

## ANALYSIS OF A BAFFLE PLATE IN CYLINDRICAL VESSEL TO REDUCE THE PRESSURE EFFECT DURING SLOSHING

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### Abstract

In this article, major focus is on the design, analysis, and modification of baffle plates which will help in slowing down the sloshing effects. Half-filled fluid which causes sloshing is a major concern. It affects the structure of the tanks moreover it reduces the braking efficiency of the truck carrying tank. With a capacity of 4900 liters, it is capable of impacting the tank walls with high forces. So it becomes necessary to reinforce the baffle plates in such tank, with the help of Solid works, CFD (Computational fluid dynamics). With the introduction of porous plate inside the tank it is seen the pressure has considerably reduced during sloshing when compared with the existing tank.

**Keywords:** Fluid Sloshing, Baffle plate, CFD

### 1. Introduction

Fluid sloshing is a source of major concern when it comes to designing of heavy-duty trucks. The main cause of fluid sloshing is due to the free surface motion of fuel in a partially filled containers. With the huge capacity of 4900 liters, this phenomenon is capable of impacting the container tank with high forces and some parts become vulnerable due to heavy dynamic loads. This is non-linear phenomena and can be simulated using computational fluid dynamics i.e CFD. This problem can be solved by using volume of fluid (VOF) interface capturing approach. If we observe the thin-walled structures of the tank, it becomes tedious to tackle this effects of fluid structure.

Interaction (FSI). It is done by using those material which aim for reduction of weight which are feasible. Analysis of fluid sloshing is an interesting challenge in computational mechanics due to its underlying complex physics. Simulation plays an important role here, which involves an accurate modelling of two phase flow problems as well as considering the sloshing effect on solid structure through coupled fluid solid interaction. Such simulations have found their place in industrial applications. Simulations can help in a collection of important information on structure and design of Tanks at an early stage by reducing the lead time in the manufacturing process. Also, the advent of novel materials like plastics and composites, aimed at overall weight reduction, has made such analysis procedure an absolute necessity.

Heavy-duty volvo fuel tanks are made of aluminum usually. There is a D-shaped body which is reinforced with baffles which is included in the tank structure. The baffles provide structural

rigidity and reduces the effect of sloshing waves. During test runs, cracks and leakages have been observed due to the sloshing impacts leading to eventual failure of the tank.

## 2. Literature review

The nonlinear nature of sloshing is the greatest hindrance in solving such a problem analytically and even computationally. Further, a number of assumptions are to be made, in which the solutions may deviate from the actual values. Experimental studies have been the most popular approach for liquid sloshing and have provided valuable insights into the physics

### Abbreviations and Acronyms

CFD - Computational Fluid Dynamics

VOF - Volume of fluid

FEM - Finite element method

a - Acceleration

b - Depth

c - Courant Number

$F^{\rightarrow}$  - Force Vector

g - Acceleration due to gravity

h - Height

i - Unit tensor

$M^{\rightarrow}$  - Moment vector

p,q - Phases

t - Time

$\Delta t$  - Time step

$\Delta x_{\text{cell}}$  - Cell size

V - Volume of fluid

X,Y,Z - Co-ordinates axes

Greek Symbol

K Turbulence kinetic energy

$\varepsilon$  Turbulence dissipation

$\alpha_q$  qth fluid volume fraction

$\rho$  Density

$\mu$  Viscosity

### Continuity Equations:

This Equation represents that mass is conserved in a flow. For cylindrical coordinates, the incompressible, unsteady, continuity equation is:

$$\frac{\partial \rho}{\partial t} = \frac{1}{r} \frac{\partial}{\partial r} (\rho r u_r) + \frac{1}{r} \frac{\partial}{\partial \varphi} (\rho u_\varphi) + \frac{\partial}{\partial z} (\rho u_z) = 0$$

$u_r, u_\varphi, u_z$  are components of velocity in r,  $\Phi$  and z direction and  $\rho$  is the density.

### Navier-Stokes Equation:

This equation is also called as Momentum equation because these are the results of applying Newton's law of motion. The equation can be applied for both laminar and turbulent flow.

