Sharan Kishore

MAE-598 Applied CFD

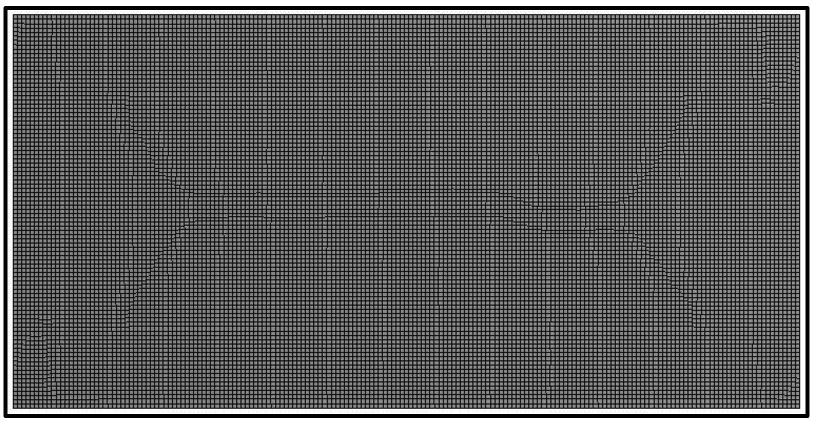
Project:2 (Task1-Task4)

Task 1:

Mesh:

The mesh used for this task is:

Relevance(Sizing)	Fine
Face Refinement	2



Statistics	
Nodes	17296
Elements	17019
Mesh Metric	None

Figure 1: Mesh used for Task-1

Time step

0.01s time step size was used for stability of the solution and to avoid the courant number to exceed 2. 1000 iterations was run and the setting for obtaining the data at 1,5 & 10 seconds was configured.

Case A: Viscous-Laminar Model

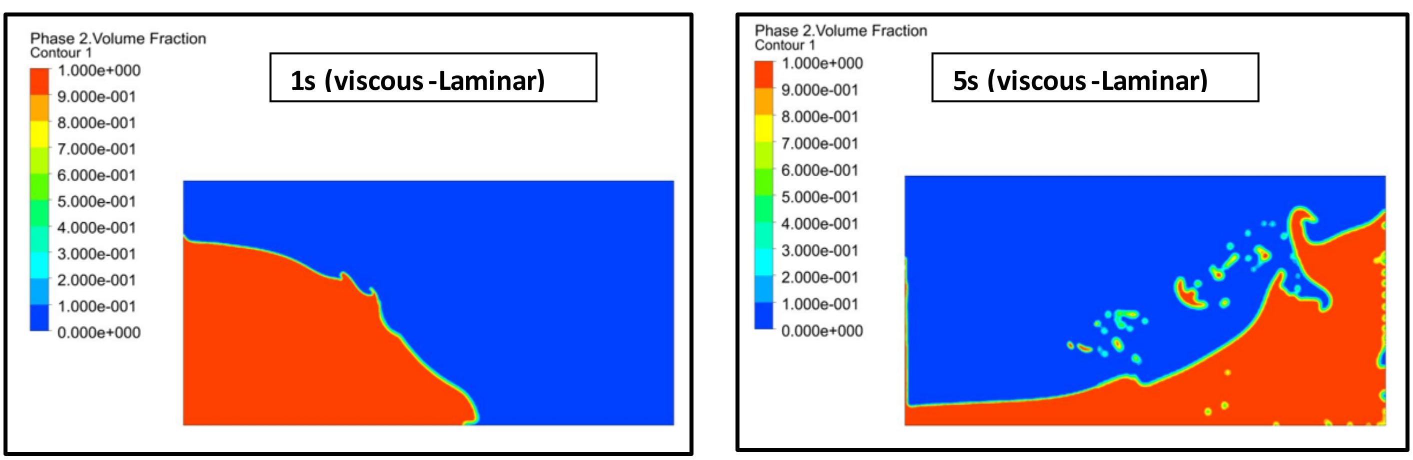


Figure 2: Volume fraction of Phase-2 at 1s (left) and 5s (right)

