MAE 560: Applied Computational Fluid Dynamics

Project 2

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(NO COLLABORATION)

Task 1

(D1) Contour plots of the volume fraction of methane at t = 1 s and t = 2.5 s.

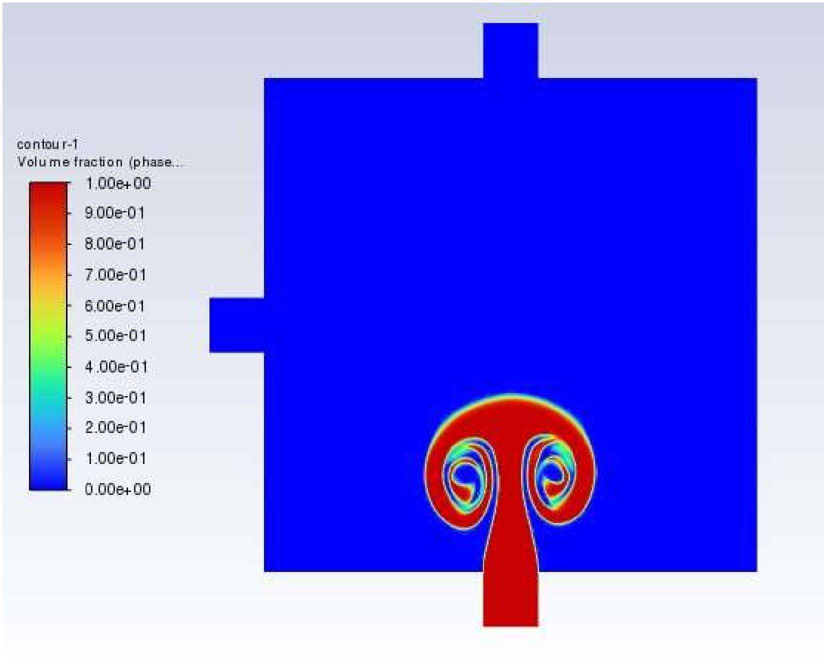


Figure 1: Contour plot for the Volume fraction of Methane for 1 sec. (varad lad)

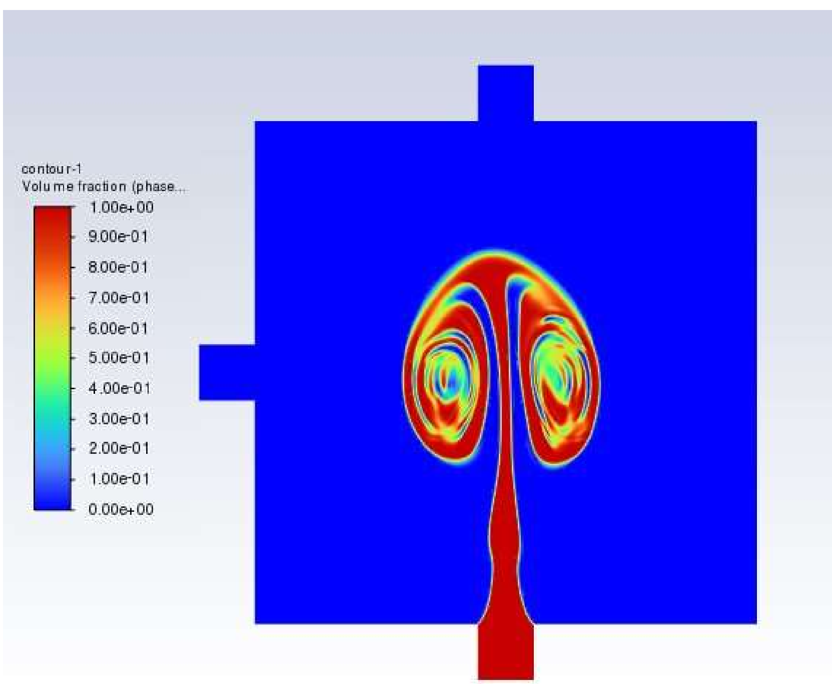
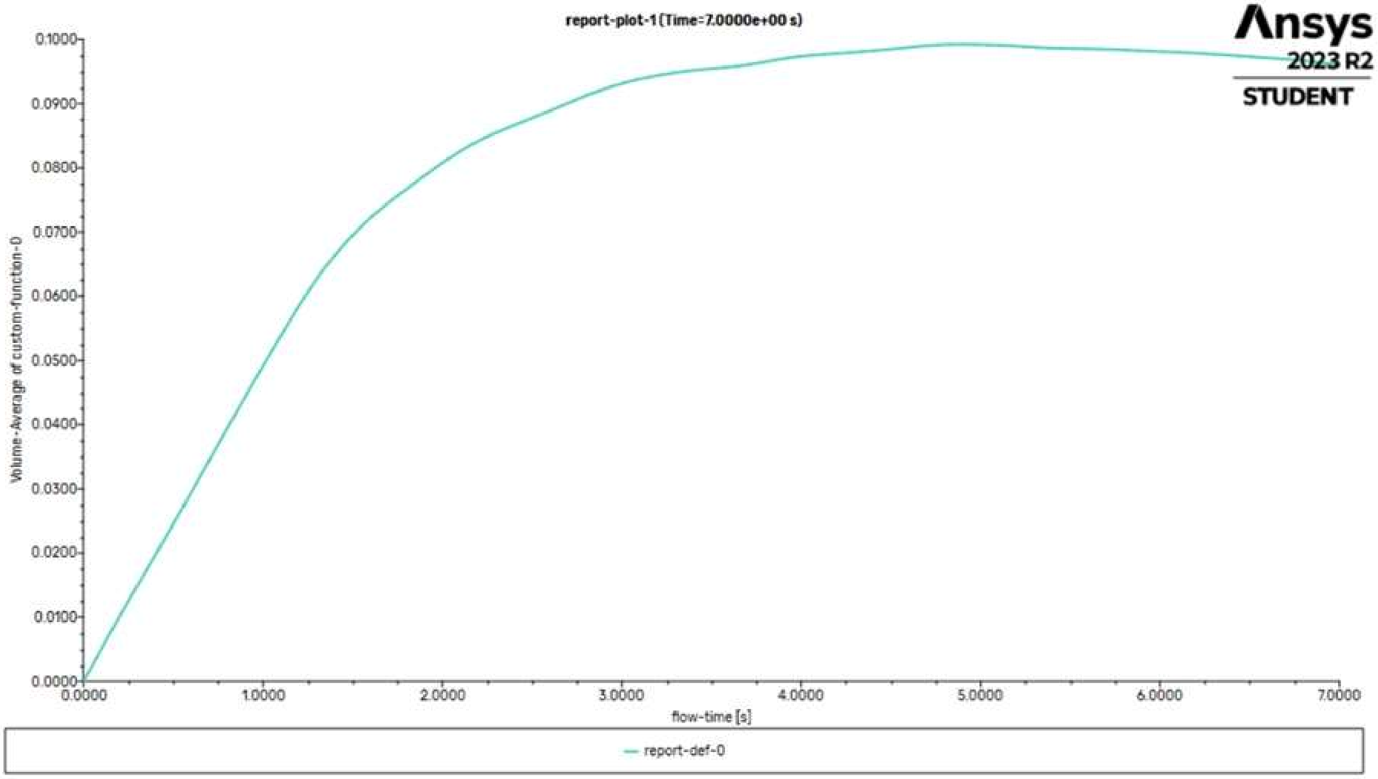
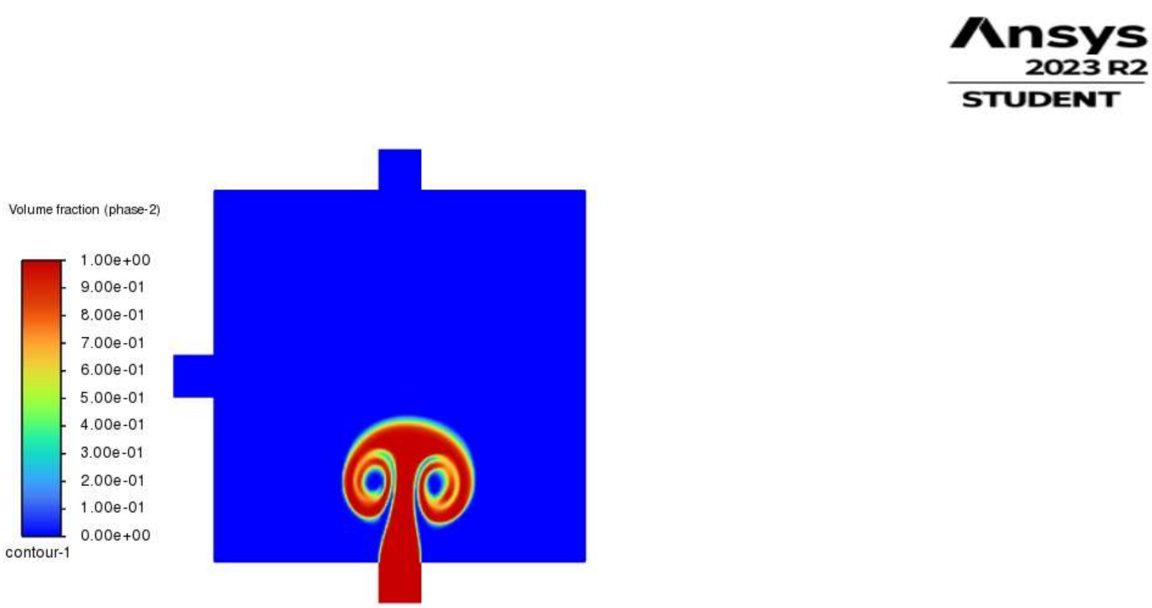


