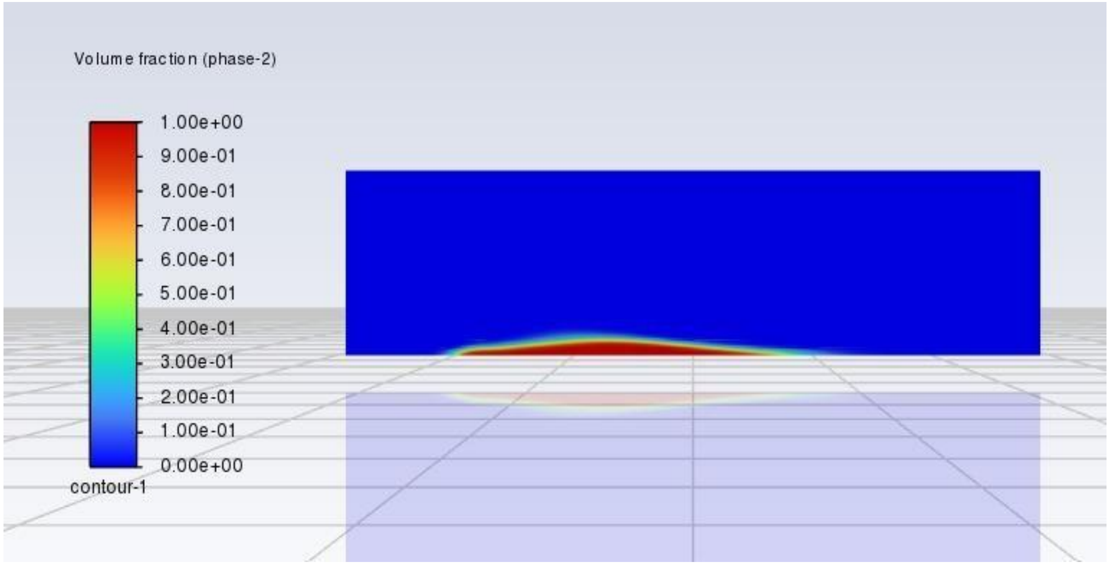
- **Three contour plots of the VOF of mercury on the plane of symmetry, at t = 0, 0.05 s, and 0.1 s.**



Contour of VOF of Mercury at t= 0s



Contour of VOF of Mercury at t= 0.05s



Contour of VOF of Mercury at t= 0.1s

Deliverables 11

- **A description of the computational domain, boundary conditions, mesh resolution, and time step size used in the two simulations. If different settings are used for (a) and (b), please clearly state the differences.**

Same for both Case A and Case B

1. **Boundary conditions:** set to pressure outlet with zero pressure gauge to the air, to consider it as an open environment and the bottom plate set as wall.
2. **Mesh Resolution:** 0.30cm
3. **Time step size (s):** 0.003
4. **Number of time steps:** 25
5. **Iterations:** 20