R - momentum equation:

$$\left(\frac{\partial u_r}{\partial t} + u_r \frac{\partial u_r}{\partial r} + \frac{u_\varphi}{r} \frac{\partial u_r}{\partial \varphi} + u_z \frac{\partial}{\partial z} - \frac{u_\varphi^2}{r}\right) = -\frac{\partial p}{\partial r} + \mu \left[ \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial u_r}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 u_r}{\partial \varphi^2} + \frac{\partial^2 u_r}{\partial z^2} - \frac{u_r}{r^2} - \frac{2}{r^2} \frac{\partial u_\varphi}{\partial \varphi} \right] + \rho g_r$$

$\phi$ -momentum equation:

$$\left(\frac{\partial u_\varphi}{\partial t} + u_r \frac{\partial u_\varphi}{\partial r} + \frac{u_\varphi}{r} \frac{\partial u_\varphi}{\partial \varphi} + u_z \frac{\partial u_\varphi}{\partial z} + \frac{u_r u_\varphi}{r}\right) = -\frac{1}{r} \frac{\partial p}{\partial \varphi} + \mu \left[ \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial u_\varphi}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 u_\varphi}{\partial \varphi^2} + \frac{\partial^2 u_\varphi}{\partial z^2} - \frac{u_\varphi}{r^2} + \frac{2}{r^2} \frac{\partial u_r}{\partial \varphi} \right] + \rho g_\varphi$$

Z -momentum equation:

$$\rho \left( \frac{\partial u_z}{\partial t} + u_r \frac{\partial u_z}{\partial r} + \frac{u_\varphi}{r} \frac{\partial u_z}{\partial \varphi} + u_z \frac{\partial u_z}{\partial z} \right) = -\frac{\partial p}{\partial z} + \mu \left[ \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial u_z}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 u_z}{\partial \varphi^2} + \frac{\partial^2 u_z}{\partial z^2} \right] + \rho g_z$$

Where P is the static pressure,  $u_r, u_\varphi, u_z$  are the velocity components in r,  $\varphi$  and z direction.  $\mu$  is the dynamic viscosity,  $\rho$  is the density and  $\rho g_r, \rho g_\varphi, \rho g_z$  are body forces due to gravity. For our problem we had add extra force term in the direction of z for the acceleration in the longitudinal direction.

### Physical Model of Container

The problem consists of an elliptical tank with a moving vehicle. The length and major axis, the minor axis of the outer and inner tank are 5706 mm and 2200 mm, 1400 mm and 1900 mm and 1100 mm respectively. The tank is partially filled with Water ( $\mu=0.001003$  kg/m-s) and the remaining part is air. As the vehicle is under the influence of acceleration and deceleration, the fluid inside the container shows sloshing.

To reduce the sloshing effect, different types of baffles plates are introduced inside the cylindrical container.

Reasons why to use so many holes

The perforated baffle plates with suitable smalls numbers of holes is considered to be an effective baffle arrangement in tanks on reducing the sloshing amplitude at higher excitation frequency due to the potential advantage of the perforated baffles on enabling the tanker payload to be increased without comprising safety.

The vertical baffle and the perforated baffle can obstruct fluids' movement and change the velocity fields, making the sloshing amplitude remarkably reduced due to the buffering effects of the baffles.

### Mesh Generation

Once the geometry is modeled, we need to discretize it into control-based volumes and this process is known as meshing. In the CFD tool after modeling the geometry of baffles as well as cylinder, we will mesh it in the same tool. In project analysis, we will do tetrahedron mesh in all conditions. It is important because the courant number c depends on it.

Once meshing is being done, the mesh file is exported to CFD code SOLIDWORKS. In the present study 3-D, double precision fluent solvers with serial processing is used. The following procedure is followed in Solid works: 1) In setup, it is scaled to proper units if required and mesh quality is checked. 2) Pressure based transient solver is used with explicit formulation and a gravitational field is enabled. 3) Multiphase model with a volume of fluid (VOF) method is used, and turbulent model is considered.

**Global Mesh Settings**  
 Automatic initial mesh: Off  
 Basic Mesh Dimensions

|                      |    |
|----------------------|----|
| Number of cells in X | 26 |
| Number of cells in Y | 4  |
| Number of cells in Z | 8  |

**Control Planes**  
 Control planes in X direction

| Name | Minimum | Maximum | Number of cells | Ratio     |
|------|---------|---------|-----------------|-----------|
| X1   | -3.058  | 3.058   | -               | 1.0000000 |

Control planes in Y direction

| Name | Minimum | Maximum | Number of cells | Ratio     |
|------|---------|---------|-----------------|-----------|
| Y1   | -0.580  | 0.593   | -               | 1.0000000 |