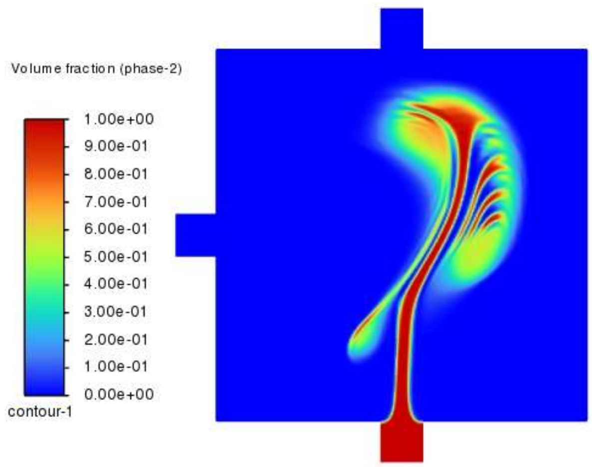
Figure 2: Contour plot for the Volume fraction of Methane for 2.5 sec. (varad lad)

(D2) A plot of the D-index as a function of time, for $0 \leq t \leq 7$ s



(D3) Contour plots of the volume fraction of methane at t = 1 s and t = 2.5 s.





(D4) A plot of the D-index as a function of time, for 0 ≤ t ≤ 7 s. Compared to the result in (D2), does the injection of fresh air help reducing the D-index?

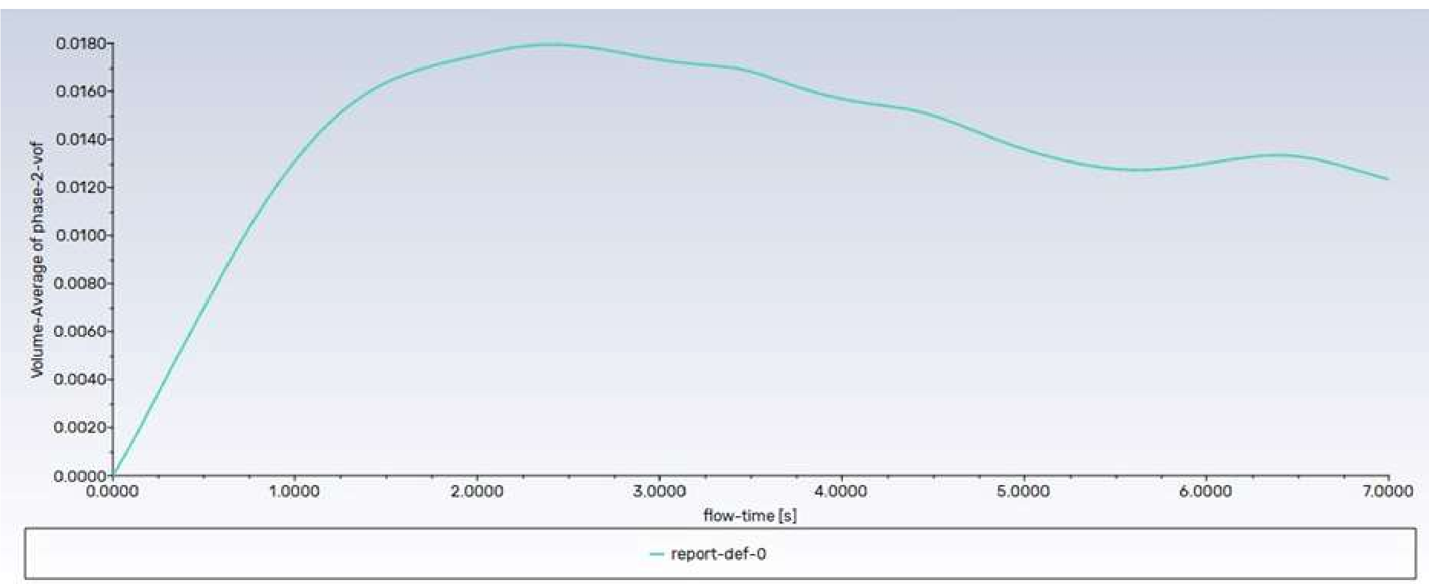
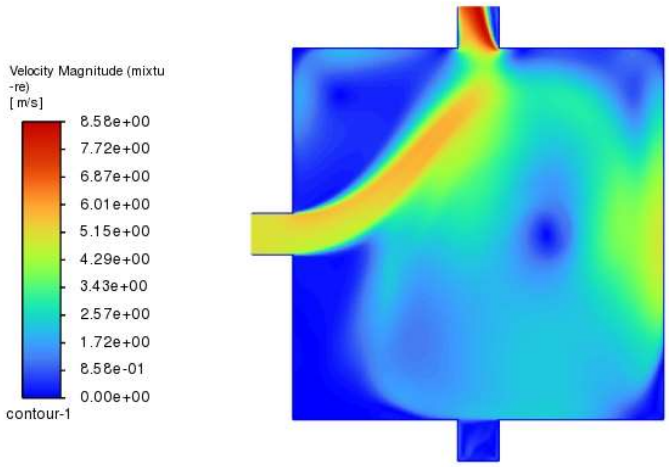


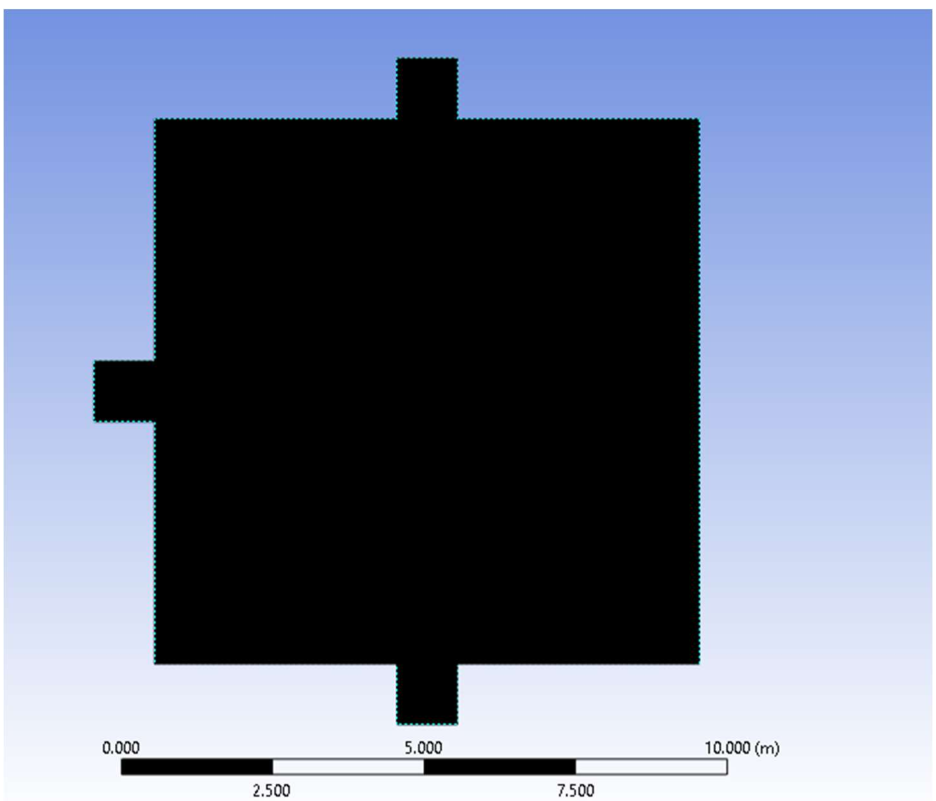
Figure 3: : A plot of the D-index as a function of time, for 0 ≤ t ≥ 7s (varad lad)

Looking at the two graphs, it seems that injecting fresh air does help lower the D-index as time passes (after 3 seconds). The graph in Deliverable 4 displays a consistently decreasing D-index, while the graph in Deliverable 2 does not show this downward trend in the D-index.

(D5) A contour plot of the velocity magnitude of the mixture at t = 7 s



(D6) Mesh resolution and time step size used in the two simulations. If different settings are used for Case A and B, please clearly state the differences.