Task 3 :-

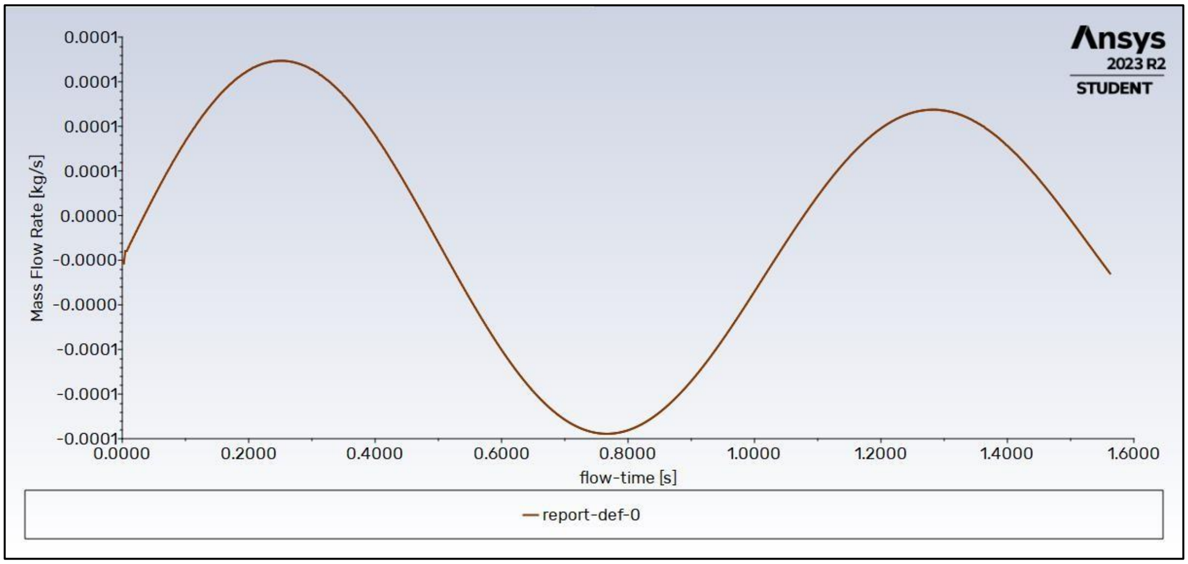
(Case A)- Give the setting described above, run the transient simulation to at least one full period of oscillation.

Deliverables 12

- **Boundary conditions:**
  1. Both the air openings are set as pressure outlets with zero-gauge pressure and back flow of the water set to zero.
  2. It was a transient simulation with pressure base solver.
- **Mesh resolution**: 0.2 cm
- **Time step size:** 0.002 s
- **Number of steps:** 625
- **Max iterations:** 20

Deliverables 13 :-

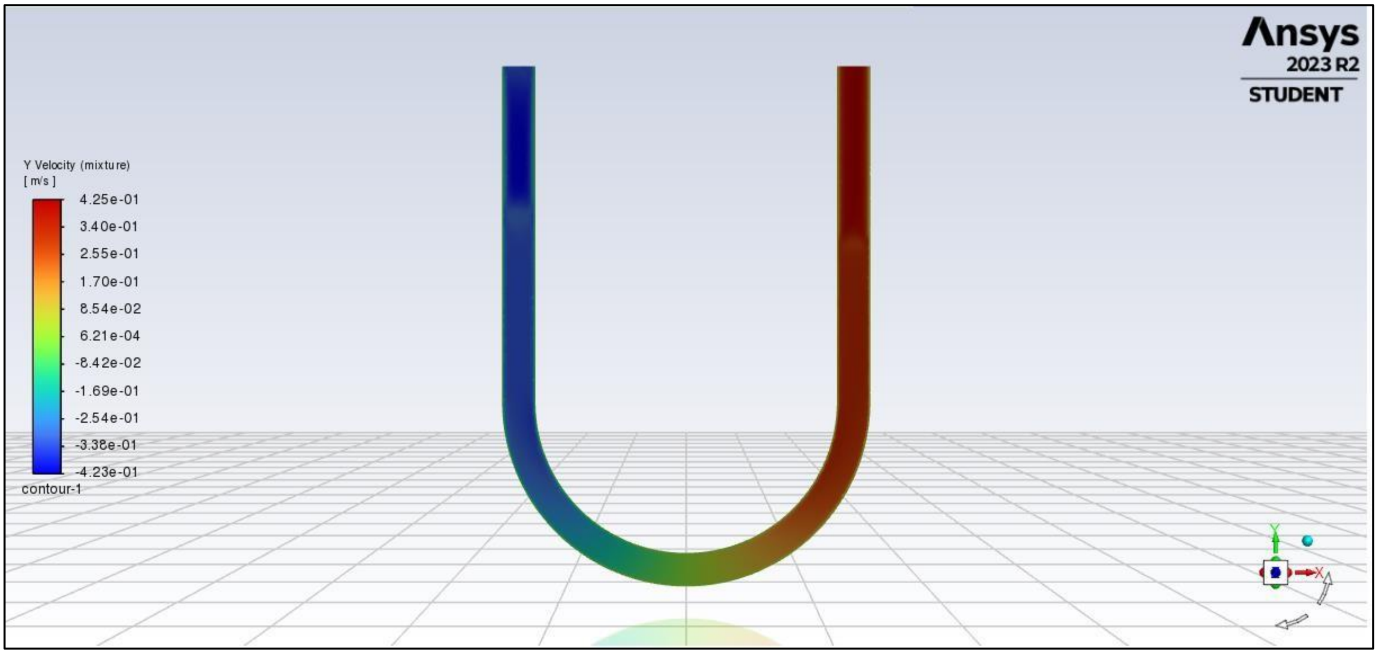
***τ*= 1.0280 = rounded to first digit 1 seconds**