Control planes in Z direction

| Name | Minimum | Maximum | Number of cells | Ratio     |
|------|---------|---------|-----------------|-----------|
| Z1   | -1.022  | 1.022   | -               | 1.0000000 |

**Solid/Fluid Interface**

|                                      |           |
|--------------------------------------|-----------|
| Small Solid Feature Refinement Level | 1         |
| Curvature Level                      | 0         |
| Curvature Criterion                  | 0.390 rad |
| Tolerance Level                      | 1         |
| Tolerance Criterion                  | 0.139 m   |

**Refining cells**

|                      |     |
|----------------------|-----|
| Refine fluid cells   | Off |
| Refine partial cells | Off |
| Refine solid cells   | Off |

**Narrow Channels**

|  |     |
|--|-----|
| Advanced narrow channel refinement                     | On  |
| Characteristic number of cells across a narrow channel | 5   |
| Maximum Channel Refinement Level                       | 2   |
| Minimum Height of Channel to Refine                    | Off |

|                                     |     |
|-------------------------------------|-----|
| Maximum Height of Channel to Refine | Off |
|-------------------------------------|-----|

Computational Domain Size

|       |          |
|-------|----------|
| X min | -3.058 m |
| X max | 3.058 m  |
| Y min | -0.580 m |
| Y max | 0.593 m  |
| Z min | -1.022 m |
| Z max | 1.022 m  |

Boundary Conditions

|               |         |
|---------------|---------|
| 2D plane flow | None    |
| At X min      | Default |
| At X max      | Default |
| At Y min      | Default |
| At Y max      | Default |
| At Z min      | Default |
| At Z max      | Default |

Physical Features

Heat conduction in solids: On  
 Heat conduction in solids only: Off  
 Radiation: Off  
 Time-dependent: On  
 Gravitational effects: On  
 Rotation: Off  
 Flow type: Laminar and turbulent

Global Mesh Settings

Automatic initial mesh: Off

Basic Mesh Dimensions

|                      |    |
|----------------------|----|
| Number of cells in X | 26 |
| Number of cells in Y | 4  |
| Number of cells in Z | 8  |

Control Planes

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| Name | Minimum | Maximum | Number of cells | Ratio     |
|------|---------|---------|-----------------|-----------|
| Y1   | -0.580  | 0.593   | -               | 1.0000000 |

Control planes in Z direction

| Name | Minimum | Maximum | Number of cells | Ratio     |
|------|---------|---------|-----------------|-----------|
| Z1   | -1.022  | 1.022   | -               | 1.0000000 |

Solid/Fluid Interface

|                                      |           |
|--------------------------------------|-----------|
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| Curvature Level                      | 0         |
| Curvature Criterion                  | 0.390 rad |
| Tolerance Level                      | 1         |
| Tolerance Criterion                  | 0.139 m   |

Refining cells

|                      |     |
|----------------------|-----|
| Refine fluid cells   | Off |
| Refine partial cells | Off |
| Refine solid cells   | Off |

Narrow Channels

|  |     |
|--|-----|
| Advanced narrow channel refinement                     | On  |
| Characteristic number of cells across a narrow channel | 5   |
| Maximum Channel Refinement Level                       | 2   |
| Minimum Height of Channel to Refine                    | Off |
| Maximum Height of Channel to Refine                    | Off |

Computational Domain Size  
 Boundary Conditions

|       |          |
|-------|----------|
| X min | -3.058 m |
| X max | 3.058 m  |
| Y min | -0.580 m |
| Y max | 0.593 m  |
| Z min | -1.022 m |
| Z max | 1.022 m  |

|               |         |
|---------------|---------|
| 2D plane flow | None    |
| At X min      | Default |
| At X max      | Default |
| At Y min      | Default |
| At Y max      | Default |
| At Z min      | Default |
| At Z max      | Default |

Physical Features

Heat conduction in solids: On  
 Heat conduction in solids only: Off  
 Radiation: Off  
 Time dependent: On

Gravitational effects: On  
 Rotation: Off  
 Flow type: Laminar and turbulent  
 High Mach number flow: Off  
 Default roughness: 0 micrometer

Gravitational Settings

|             |                        |
|-------------|------------------------|
| X component | Table from time        |
| Y component | -9.81 m/s <sup>2</sup> |
| Z component | 0 m/s <sup>2</sup>     |