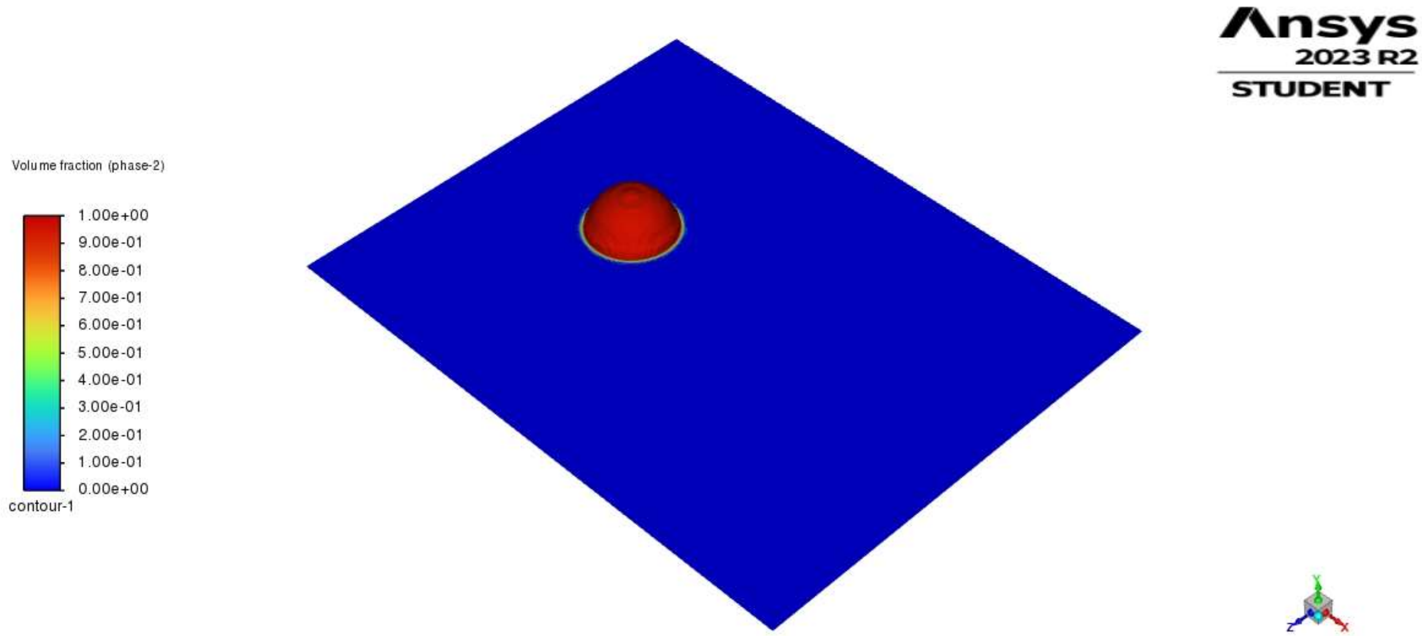
Case A and B setting are similar with their time steps and step sizes:

Number of Time Steps	Time steps Size	Max Iterations
25	0.04	12
25	0.1	12
25	0.28	12

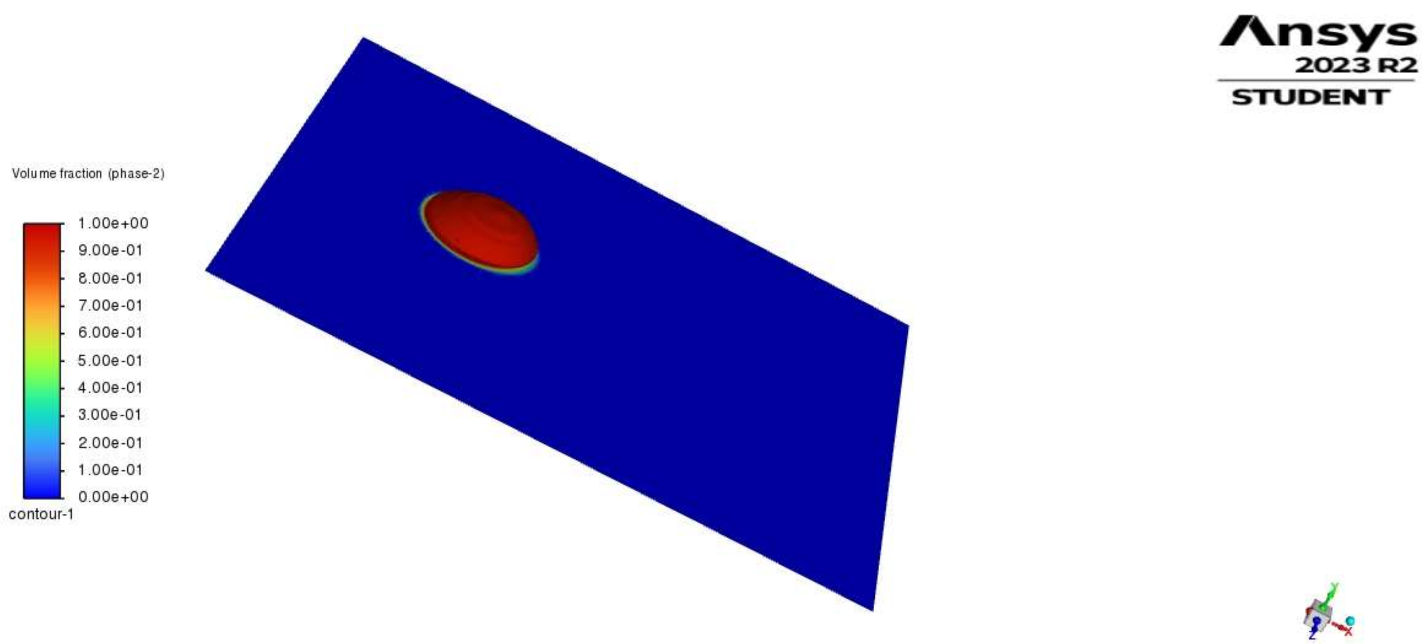
Task 2

(a) Use *engine oil* as the liquid

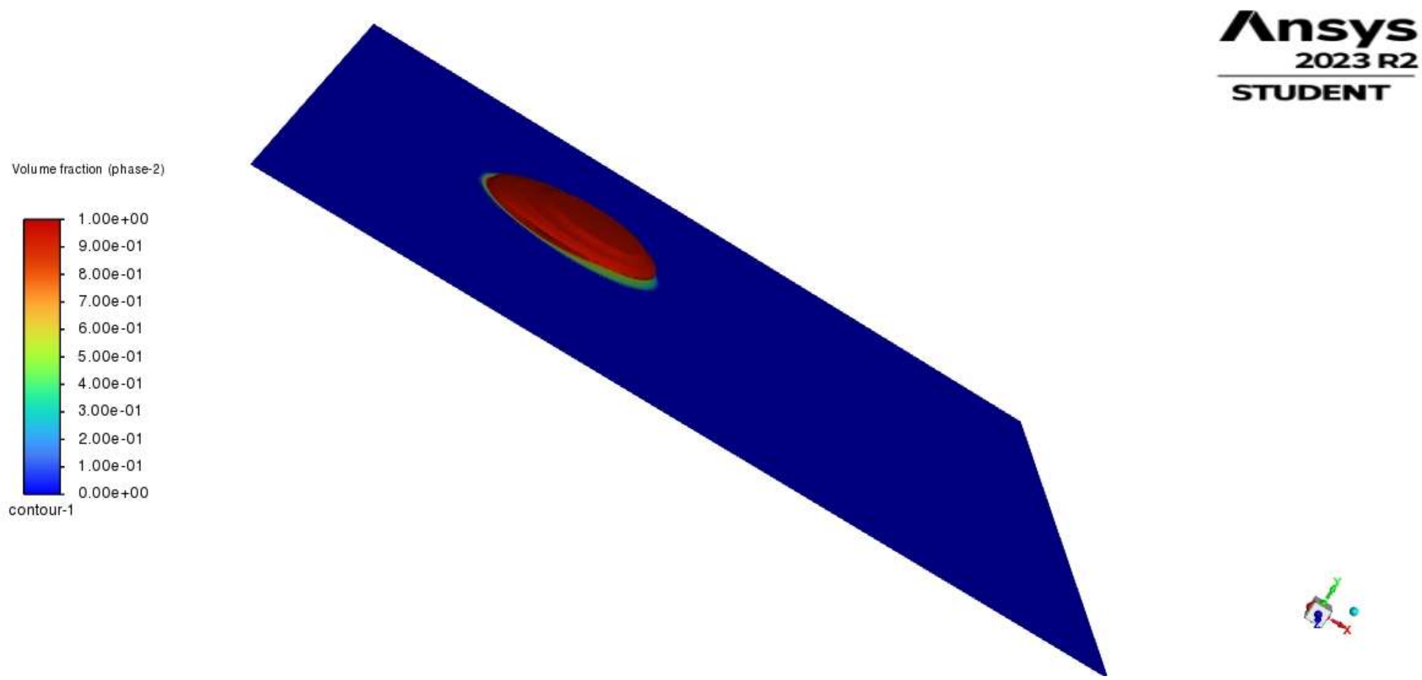
(D7)



ISO Surface of the engine oil drop at t=0 (varad lad)