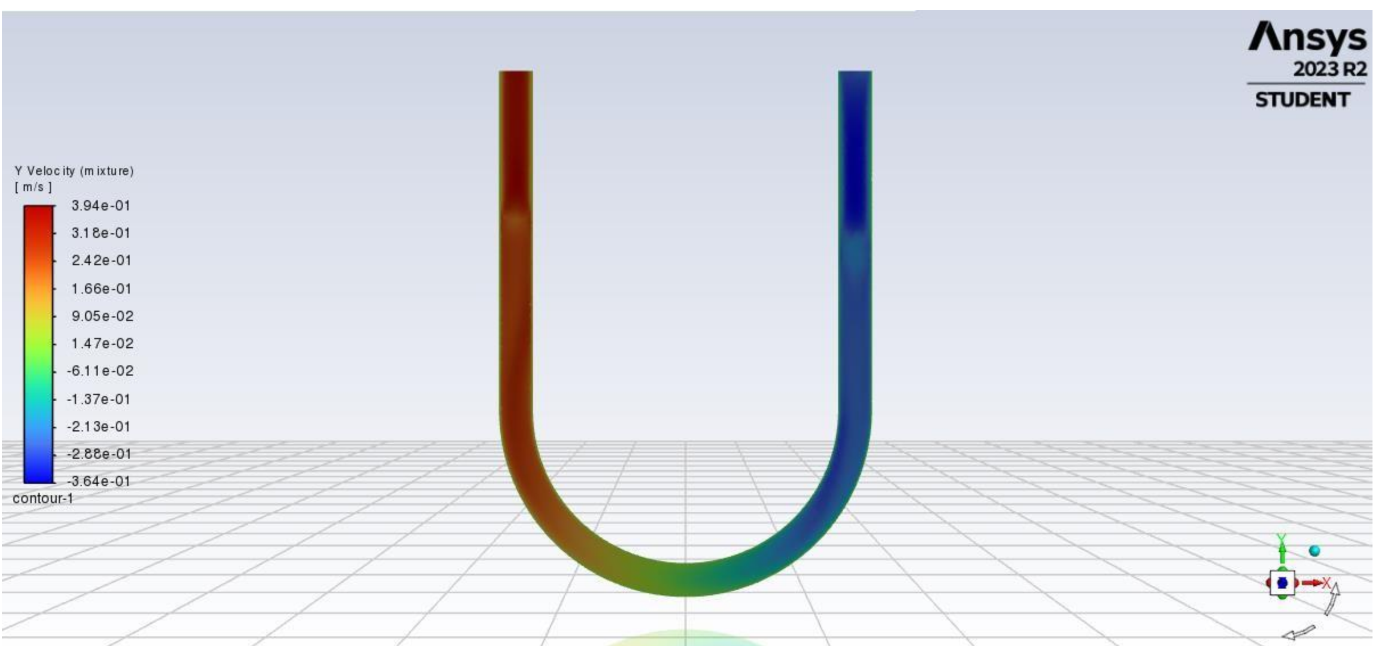
Plot of Mass flow rate of air Vs flow time for the full time

Deliverables 14

Contour plots of the y-velocity of the mixture on the plane of symmetry, at t = 0.25 τ and t = 0.75 τ.



