SLOSHING – EFFECT OF INTERNAL BAFFLES USING CFD

Objective

To assess the effect of internal baffles on the intensity of dynamic pressure imparted by the fluid on the walls of its enclosure and to optimize the baffle design and shape.

Challenges

- Dynamic pressure formulation.
- Effect of turbulence near the baffles and wall regions.

CFD Model

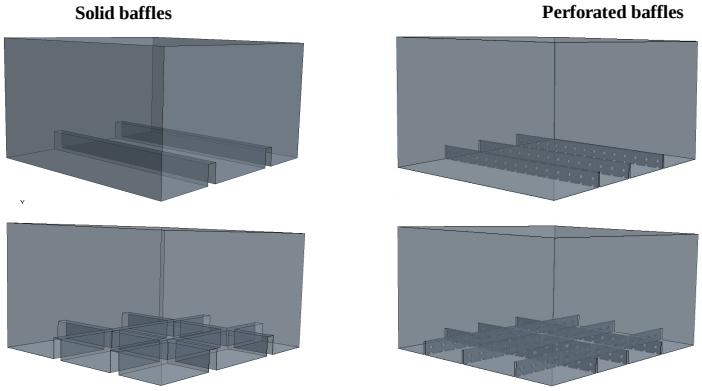


Fig-1 Geometry – Tank with Baffles

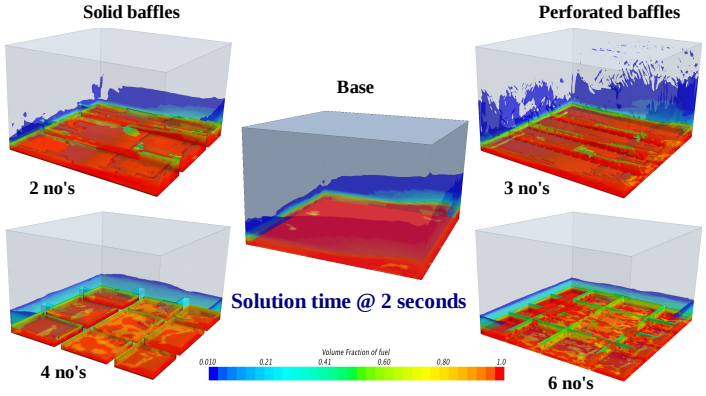


Fig-2 Volume fraction of fluids-10% Volume Fill

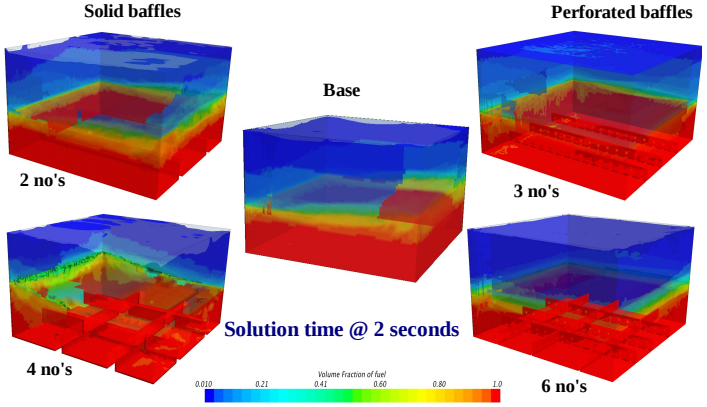
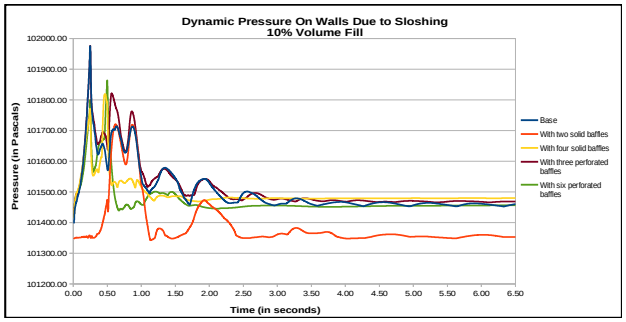
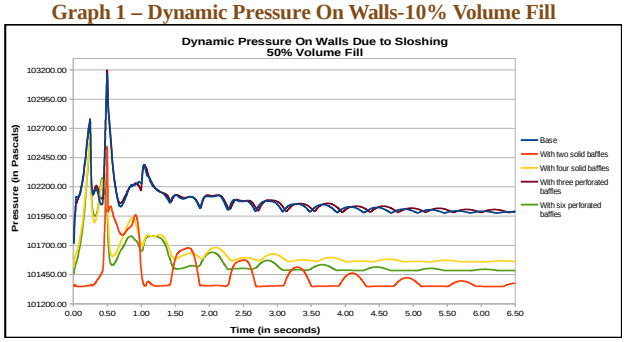


Fig-3 Volume fraction of fluids-50% Volume Fill



Graph 1 – Dynamic Pressure On Walls-10% Volume Fill



Graph 2 – Dynamic Pressure On Walls-50% Volume Fill

Approach

Fuel tank with a volume of 0.0172 m^3, holding kerosene was subjected to random acceleration input. The resulting phenomenon of sloshing was simulated in detail using Standard K-Epsilon turbulence model with fine structured mesh. The effect of internal baffles on the intensity of dynamic pressure induced on tank walls was simulated and compared through transient state simulations; with initial condition of tank filled with 10% and 50% of its volume. Further optimization of internal baffles geometry and design was attempted and resulting dynamic pressure on tank walls were simulated and compared.

Conclusion

The comparitive results obtained were beneficial to understand the effect of internal baffles in controlling the sloshing phenomenon. Significant reduction in dynamic pressure imparted on the walls of tank and changes in the pattern of sloshing phenomenon could be obtained through choosing suitable design of internal baffles.

Benefits

- Predict and mitigate the adverse effects of sloshing on tank walls
- Assess the effect of internal baffles on the sloshing phenomenon
- Predict and visualize pressure distribution within the tank due to sloshing
- Design suitable structural supports for the external surfaces of tank to control the sloshing

Applications

- Fuel tanks design for automotive, aerospace and LNG tank carriers
- Vehicle stability analysis during manoeuvring

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