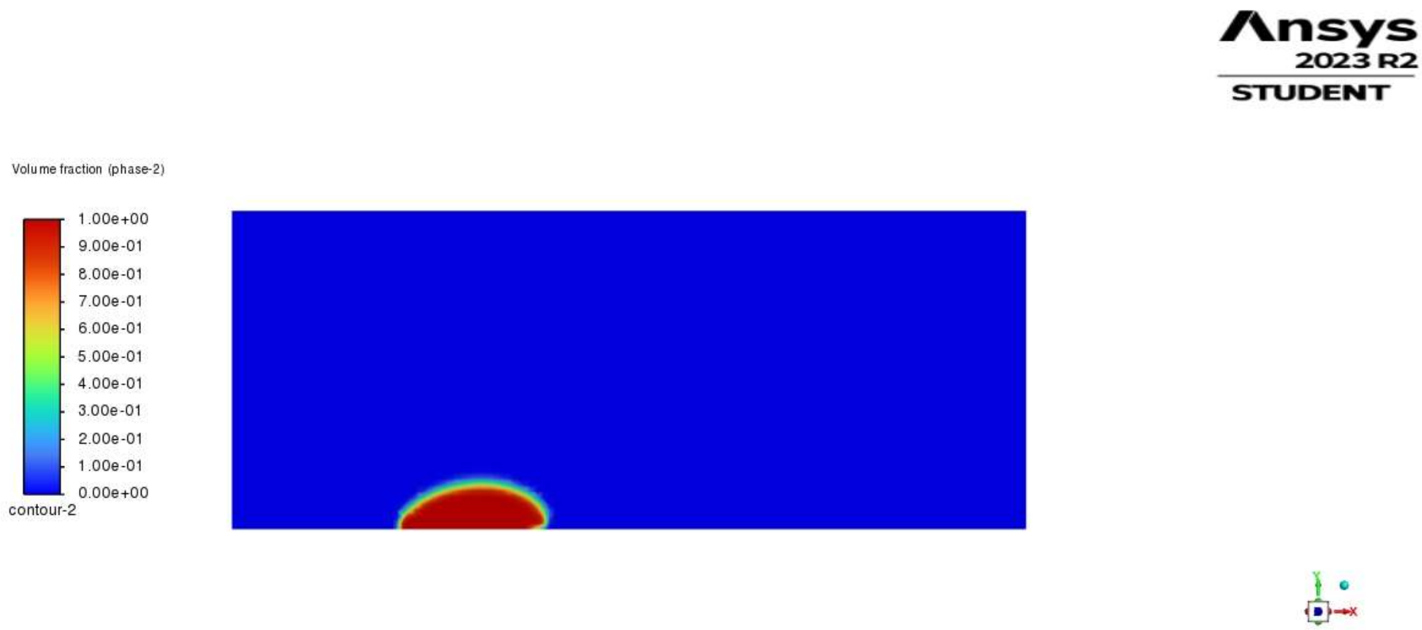
ISO Surface of the engine oil drop at t=0.05 (varad lad)



ISO Surface of the engine oil drop at t=0.1(varad lad)

(D8)

Contour plot of the volume Fraction of engine oil for plane of symmetry at t=0 (varad lad)

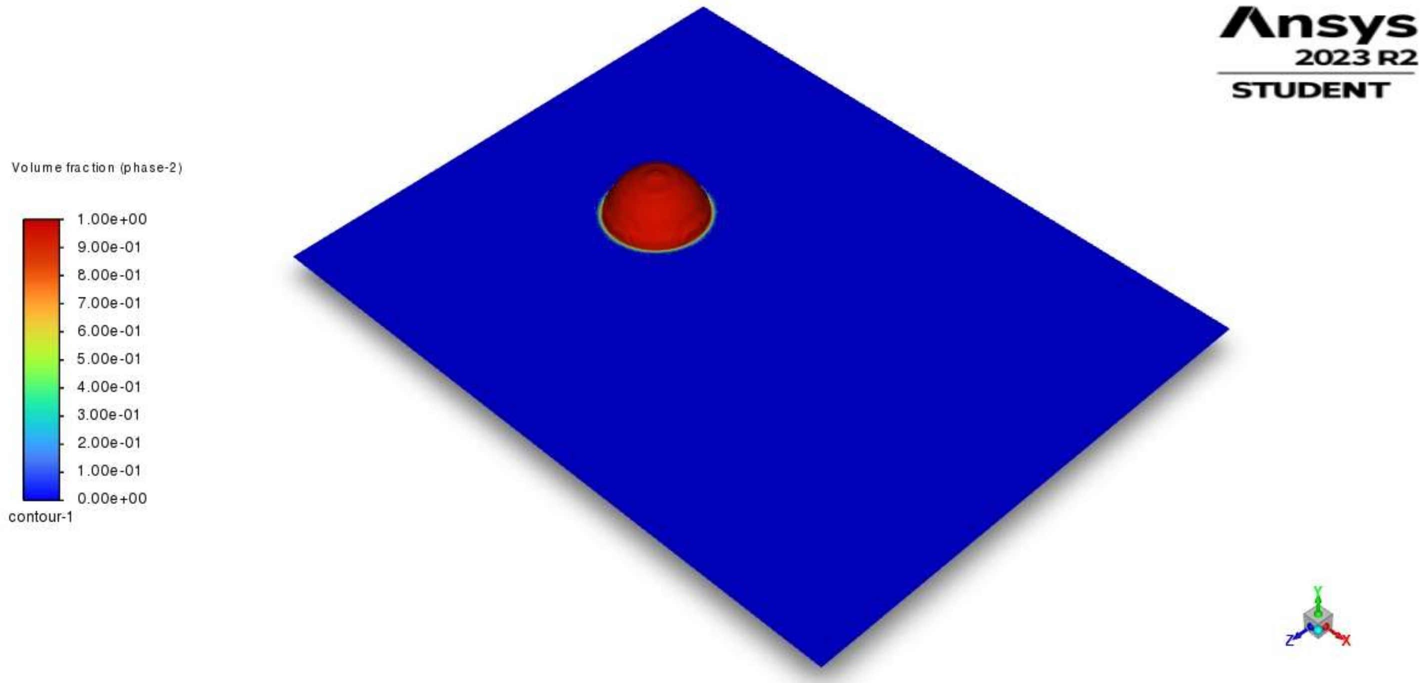


Contour plot of the volume Fraction of engine oil for plane of symmetry at t=0.05 (varad lad)

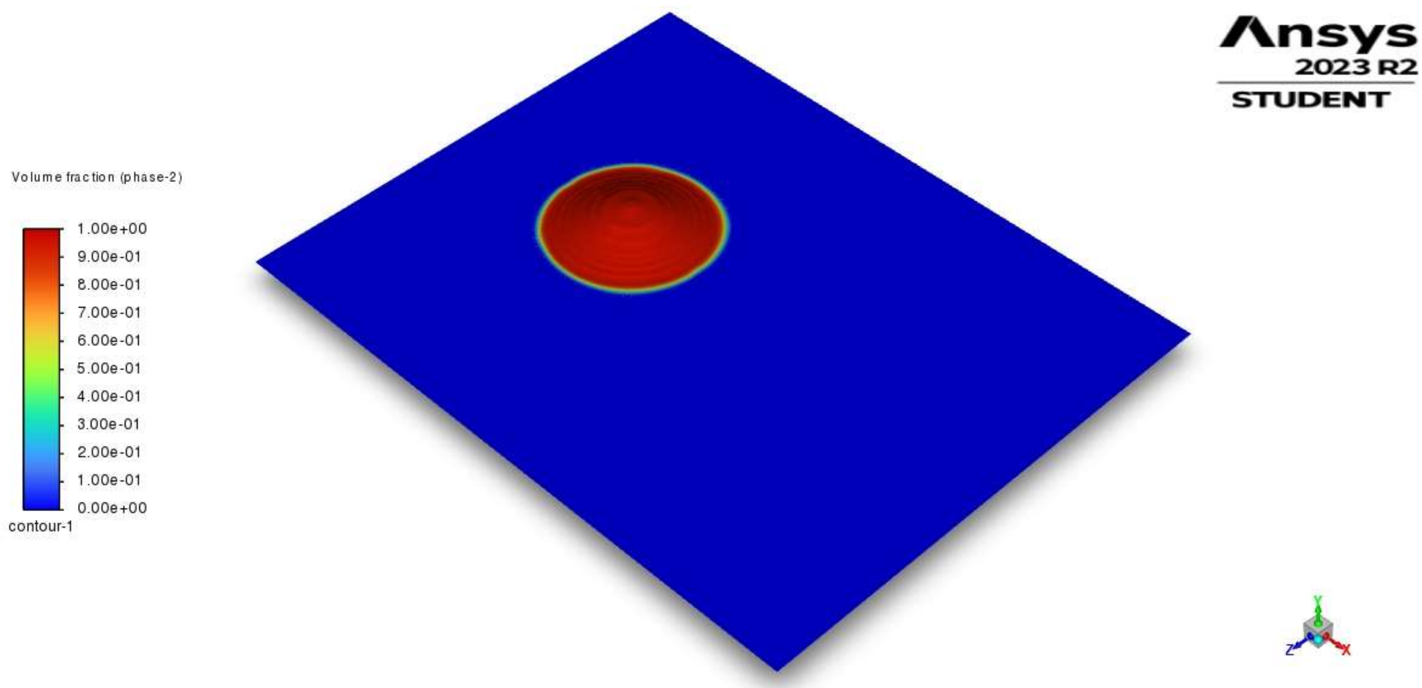
Contour plot of the volume Fraction of engine oil for plane of symmetry at t=0.1s (varad lad)