Default outer wall condition: Adiabatic wall

Initial Conditions

|                          |                                     |
|--------------------------|-------------------------------------|
| Thermodynamic parameters | Static Pressure: 101325.00 Pa       |
|                          | Temperature: 20.05 °C               |
| Velocity parameters      | Velocity vector                     |
|                          | Velocity in X direction: 0 m/s      |
|                          | Velocity in Y direction: 0 m/s      |
|                          | Velocity in Z direction: 0 m/s      |
| Solid parameters         | Default material: Aluminum 6061     |
|                          | Initial solid temperature: 20.05 °C |
| Concentrations           | Substance fraction by mass          |
| Turbulence parameters    |                                     |

Global Mesh Settings

Automatic initial mesh: Off

Basic Mesh Dimensions

|                      |    |
|----------------------|----|
| Number of cells in X | 26 |
| Number of cells in Y | 4  |
| Number of cells in Z | 8  |

Control Planes

Control planes in X direction

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|------|---------|---------|-----------------|-----------|
| X1   | -3.058  | 3.058   | -               | 1.0000000 |

Control planes in Y direction

| Name | Minimum | Maximum | Number of cells | Ratio |
|------|---------|---------|-----------------|-------|
|------|---------|---------|-----------------|-------|

|    |        |       |   |           |
|----|--------|-------|---|-----------|
| Y1 | -0.580 | 0.593 | - | 1.0000000 |
|----|--------|-------|---|-----------|

Control planes in Z direction

| Name | Minimum | Maximum | Number of cells | Ratio     |
|------|---------|---------|-----------------|-----------|
| Z1   | -1.022  | 1.022   | -               | 1.0000000 |

Solid/Fluid Interface

|                                      |           |
|--------------------------------------|-----------|
| Small Solid Feature Refinement Level | 1         |
| Curvature Level                      | 0         |
| Curvature Criterion                  | 0.390 rad |
| Tolerance Level                      | 1         |
| Tolerance Criterion                  | 0.139 m   |

Refining cells

|                      |     |
|----------------------|-----|
| Refine fluid cells   | Off |
| Refine partial cells | Off |
| Refine solid cells   | Off |

Narrow Channels

|  |     |
|--|-----|
| Advanced narrow channel refinement                     | On  |
| Characteristic number of cells across a narrow channel | 5   |
| Maximum Channel Refinement Level                       | 2   |
| Minimum Height of Channel to Refine                    | Off |
| Maximum Height of Channel to Refine                    | Off |

Computational Domain Size

|       |          |
|-------|----------|
| X min | -3.058 m |
| X max | 3.058 m  |
| Y min | -0.580 m |
| Y max | 0.593 m  |
| Z min | -1.022 m |
| Z max | 1.022 m  |

Boundary Conditions

|               |         |
|---------------|---------|
| 2D plane flow | None    |
| At X min      | Default |
| At X max      | Default |
| At Y min      | Default |
| At Y max      | Default |
| At Z min      | Default |
| At Z max      | Default |



Physical Features  
 Heat conduction in solids: On  
 Heat conduction in solids only: Off  
 Radiation: Off  
 Time dependent: On  
 Gravitational effects: On  
 Rotation: Off  
 Flow type: Laminar and turbulent  
 High Mach number flow: Off  
 Default roughness: 0 micrometer  
 Gravitational Settings

|             |                        |
|-------------|------------------------|
| X component | Table from time        |
| Y component | -9.81 m/s <sup>2</sup> |
| Z component | 0 m/s <sup>2</sup>     |

Default outer wall condition: Adiabatic wall  
 Initial Conditions

|                          |                                     |
|--------------------------|-------------------------------------|
| Thermodynamic parameters | Static Pressure: 101325.00 Pa       |
|                          | Temperature: 20.05 °C               |
| Velocity parameters      | Velocity vector                     |
|                          | Velocity in X direction: 0 m/s      |
|                          | Velocity in Y direction: 0 m/s      |
|                          | Velocity in Z direction: 0 m/s      |
| Solid parameters         | Default material: Aluminum 6061     |
|                          | Initial solid temperature: 20.05 °C |
| Concentrations           | Substance fraction by mass          |
| Turbulence parameters    |                                     |