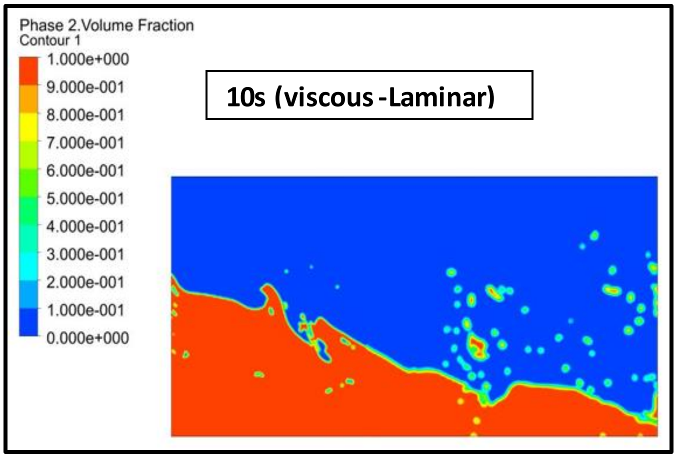


Figure 3: Volume fraction of Phase-2 at 10s

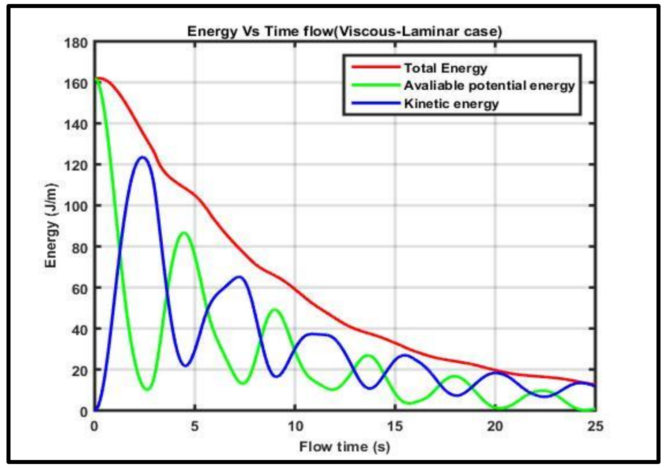


Figure 4: Energy plot(viscous-Laminar)

Case B: Inviscid model

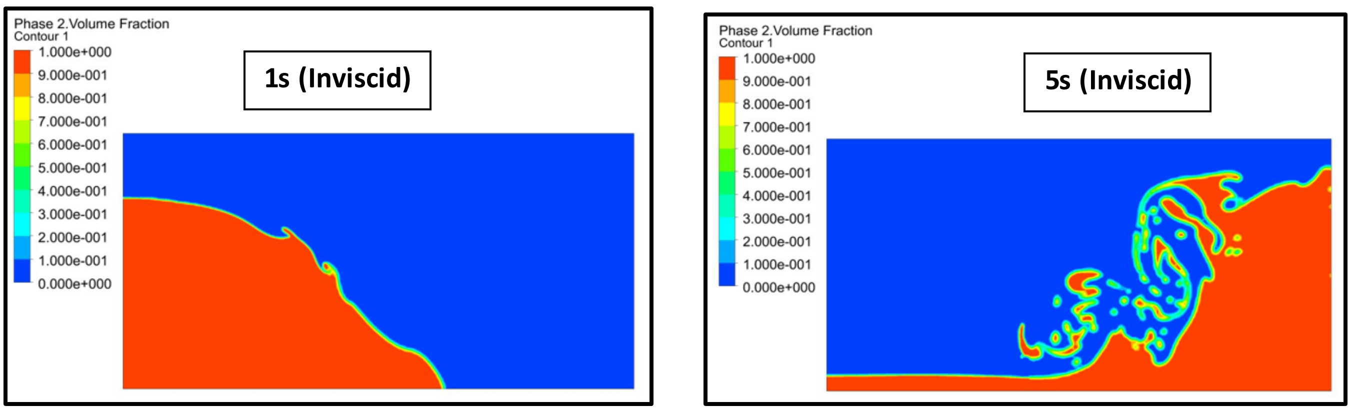


Figure 5: Volume fraction of Phase-2 at 1s (left) and 5s (right)

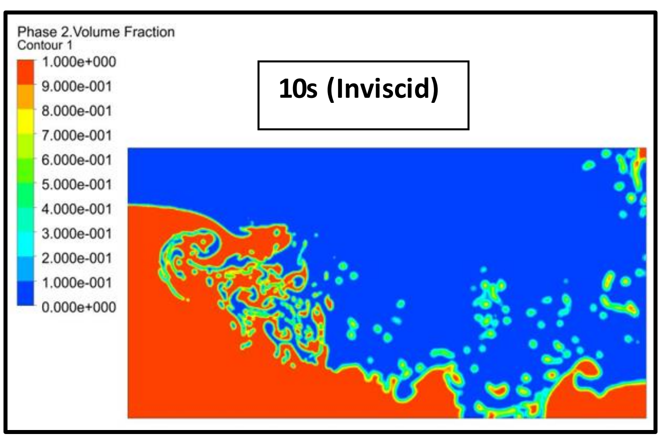


Figure 6: Volume fraction of Phase-2 at 10s

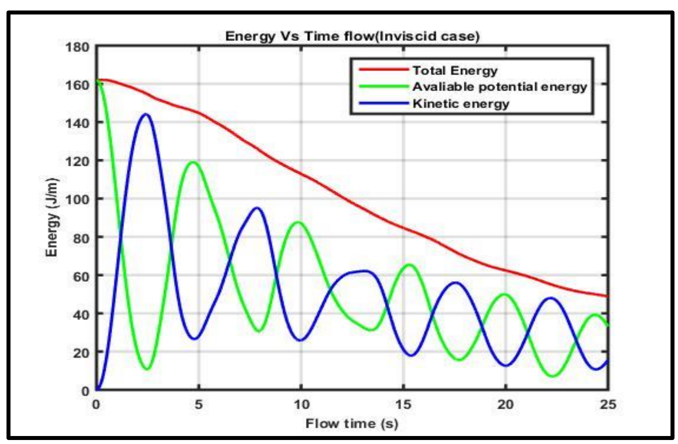


Figure 7: Energy plot(Inviscid)

The potential energy at t $\to \infty$ was calculated to be 7753.38 J/m. Half of this value was subtracted from the system's potential energy and entered as a custom field function. Kinetic energy along with Total energy was also entered as a custom field function.