(b) Use mercury as the liquid

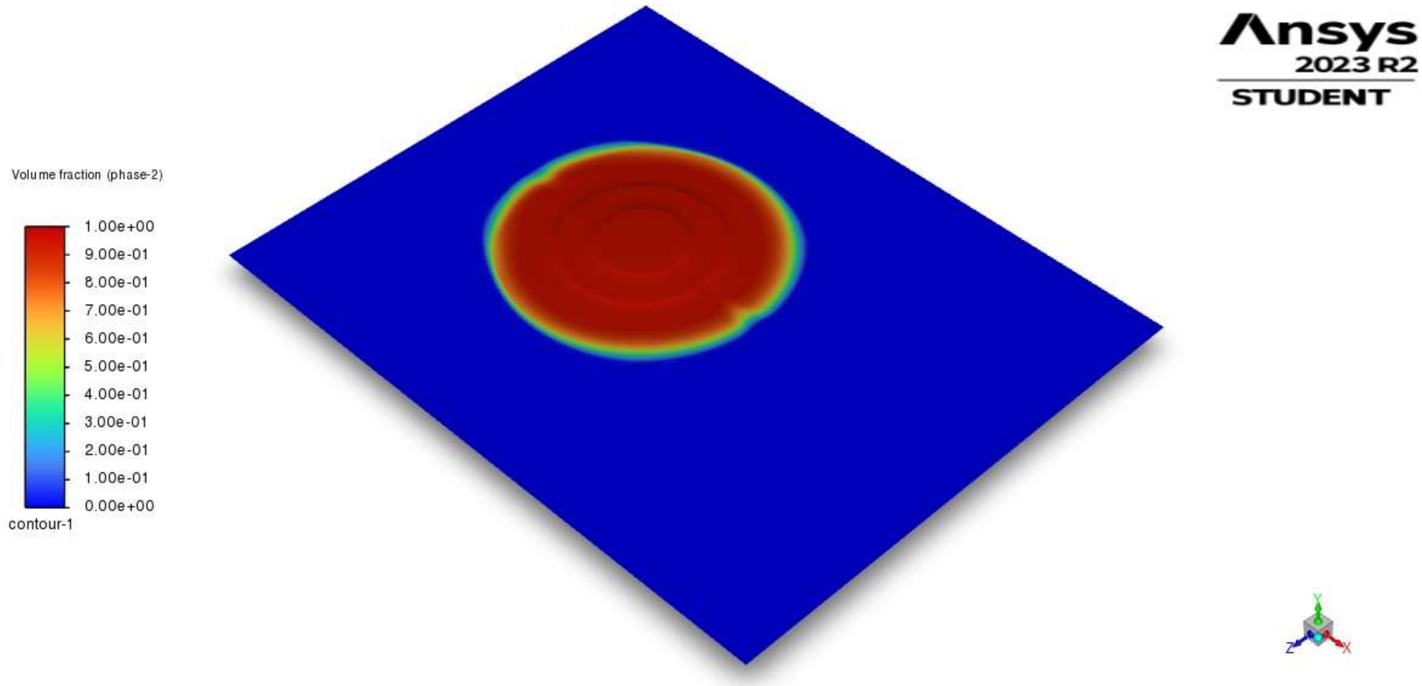
(D9)



ISO Surface of the blob mercury for the t=0 (varad lad)



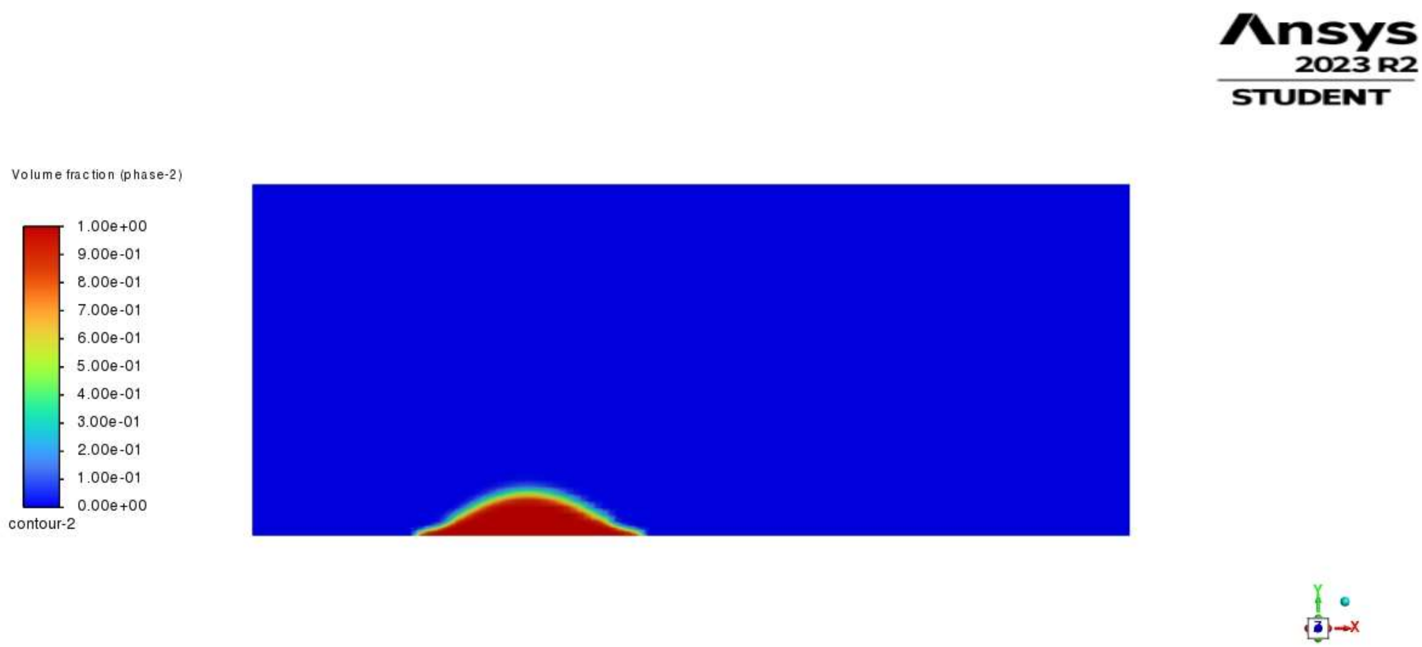
ISO Surface of the blob mercury for the t=0.05 (varad lad)



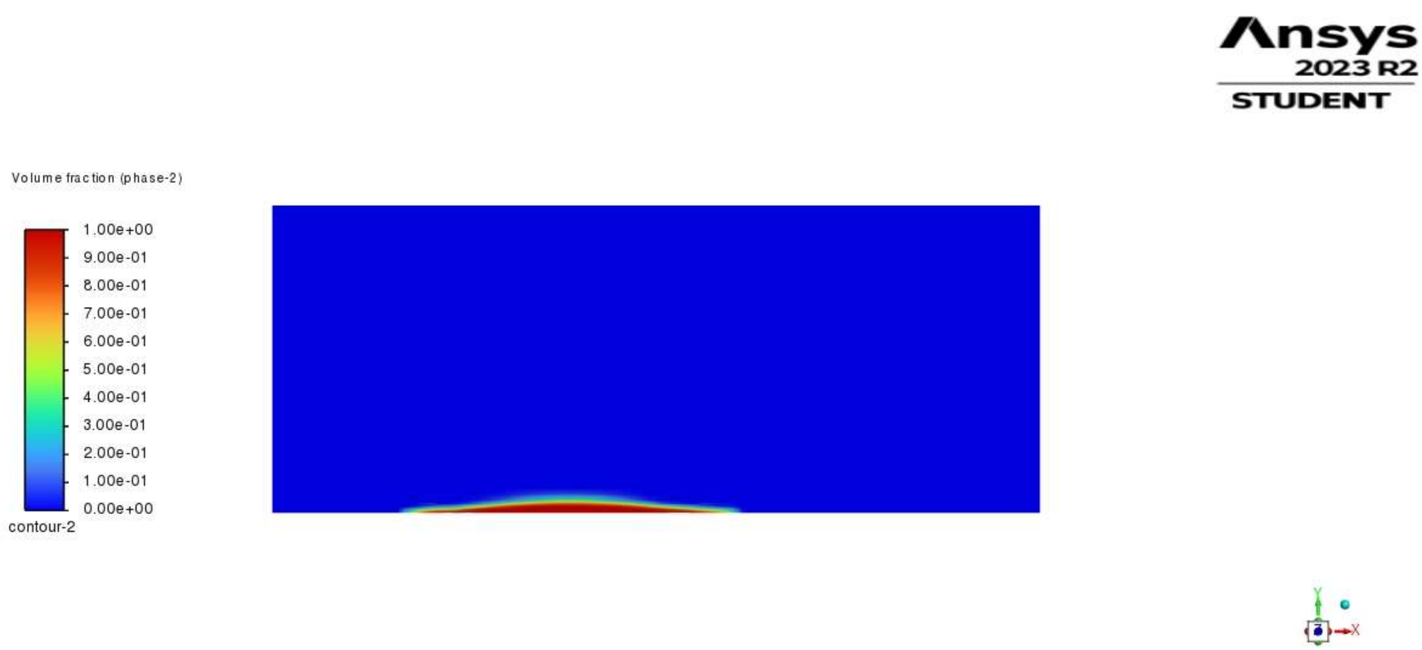
ISO Surface of the blob mercury for the t=0.1 (varad lad)

(D10)

Contour plot of the volume Fraction of mercury for plane of symmetry at t=0 (varad lad)



Contour plot of the volume Fraction of mercury for plane of symmetry at t=0.05 (varad lad)



Contour plot of the volume Fraction of mercury for plane of symmetry at t=0.1 (varad lad)

(D11)

The simulation occurs in a 12 cm x 12 cm x 4 cm rectangular space. The borders are set as pressure outlets with no gauge pressure (0-gauge pressure), modeling an open surrounding. The bottom surface is set as a wall boundary condition.