Contour plot of the Y- Velocity of the mixture on plane of the symmetry at t=0.25

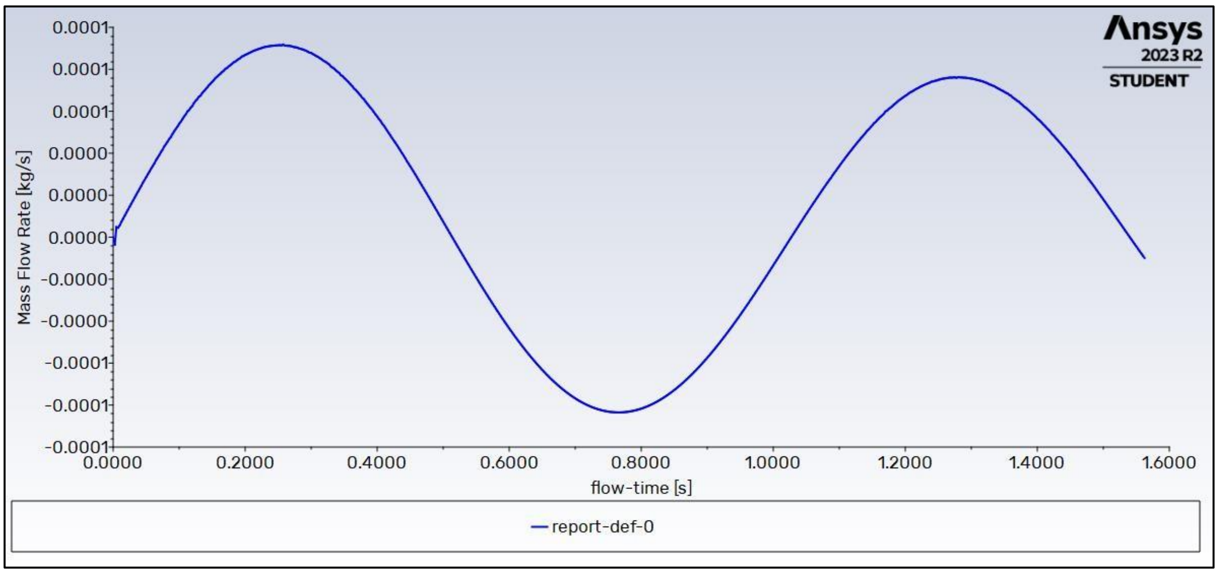


Contour plot of the Y- Velocity of the mixture on plane of the symmetry at t=0.75

Case B- Repeat the simulation in Part (a) but artificially double the density of water. (Viscosity remains unchanged.) This can be done by manually editing the material property of water in Fluent, changing density from 998.2 to 1996.4 kg/m3.

Deliverables 15

τ= 1.0280 = rounded to first digit 1 seconds



Plot of Mass flow rate of air Vs flow time for the full time

(a)The basic oscillation pattern remains the same, but there are noticeable differences in period, amplitude, and damping between the two scenarios due to changes in water density and inertia. In scenario

(b) The peaks are expected to have lower amplitudes due to the higher water density, causing quicker damping of the oscillation.

