

SLOSHING MONITORING AT SEA ON LNG CARRIERS



Photo: Christian Bräthen

Sloshing-induced impact load can cause a critical damage on a tank structure. Sloshing is especially troublesome in large LNG tankers of membrane type. To tackle the problem HULLMOS® Sloshing Monitoring System is provided in connection with Hull Monitoring System. The integrated systems provide warning and assistance to the crew in real time.



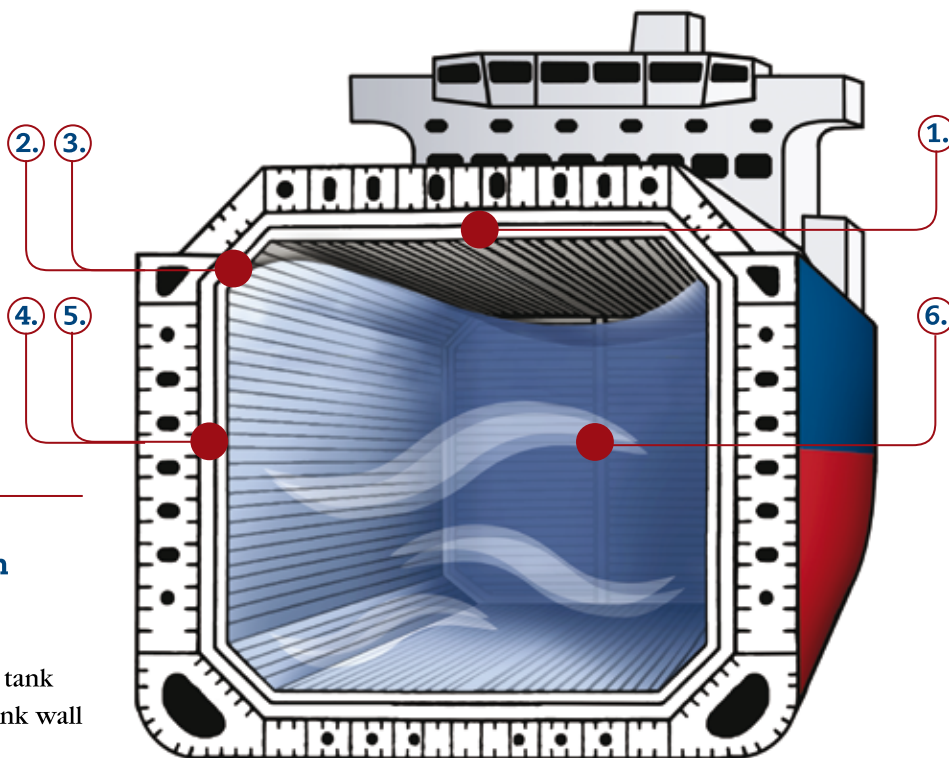
THE SLOSHING MONITORING SYSTEM PROVIDES IN REAL TIME:

- Detection of sloshing impacts on tank structures
- Prediction of sloshing occurrence
- Measurement of sloshing impact loads in correlation with ship motions
- Membrane Strain Control

1. PREDICTION OF SLOSHING RISK

Prediction provides a warning to the crew when sloshing is about to occur and actions to minimise problems need to be taken. Actions include change of the ship course with respect to waves, reduction of the ship speed or avoiding troublesome weather systems.

The risk of liquid sloshing in LNG tanks is evaluated by comparing frequencies of longitudinal and transverse motions with the resonance of the tanks. Motion frequency spectrum is determined by measuring roll and pitch motions as well as local longitudinal and transverse accelerations at each tank location. The tank resonant frequency can be tabulated for each filling level.



LNG SLOSHING

Example of sensor configuration

(Sensors installed on each LNG tank)

1. on tank top
2. (S) and 3. (P) on the upper part of the tank
4. (S) and 5. (P) on the mid part of the tank wall
6. on the transverse bulkhead

2. DETECTION IN REAL TIME OF SLOSHING OCCURRENCE

HULLMOS® Sloshing Monitoring System utilizes in detection the sound associated with liquid impact on tank walls. Use of sound detection is advanced approach for sloshing monitoring. The system utilises intrinsically safe accelerometers, fibre optic sensors and the signal conditioning unit.

The bandwidth of the sensors and the acquisition rate are high enough to detect transient signals. An acquisition and processing unit is provided with sensors. The system monitors, detects sloshing signal by comparison with preset thresholds, and stores the time of the sloshing event.

3. MEASUREMENT IN REAL TIME OF THE SLOSHING LOADS

The measurement is used for validation of model scale analyses. This correlates local loads and pressures in the tanks measured at full scale and at model scale. When performing correlation with model tests data, recording of ship motion and information on encountered sea state is utilised in connection with measured loads.

The integrated systems are used for monitoring strength and fatigue of the tank structure and assist the captain on board. Intrinsically safe HULLMOS® strain sensors are used for measuring strains in insulation boxes.

4. MEMBRANE STRAIN CONTROL

According to class rules for LNG vessels with membrane tanks, the hull girder strain limits need to be met in the design of the vessel. These limits control the minimum required hull girder section modulus.

HULLMOS® can beneficially be utilised in controlling strain levels and in maintaining the acceptable stress levels. Safe operation is clearly enhanced if the crew has knowledge about strain levels and sloshing loads on a ship hull.