Surface integral was performed and the energy was monitored with the flow time. From the two energy curves we observe that the total energy decreases much slower for the inviscid case than the viscous laminar case. This is because for the latter case, the viscosity of the system damps the kinetic energy and potential energy and thus making the total energy to drop much faster. So the steady state for the viscous laminar will be achieved much quicker than the inviscid case.

Task-2

Mesh:

The mesh used for this task is:

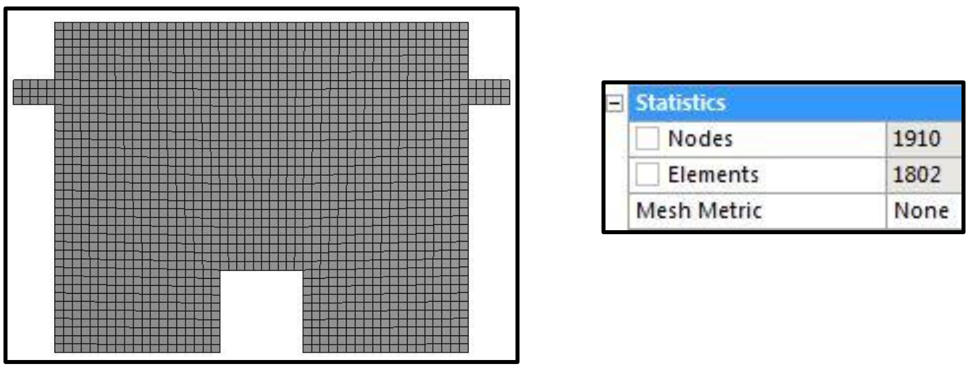


Figure 8: Mesh used for Task-2

The mesh was also refined by using the adapt command. Since there is no water inside the tank at time=0, volume fraction for the surface is patched as '0' . The time step size used is 0.001s

Case A: $V_{inlet} = 0.3$ m/s

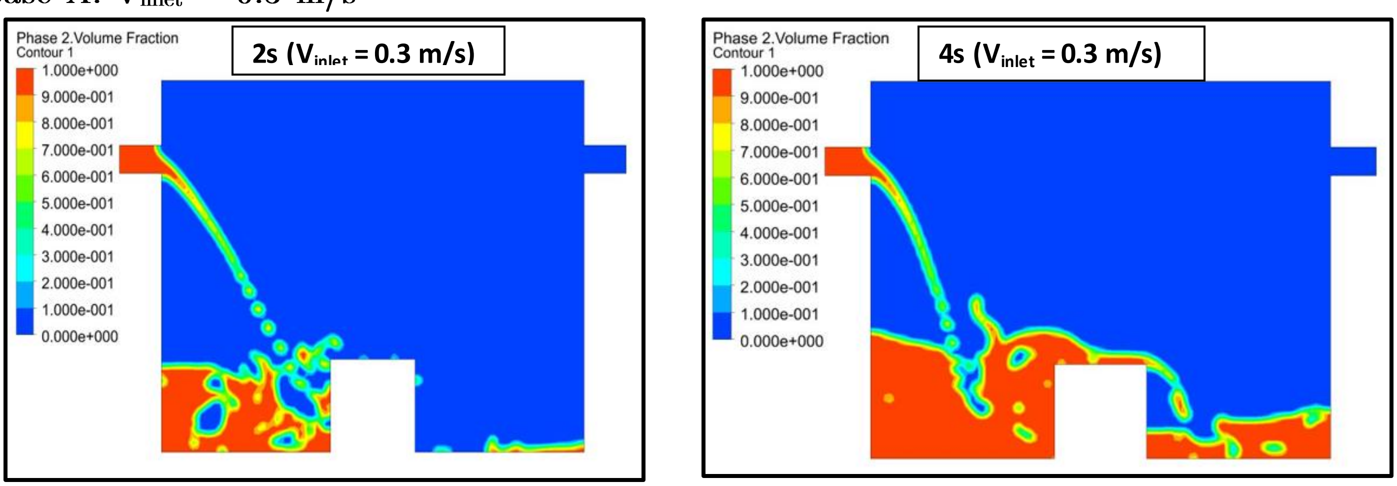


Figure 9: Volume fraction of Phase-2 at 2s (left) and 4s (right)