Fluids  
 Air  
 Water  
 Solids

Aluminum 6061  
 Local Initial Conditions  
 Initial Condition 1

|                             |                                 |
|-----------------------------|---------------------------------|
| Components                  | cylinder hollow_Case1.STEP[3]   |
| Coordinate system           | Global coordinate system        |
| Reference axis              | X                               |
| Thermodynamic Parameters    | Static Pressure: 101325.00 Pa   |
|                             | Pressure potential: On          |
|                             | Temperature: 20.05 °C           |
| Velocity Parameters         | Velocity in X direction: 0 m/s  |
|                             | Velocity in Y direction: 0 m/s  |
|                             | Velocity in Z direction: 0 m/s  |
| Turbulence parameters type: | Turbulence intensity and length |
| Intensity                   | 2.00 %                          |

|                |                            |
|----------------|----------------------------|
| Length         | 0.020 m                    |
| Concentrations | Substance fraction by mass |

Goals  
 Global Goals  
 GG Av Dynamic Pressure 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Dynamic Pressure         |
| Calculate          | Average value            |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

GG Av Velocity (Y) 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Velocity (Y)             |
| Calculate          | Average value            |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

GG Av Turbulent Energy 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Turbulent Energy         |
| Calculate          | Average value            |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

Material Settings

Fluids

Air

Water

Solids

Aluminum 6061

Local Initial Conditions

Initial Condition 1

|                             |                                 |
|-----------------------------|---------------------------------|
| Components                  | cylinder hollow_Case1.STEP[3]   |
| Coordinate system           | Global coordinate system        |
| Reference axis              | X                               |
| Thermodynamic Parameters    | Static Pressure: 101325.00 Pa   |
|                             | Pressure potential: On          |
|                             | Temperature: 20.05 °C           |
| Velocity Parameters         | Velocity in X direction: 0 m/s  |
|                             | Velocity in Y direction: 0 m/s  |
|                             | Velocity in Z direction: 0 m/s  |
| Turbulence parameters type: | Turbulence intensity and length |

|                    |                            |
|--------------------|----------------------------|
| Intensity          | 2.00 %                     |
| Length             | 0.020 m                    |
| Concentrations     | Substance fraction by mass |
| Use in convergence | On                         |

Goals

Global Goals

GG Av Dynamic Pressure 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Dynamic Pressure         |
| Calculate          | Average value            |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

GG Force (Y) 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Force (Y)                |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

GG Torque (Y) 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Torque (Y)               |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

Calculation Control Options

Finish Conditions

|                       |                     |
|-----------------------|---------------------|
| Finish Conditions     | If one is satisfied |
| Maximum physical time | 10.000 s            |

Solver Refinement

Refinement: Disabled

Results Saving

|                        |                      |
|------------------------|----------------------|
| Save before refinement | On                   |
| Periodic Saving        | Units: Physical time |
|                        | Period: 0.010 s      |

Advanced Control Options

Flow Freezing

|                        |          |
|------------------------|----------|
| Flow freezing strategy | Disabled |
|------------------------|----------|

GG Av Velocity (Y) 1

|      |             |
|------|-------------|
| Type | Global Goal |
|------|-------------|

|                    |                          |
|--------------------|--------------------------|
| Goal type          | Velocity (Y)             |
| Calculate          | Average value            |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

G Av Turbulent Energy 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Turbulent Energy         |
| Calculate          | Average value            |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

GG Force (Y) 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Force (Y)                |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

GG Torque (Y) 1

|                    |                          |
|--------------------|--------------------------|
| Type               | Global Goal              |
| Goal type          | Torque (Y)               |
| Coordinate system  | Global coordinate system |
| Use in convergence | On                       |

Calculation Control Options  
 Finish Conditions

|                       |                     |
|-----------------------|---------------------|
| Finish Conditions     | If one is satisfied |
| Maximum physical time | 10.000 s            |

Solver Refinement  
 Refinement: Disabled  
 Results Saving

|                        |                      |
|------------------------|----------------------|
| Save before refinement | On                   |
| Periodic Saving        | Units: Physical time |
|                        | Period: 0.010 s      |

### 3. Results and Discussion

Before presenting the results of our project, it is important to highlight some major points. Fluid-flow analysis was confined to the inlet zone and bulk liquid flow. Therefore, the communication between multiple zones was ignored.

In both cases (existing baffle plate and modified baffle plate), the flow was considered to be symmetrical.

As water is half filled, so during analysis we taken all 3 phases (water as fluid, and other half portion is air and solid act a domain for fluid).

Dimensions and other parameters are also mentioned in WORK DONE part and in Solid works CFD analysis.

All the parameters like speed of the vehicle, dimensions, analysis time after brake applied, pressure, density of fluid, material of baffle plate, and the material of cylindrical vessel will be same for both the cases.

We will only going to change the baffle plate during different analysis.