Mesh Resolution: 0.2 cm

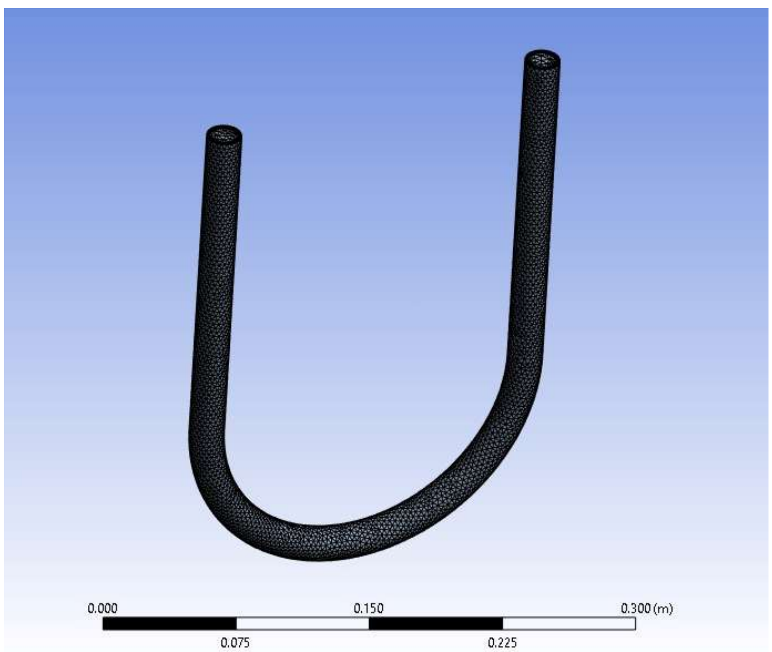
Number of Time Steps	Time Step Size	Max Iterations
50	0.001	12
50	0.001	12
50	0.001	12

Task 3

a)

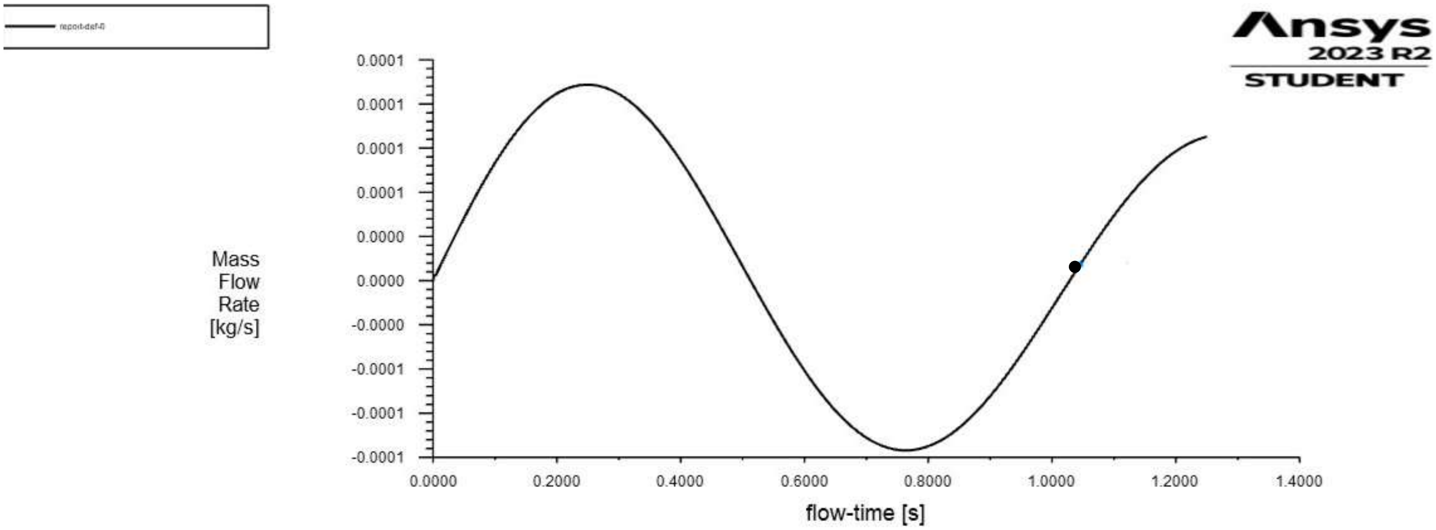
(D12) The border settings at both air openings are configured as pressure outlets with zero gauge pressure, preventing water backflow. A transient simulation was executed utilizing a pressure-based solver.

Mesh Resolution: 0.2cm

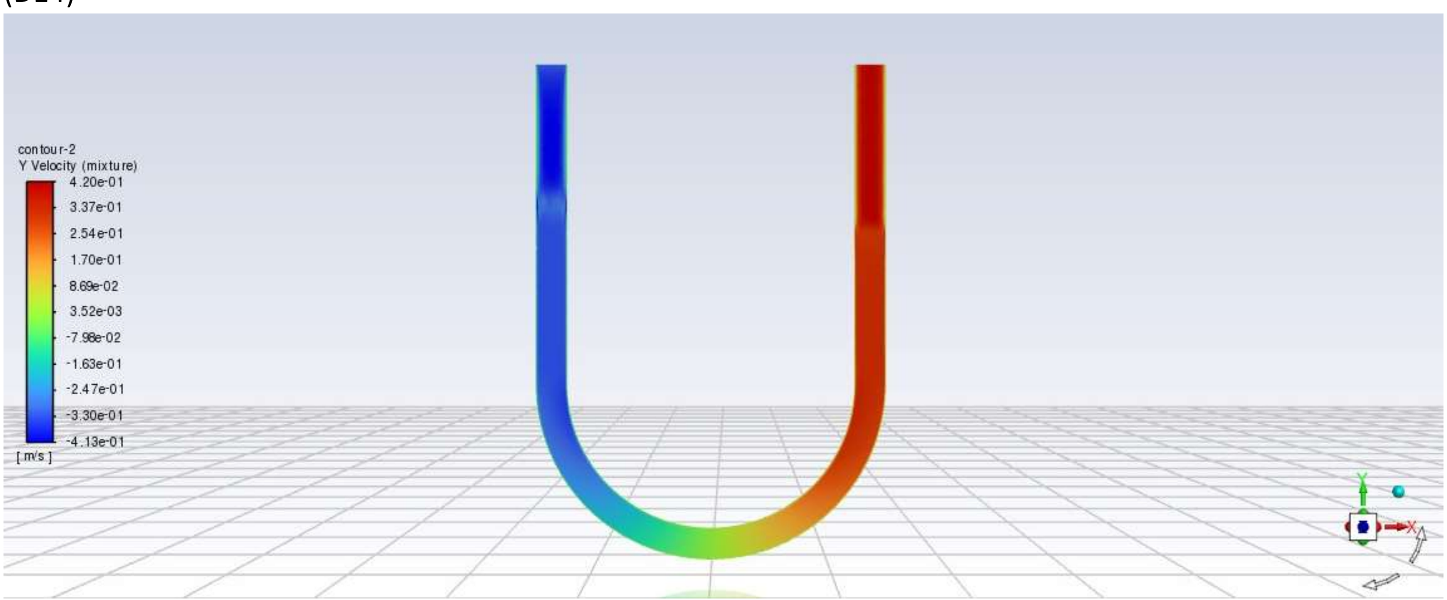


Number of Time Steps	Time Step Size	Max Iterations
625	0.002	10
625	0.002	10
625	0.002	10