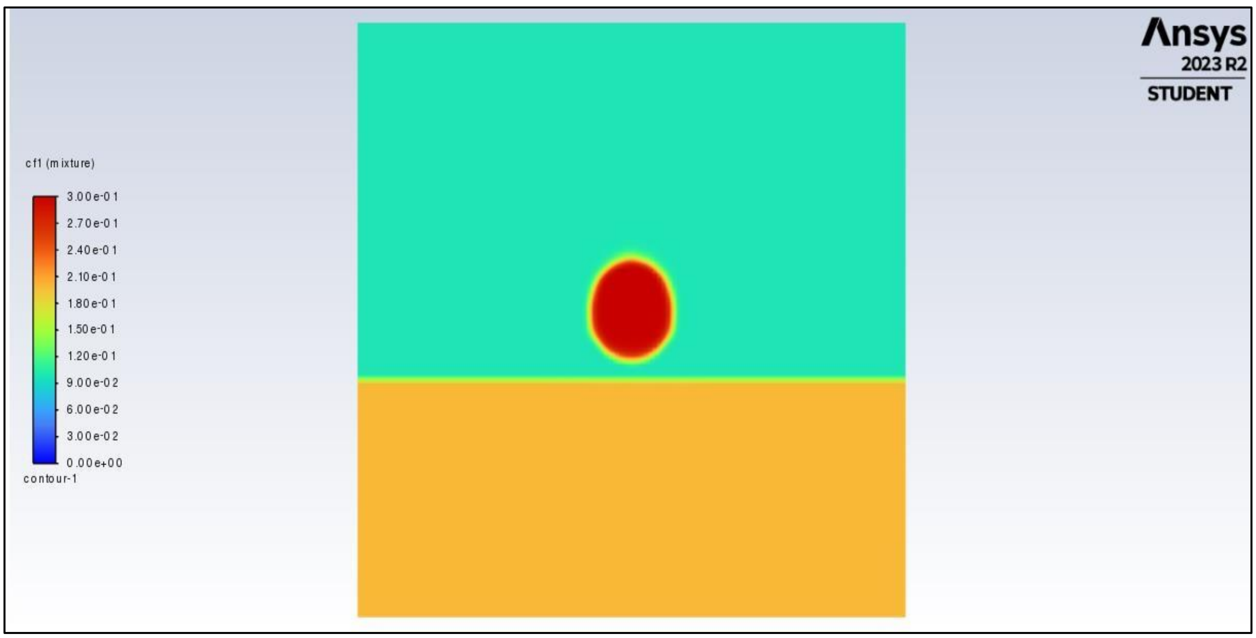
Task 4: -

Deliverables 16

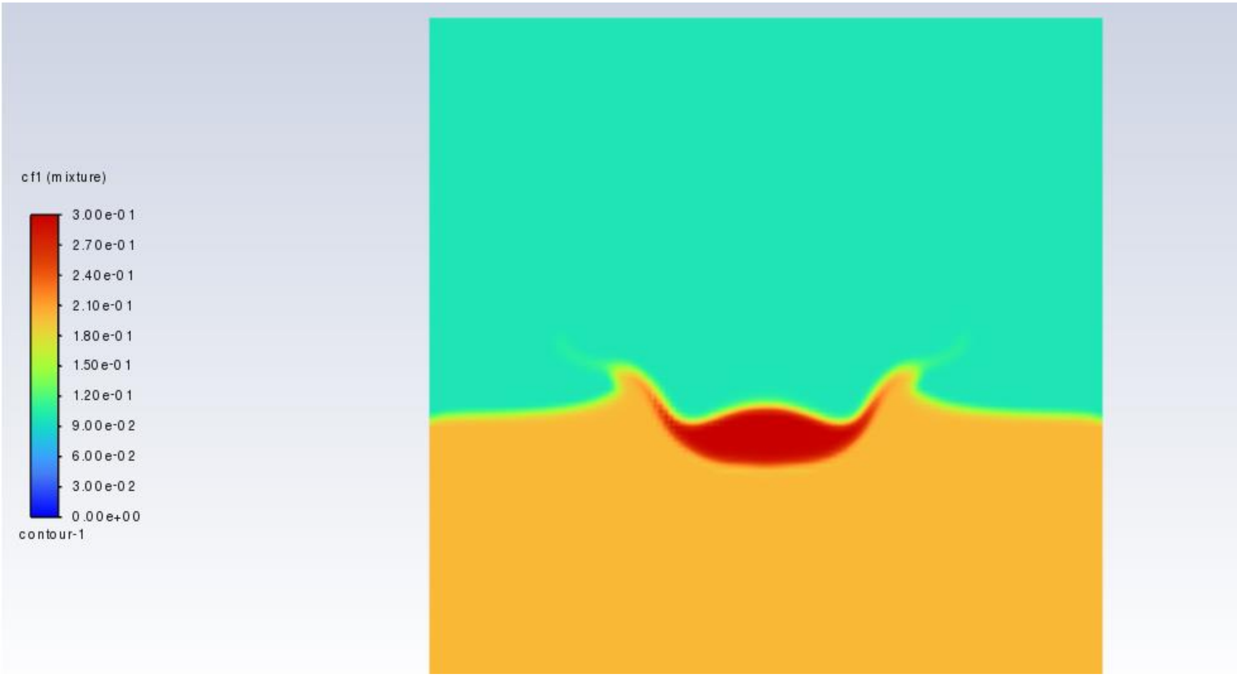
- **A description of the mesh resolution and time step size used in the simulation.**

