**CFD analysis of liquid sloshing in fuel tank for a tanker truck manufacturer in USA**

**Industry**
Tanker Truck Manufacturing, USA

**Overview**
Hitech conducted CFD analysis using VOF (Volume of Fluid) model to predict liquid sloshing in tanker truck and deliver design analysis backed insights to optimize the tank design and selecting optimum spacing of baffles – if used. Analysis was carried out with and without baffles in the tank in order to study, compare, and reduce sloshing effect while the truck is in constantly accelerated linear motion.

**Business Needs**
- Optimize tanker truck structural design to withstand the motion
- Determine proper placement of baffles to reduce sloshing effect in tank
- Compare results of container with and without baffles to optimize design
- Reduce cost of physical destructive testing and design iterations

**Benefit**
- Effects of sloshing during the motion at regular time intervals after the automobile is set to motion [both acceleration and deceleration - during the application of brakes] helped the client set designs
- The results showed possibility of weight shifts that can lead to instability and affect the safety
- It further enabled the client to determine proper placement of baffles at appropriate locations in the tank to reduce the sloshing effect

**Client**
Leading tanker truck manufacturer from USA

**Challenges**
- Flammable fluid adds to the risk of explosion due to hydrodynamic pressure and load exerted by the free surface of the fluid in partially filled closed rectangular tank
- During the transportation, sloshing of fuel and accelerated motion of automobile threatens the structural integrity of the container
- Simulate high frequency flows to capture high frequency waves understanding interaction of fuel and air inside the container to optimize the design
- Time dependent variations in oscillating velocity of tank made it difficult to simulate and capture actual scenario
Hitech’s Advantage

- Value added design support solutions for product development to build high performance, competitive products
- Excellent project management skills, scalable execution capabilities, and deep domain expertise
- State-of-the-art modeling capabilities to restore dated design data, explore design alternatives, and revamp existing designs
- Global presence: U.S., UK, Australia, and the Middle East

Hitech’s Solution

- CFD experts at Hitech predicted liquid sloshing in tanker truck by conducting CFD analysis using VOF (Volume of Fluid) model along with realizable k-epsilon turbulence model. Dynamic mesh was utilized to capture oscillatory motion of the tank partially filled with water. Simulation was carried out for multiple tank rolling cases to capture water sloshing inside the enclosed rectangular tank. Results of the CFD simulation improved tank design by adding baffles and reduce the sloshing effect & ensured stability of the truck while in motion.

Approach

- 3D CAD model of the rectangular tank was prepared using SolidWorks and mesh model in ANSYS
- Hitech CFD experts developed a fluid domain and applied dynamic mesh
- Boundary conditions for fuel [kerosene] and gas [air] were applied for VOF [Volume of Fluid] model
- To capture turbulence effects, realizable k-epsilon model was selected
- Constant linear acceleration of 5m/s² was assumed to capture the flow physics and sloshing effect inside the enclosed tank assuming the initial rest state of fluid and automobile for both the cases of with and without baffles
- Mesh sensitivity analysis was also performed to ensure accuracy in the results

Client Speaks

"We were involved in the CFD/FEA analysis from other service provider for many years but finally we benefited from Hitech – they have so much to offer."

Hitech’s Solution

- CAD Model
- Mesh
- Case Set-up

Results

- Reduction in physical test trials which saved significant costs and development time
- Optimized tank design with baffles could be made for safety
- Ease in transit of carrier fluid without the risk of hazardous situations