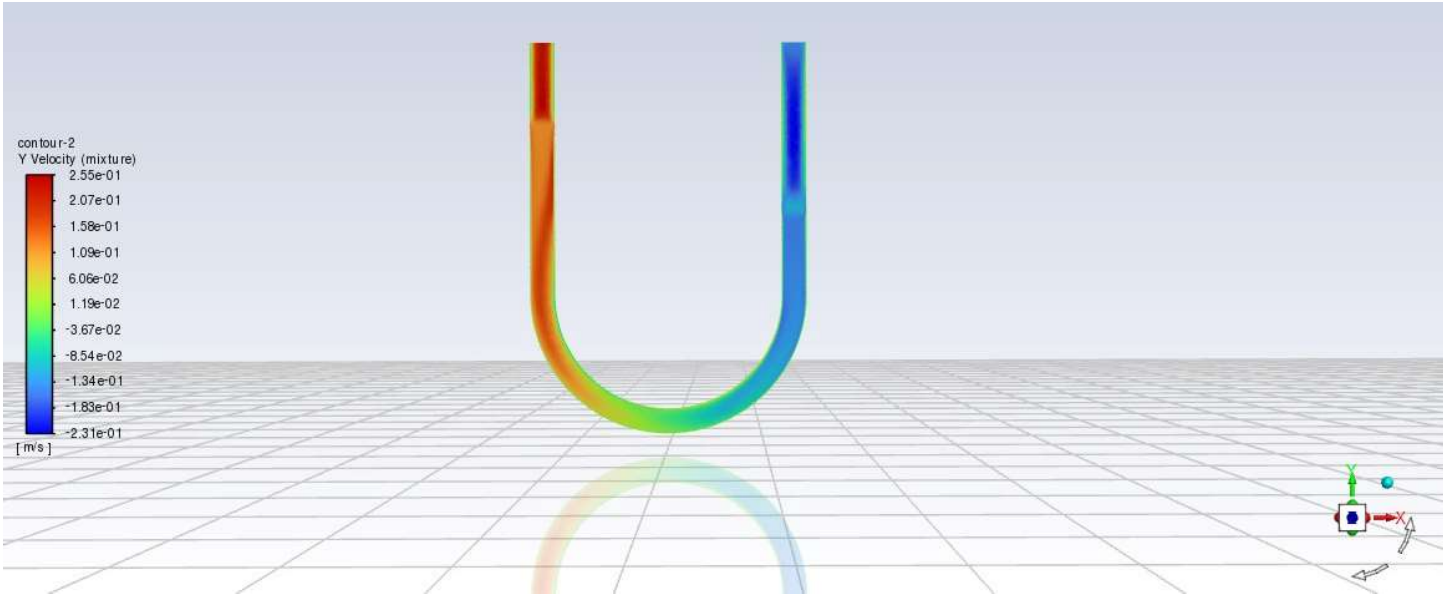
(D13) Plot of the mass flow rate of air vs flow time for the full time period and the τ = 1.0350 = rounded to first Digit 1 seconds



(D14)

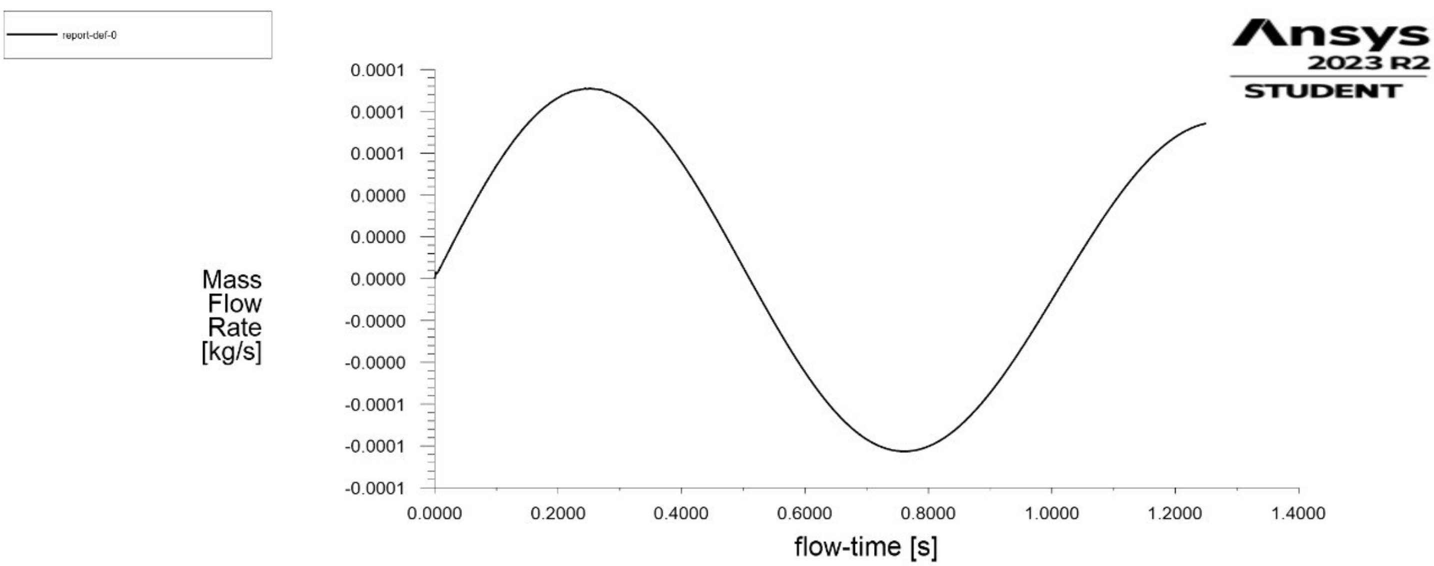


Contour plot of the Y- Velocity of the mixture on plane of the symmetry at t = 0.25 (varad lad)



Contour plot of the Y- Velocity of the mixture on plane of the symmetry at t = 0.75 (Varad lad)

b) For the Density of the water as 1996.4 kg/m3 which is essentially double of the 1st case, τ = 1.0780 = rounded to first Digit 1 seconds



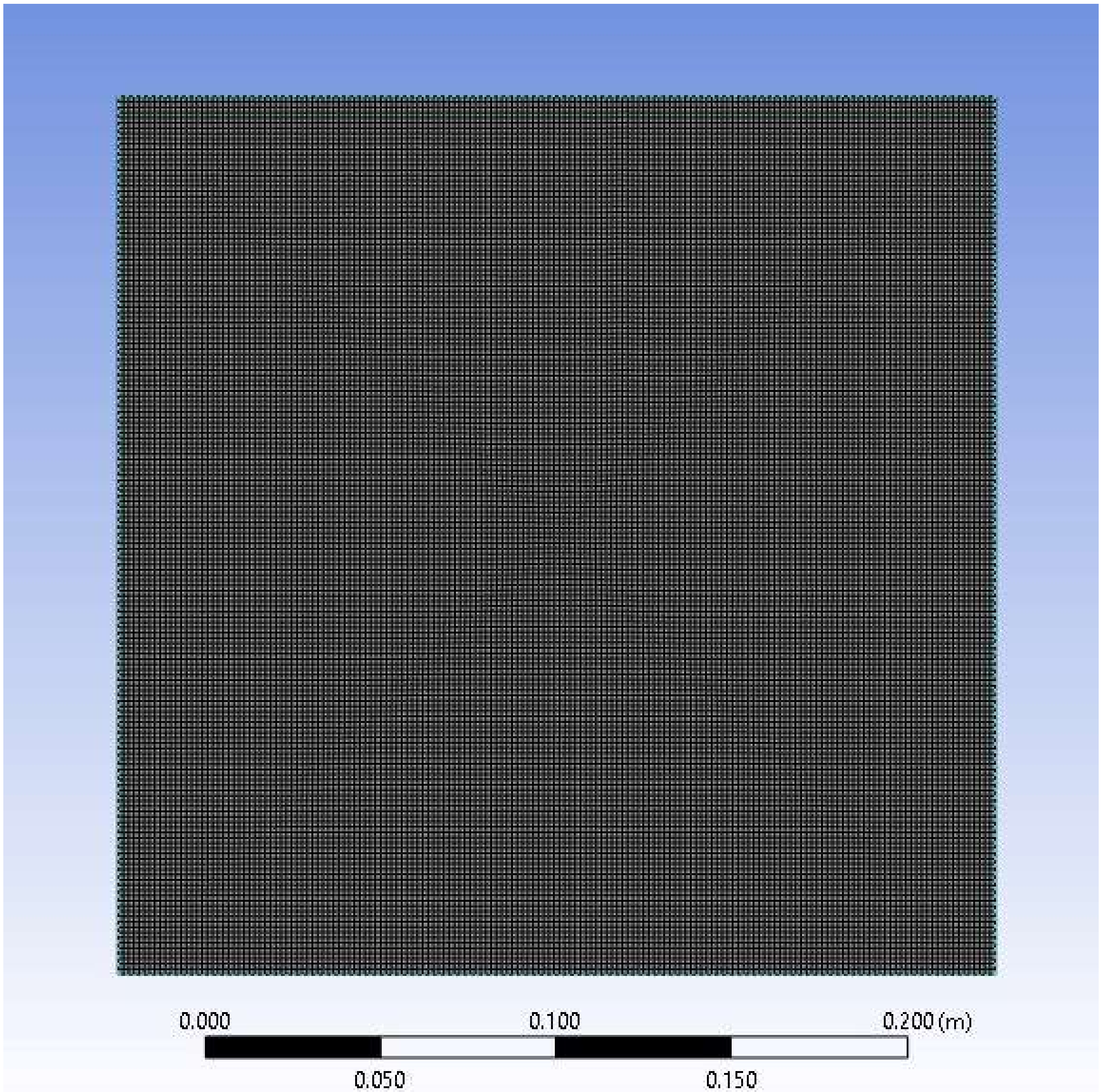
(D15)

While the general oscillating pattern stays the same, the period, amplitude, and damping rate will be quantitatively different between the two cases because of the change in water density and inertia.