**For case 1**

In this analysis, we used the baffle plate which is shown in fig 1, and the result obtained on software at t= 5 sec after brakes were applied on vehicles. After the brake applied it shows a sloshing effect inside the cylindrical vessel this time we get changes in the behavior of the sloshing of water with the help of the Volume Fraction Counter and different results are also can be differentiated.

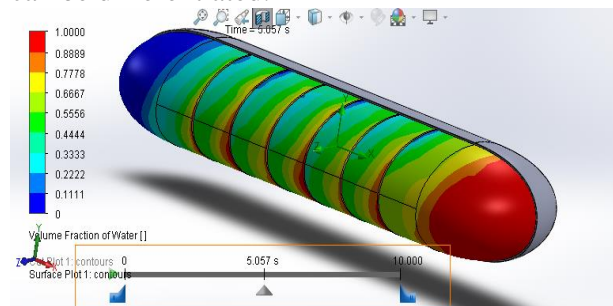


Fig. Different Global goals values for Case 1

**For case 2**

In this, we used the baffle plate shown below, and the result obtained on software from t=0 till t=10s after brakes applied on the vehicle can be shown in below figure and after brake applied it shows sloshing effect inside the cylindrical vessel and we can see the behavior of the water sloshing. The results of the 2nd Case is discussed in the Table shown below.

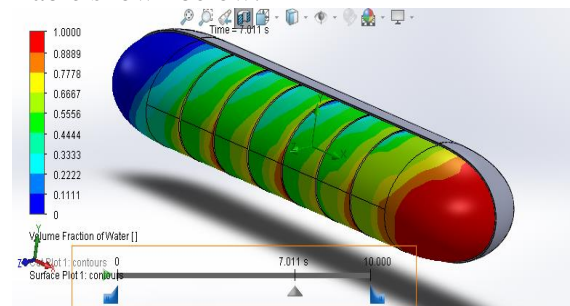


Fig. Volume Fraction Counter for 2nd case at t = 7 sec

| Goal Name                | Unit   | Value       | Averaged Value | Progress [%] |
|--------------------------|--------|-------------|----------------|--------------|
| GG Av Dynamic Pressure 1 | [Pa]   | 26.10893535 | 28.35490468    | 100          |
| GG Av Velocity (Y) 1     | [m/s]  | -0.02828267 | -0.027150469   | 100          |
| GG Av Turbulent Energy 1 | [J/kg] | 0.043534076 | 0.04390755     | 100          |
| GG Force (Y) 1           | [N]    | -38906.0949 | -38867.19908   | 100          |
| GG Torque (Y) 1          | [N*m]  | 136.5433958 | 12.83531958    | 100          |

| Goal Name                | Unit   | Value       | Averaged Value | Progress [%] |
|--------------------------|--------|-------------|----------------|--------------|
| GG Av Dynamic Pressure 1 | [Pa]   | 40.00431752 | 43.45862377    | 100          |
| GG Av Turbulent Energy 1 | [J/kg] | 0.051843471 | 0.052185061    | 100          |
| GG Force (Y) 1           | [N]    | -38385.5746 | -38251.48249   | 100          |
| GG Torque (Y) 1          | [N*m]  | -157.089399 | 51.43549562    | 100          |

**4. Conclusions**

For partially filled cylindrical vessel with water as a fluid, sloshing forces and moments are developed as it is subjected to linear acceleration/ deceleration. After simulating in SOLIDWORKS CFD and analyzing the results we can conclude that:

The FLUCTUATION in sloshing forces and moments are more at the lower fill level (bottom of the tank and near the bottom of Baffle plate).

Magnitude of the forces and moment are high in case of existing baffle plate Braking Efficiency also increased.

### Scope for Future Work

The problem like sloshing in a cylinder with baffles. Some of them are for future work:

The study can be performed with different shape of Vessel, Different Fluid can be studied. Use of different types of baffles plates and can modified them notice the analysis. The study of baffle plate with different orientation in tank.

The analysis part of any solution tool is very important step. In the present study an evaluation method used for the analysis of facility layout has been discussed. A practical case study of a automobile industry has been taken. There were two alternatives at the evaluation stage of design process, and the factor analysis method has been implemented for selecting the best among them. The score for alternative 1 and 2 are as: 865 and 829 respectively, therefore alternative 1 is selected as best among these. This study is very helpful for the layout designer for selecting the best layout. In future this method can be implement on other industries with more number of alternatives.

### References

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