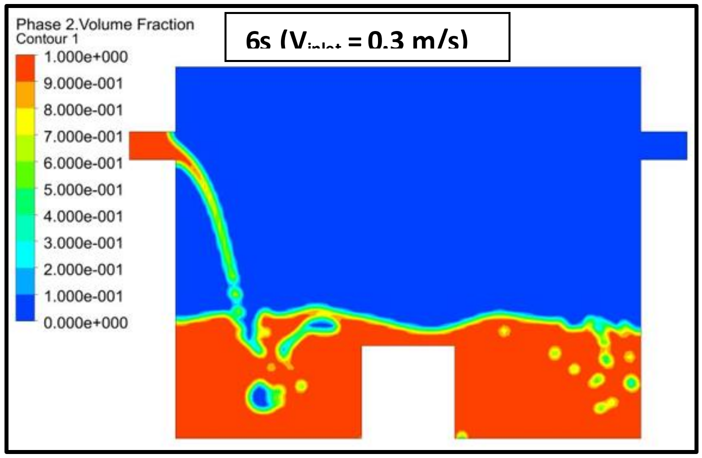


Figure 10: Volume fraction of Phase-2 at 6s

Case B: $V_{inlet} = 0.6$ m/s

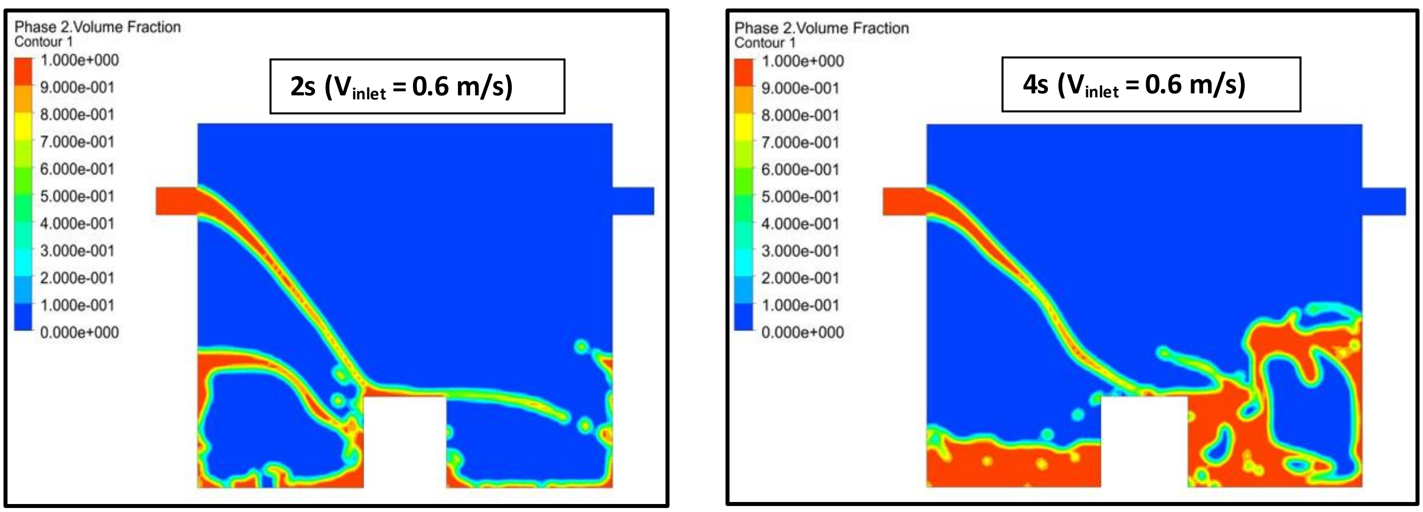


Figure 11: Volume fraction of Phase-2 at 2s (left) and 4s (right)

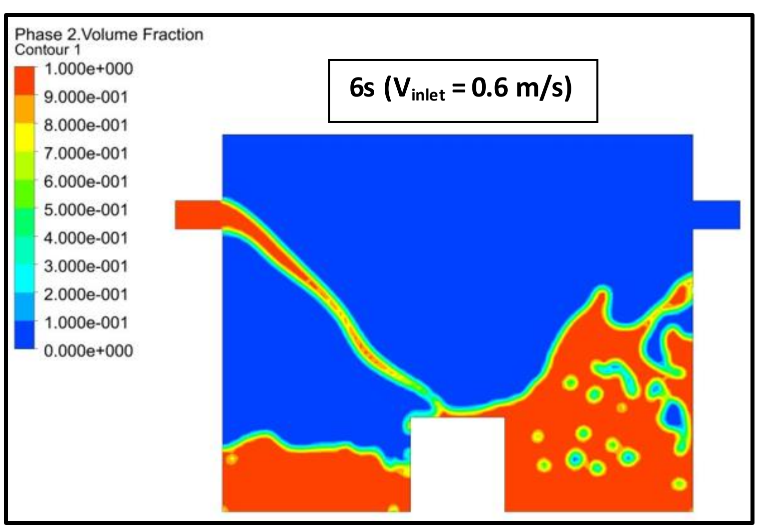
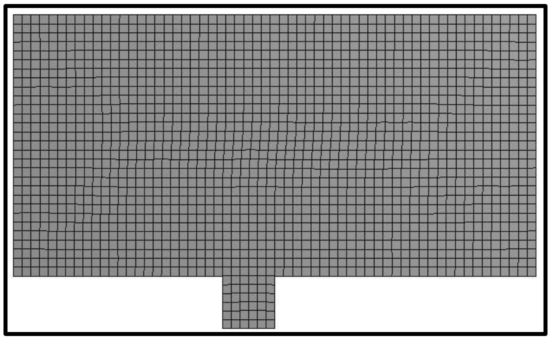


Figure 12: Volume fraction of Phase-2 at 6s

Task 3:

The time step size used is 0.001s.