- **Mesh resolution**: 0.2 cm
- **Time step size:** 0.0005s
- **Number of steps:** 400
- **Max iterations:** 10

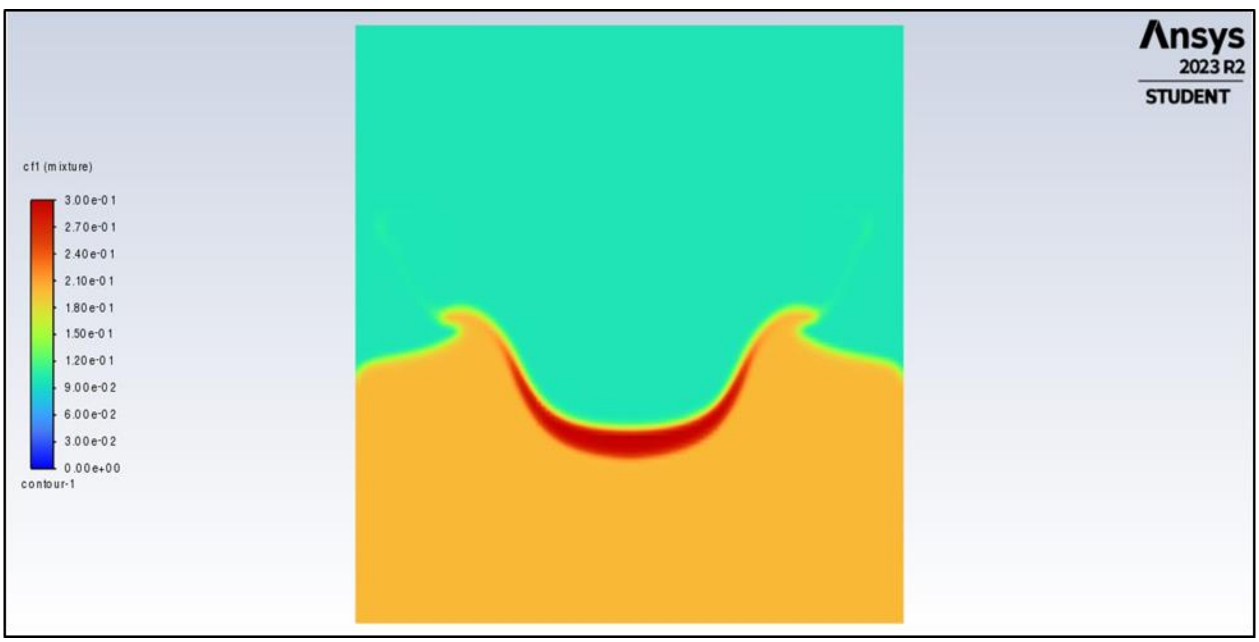
Deliverables 17



Contour plot of CF at t=0.12



Contour plot of CF at t=0.16



Contour plot of CF at t=0.2