- The amplitude of the peaks will probably be lower for case (b) since the higher inertia of the denser water will tend to dampen the oscillation more rapidly.

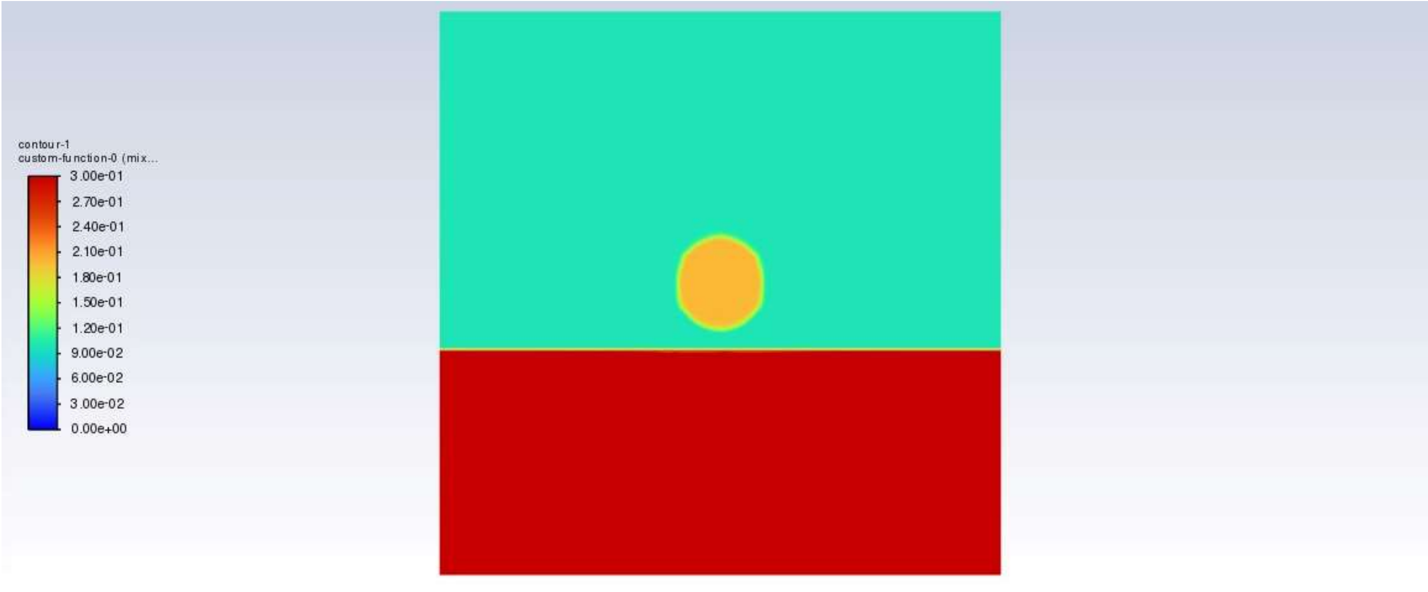
Task 4

(D16) Mesh resolution: 0.0015 m

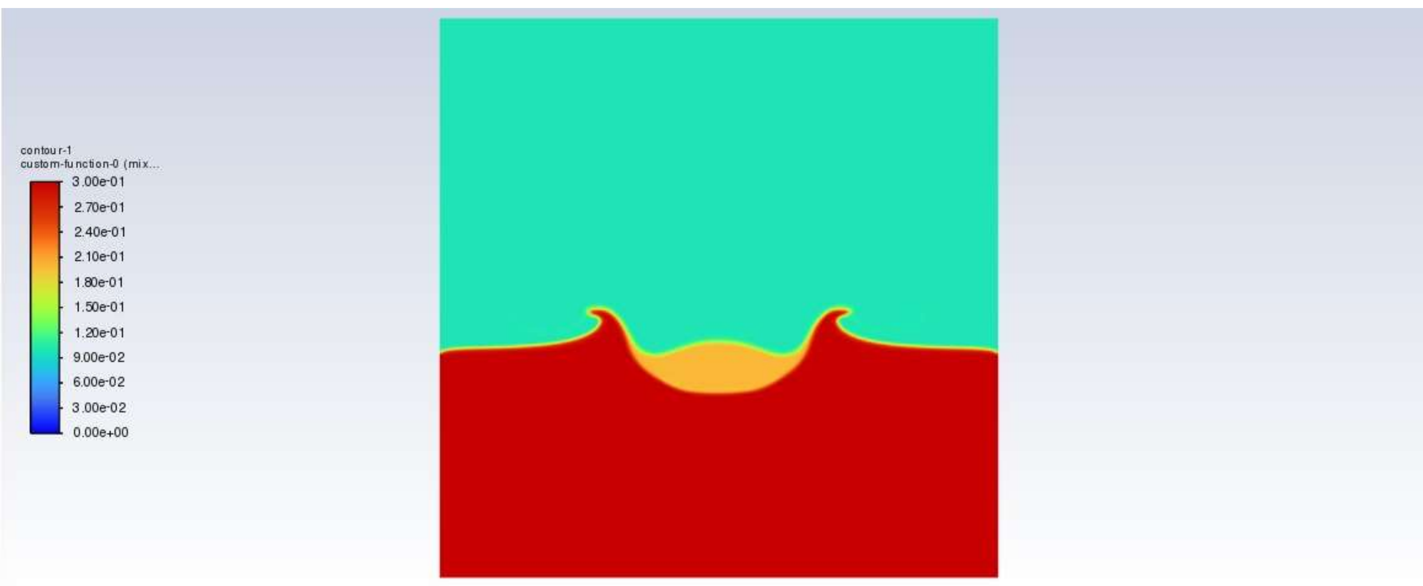


Number of Time Steps	Time Step Size	Max Iterations
600	0.0003333	12

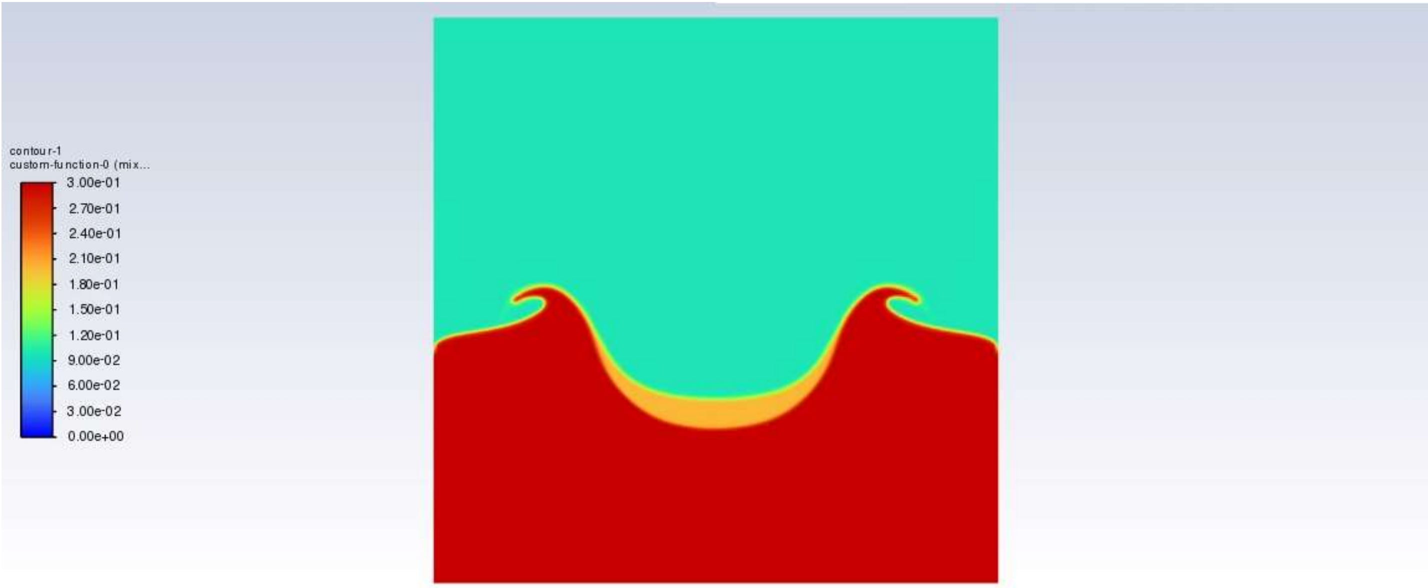
(D17) Mesh resolution: 0.001 m



Contour plot of CF at t=0.12 (varad lad)



Contour plot of CF at t=0.16 (varad lad)



Contour plot of CF at t=0.20 (varad lad)