The mesh used for this task is:



Statistics	
Nodes	1842
Elements	1747
Mesh Metric	None

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Figure 13: Mesh used for Task-3

Case A: $V_{inlet} = 0.2$ m/s

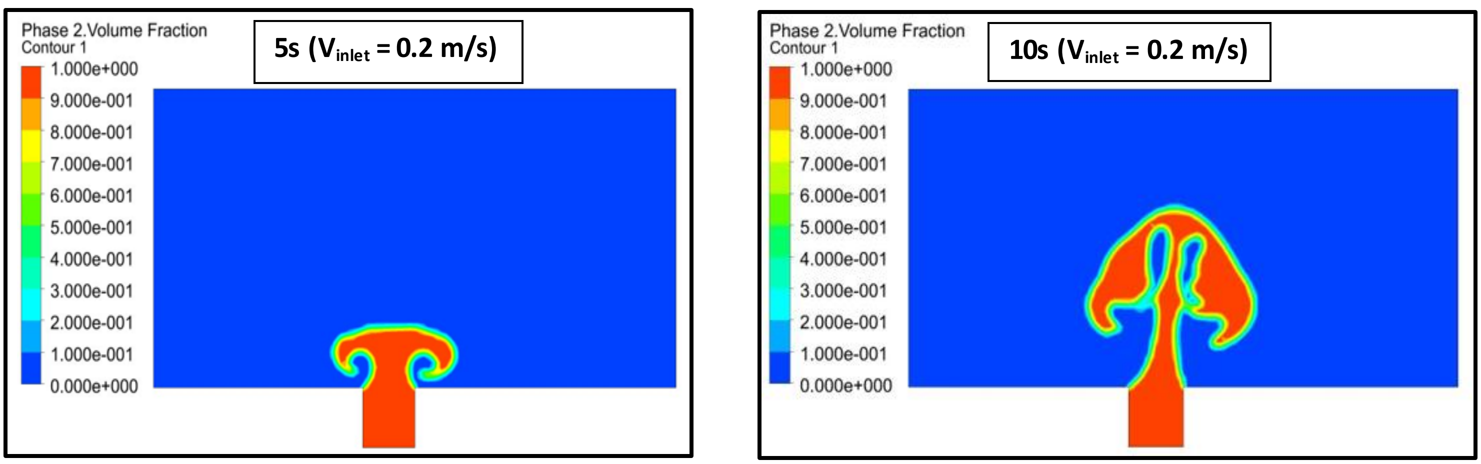

Figure 14: Volume fraction of Phase-2 at 5s (left) and 10s (right)

Case B: $V_{inlet} = 2$ m/s

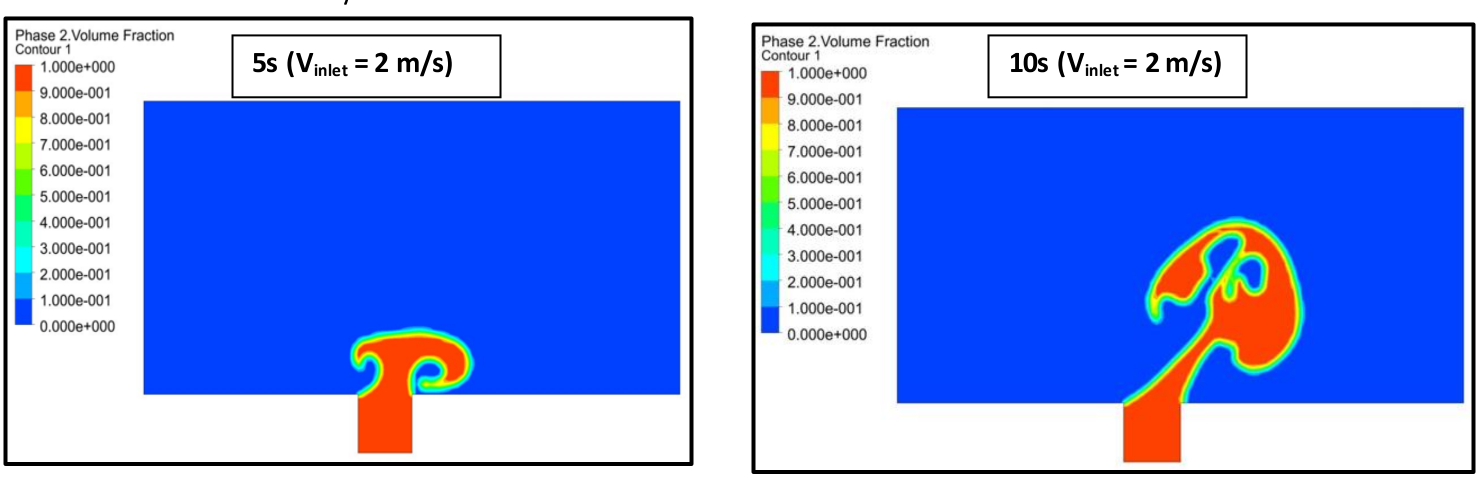

Figure 15: Volume fraction of Phase-2 at 5s (left) and 10s (right)

Task 4:

Mesh:

The mesh used for this task is:

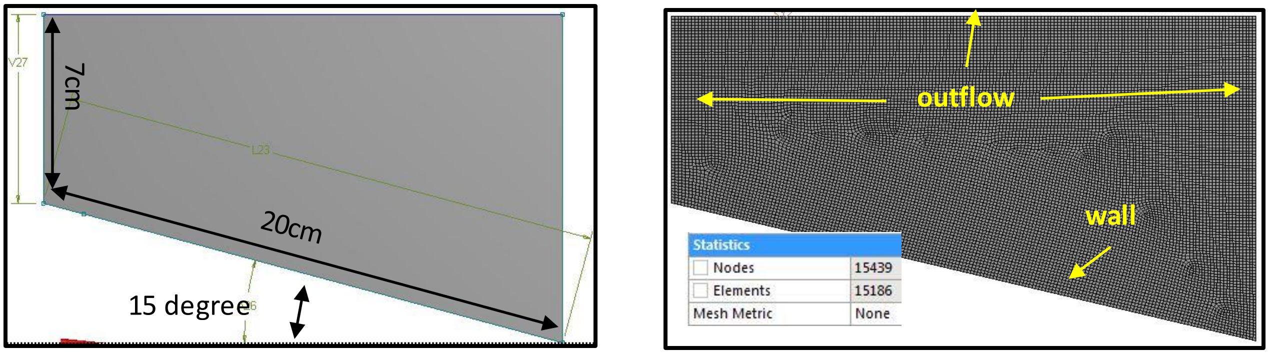

Figure 16: Geometry, Mesh & boundary condition used for Task-4a

The circle/sphere is patched with volume fraction as 1 as the secondary phase is engine oil.

Case A: 2D geometry

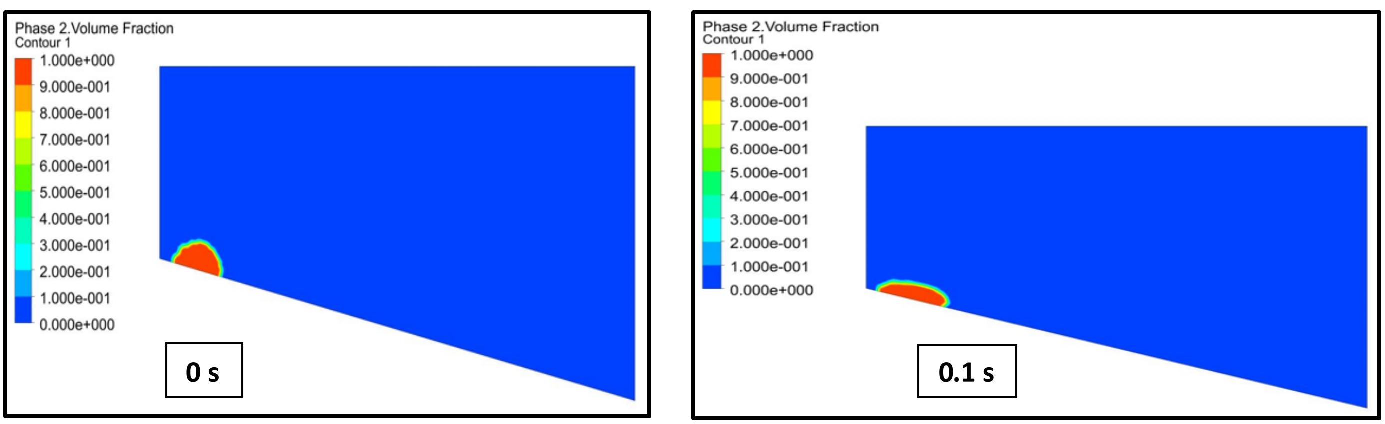

Figure 17: Volume fraction of Phase-2 at 0s (left) and 0.1s (right)

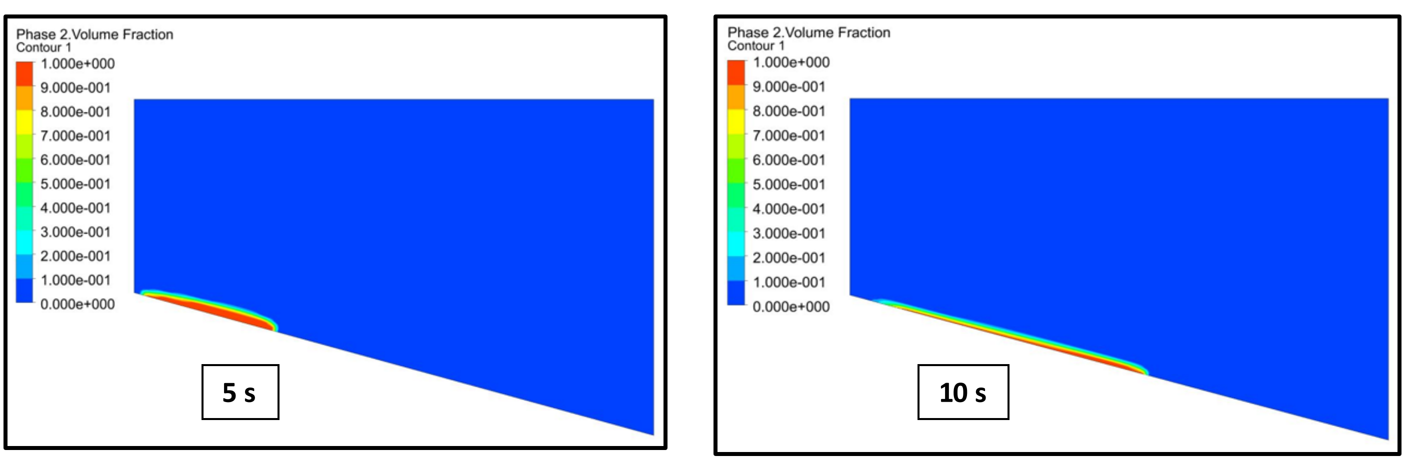

Figure 18: Volume fraction of Phase-2 at 5s (left) and 10s (right)

The time step size used is 0.001s. The **Boundary conditions** used are: the edge on which the drop is placed is taken as the wall and the remaining left, top and right edges are taken as outflow. The Outflow condition is used because the domain is open and not an enclosed region as stated in the problem. Also, when the liquid flows to a particular region, the air from that has to move out.

Case B: 3D geometry

Mesh:

The mesh used for this task is:

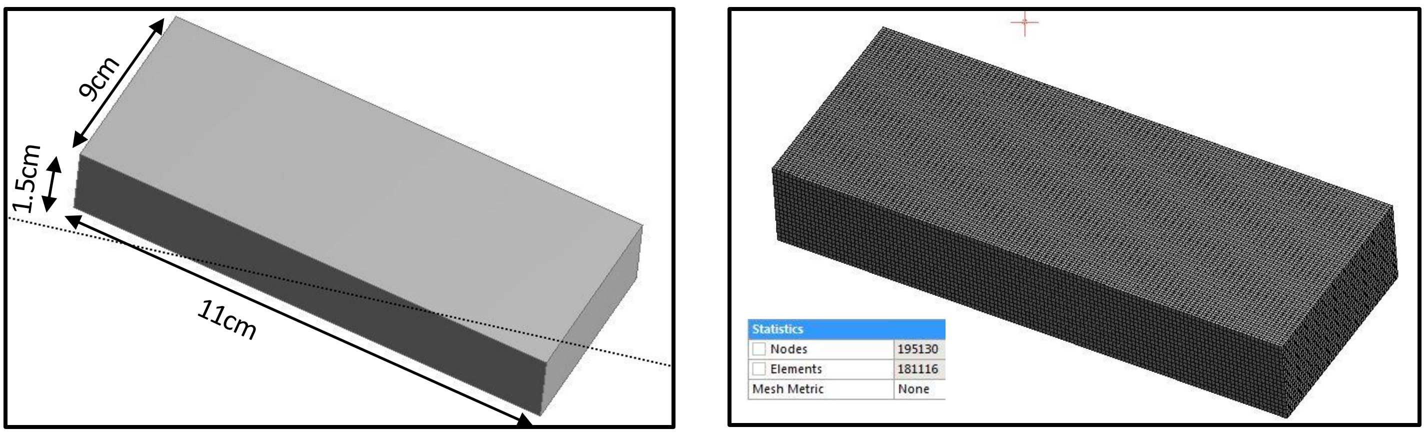

Figure 19: Geometry & Mesh used for Task-4b

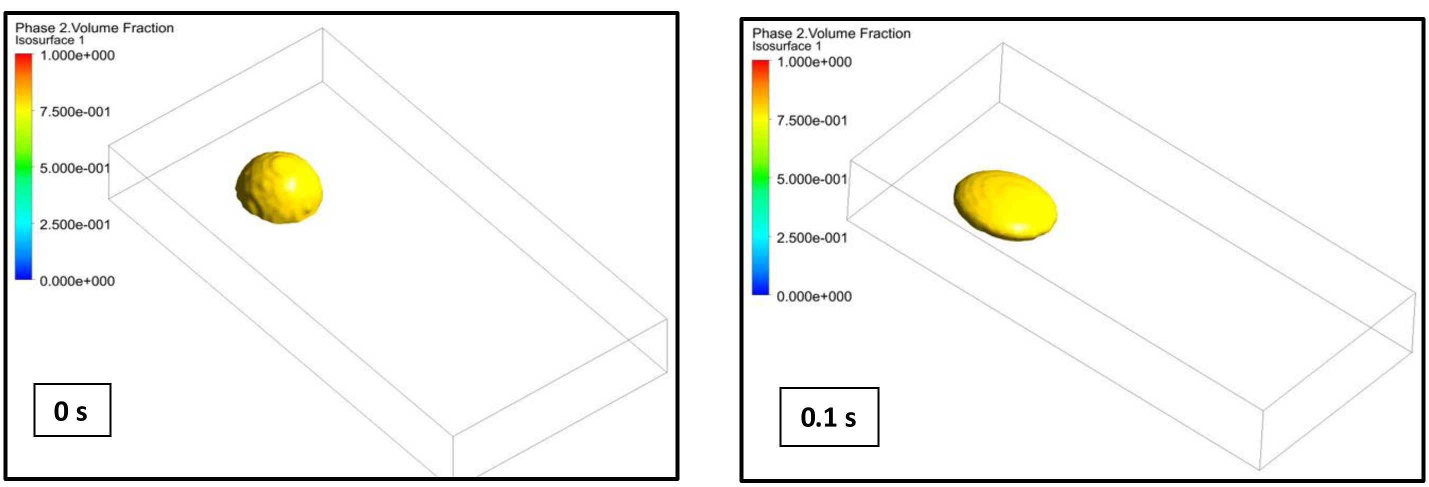

Figure 20: Iso-surface for 0.8 volume fraction at 0s (left) and 0.1s (right)

The domain was made small to reduce the computation time. A fine mesh was generated and appropriate time step size of 0.001s was used.

The **boundary conditions** are similar to the 2D case. The surface on which the drop is placed is taken as the wall. All the remaining surfaces are taken as outflow. This will allow the air to flow out as the fluid moves down the incline.

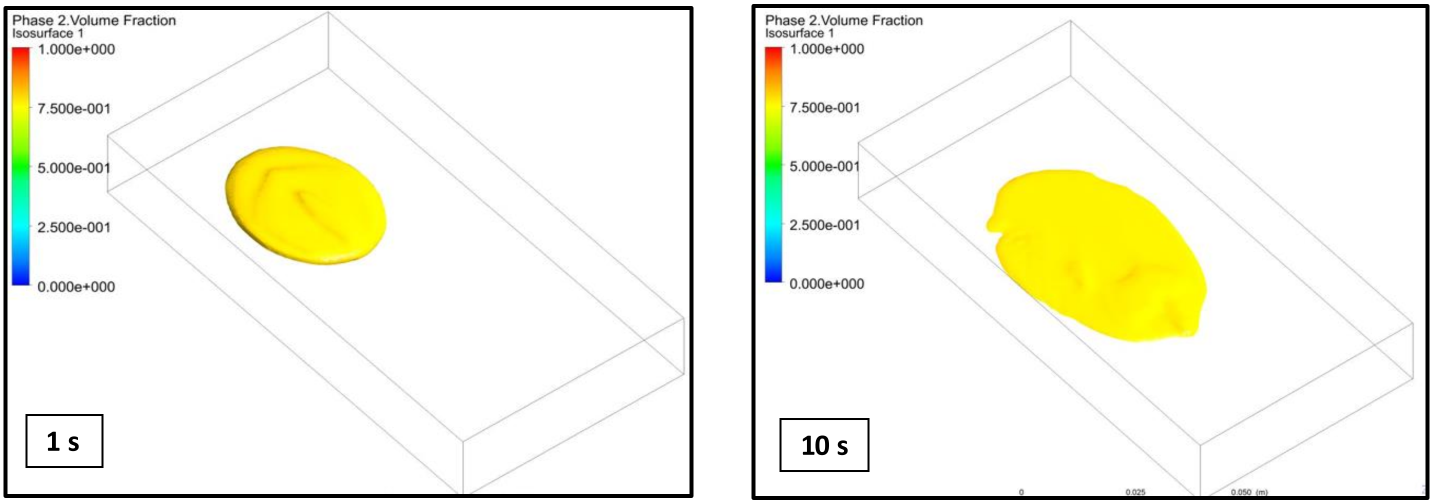

Figure 21: Iso-surface for 0.8 volume fraction at 1s (left) and 10s (right)

A mid plane was created in the 3D case to obtain the contour plot and to compare with the 2D Case. From the figure below we observe that the 2D contour matches with the Case A i.e. 2D droplet.

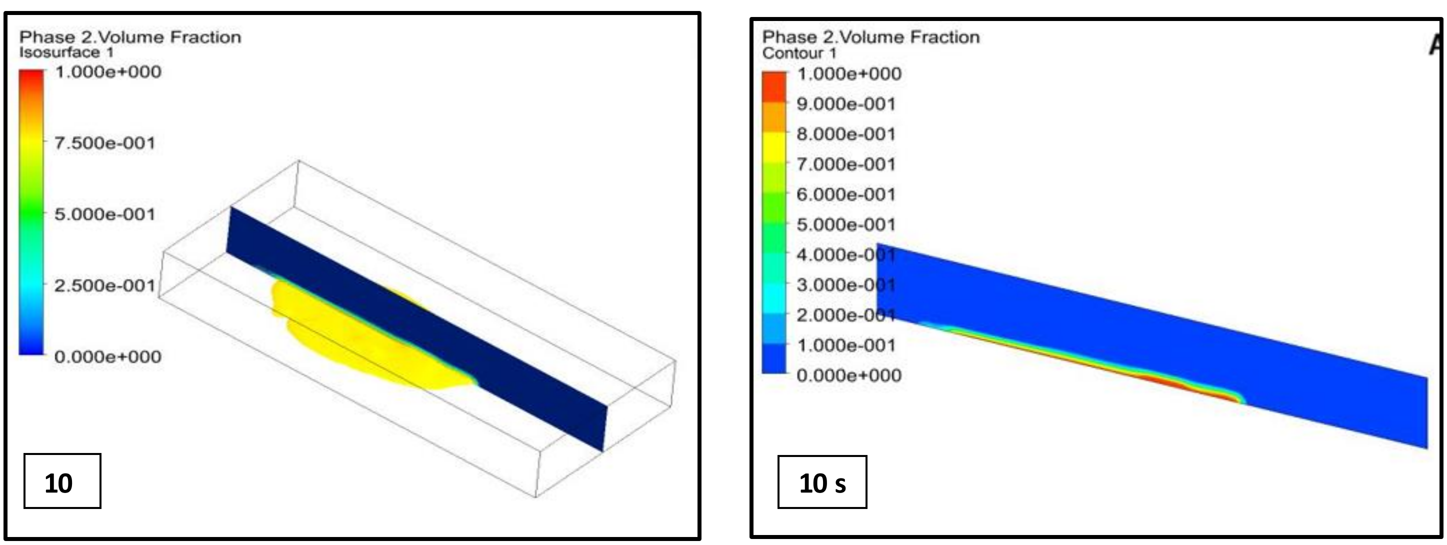

Figure 22: 2D Volume fraction contour (Phase 2) for the 3D case