Case study

Tank sloshing

THE CHALLENGE

Our client designs and manufactures gas turbines to be installed on the decks of floating oil production platforms, which provides the large quantities of power required for oil extraction. These systems are fitted with their own oil supply tank for cooling and lubrication. However, the motion of the boat can sometimes cause the oil to slosh around inside the tank, and in some instances, the oil intakes and the heater element in the sump may be uncovered. This can cause air to be drawn into the oil system resulting in damage to the turbine.

To mitigate this risk, Frazer-Nash was asked to analyse the current design to determine the movement of the oil inside the tank. The aim was to understand the limits of motion for which the unit will operate correctly and to ensure critical components were positioned to ensure maximum coverage.

OUR INVOLVEMENT

We began by establishing that the sloshing motion in the tank was time dependent, and affected by a number of factors, including:

- The amplitude and frequency of the pitching and rolling motion of the boat.
- The height and displacement of the tank from the centre of rotation.
- The geometric design of the tank and the position of internal obstructions, and
- The oil level in the tank.

To understand the interaction between all of these factors, we generated a computer simulation of the oil tank using three dimensional Computational Fluid Dynamics (CFD). We then simulated a range of motion to understand what was causing the components to be uncovered.

A complex mathematical model was developed to combine the effects of pitch and roll. The tank position relative to the centre of rotation of the vessel was also included. The mathematical model output a singe rotation vector which was then applied to the CFD model. This approach allowed a sensitivity studies to be undertaken, offering the client insight as the effect of different pitch and roll. Furthermore recommendations could be made as to the effect of different positions on the vessel.

Our evaluation showed that for the extreme motions modelled, the current design was not able to maintain oil coverage on the critical components. This was reported to the client, which allowed the component placement to be improved and tested before the unit was installed and run at sea.

Client

International power generation firm

Business need

Investigation into the effects of tank sloshing to ensure functionality of machinery in extreme sea conditions

Why Frazer-Nash?

Frazer-Nash has a strong expertise in fluid dynamics using state-of-the-art CFD analysis

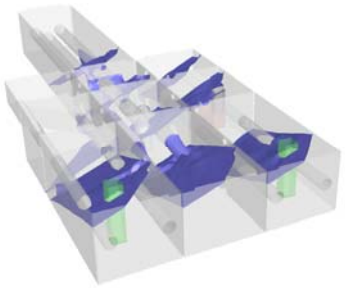

Figure 1: CFD image of the oil free surface showing the left compartments emptying.

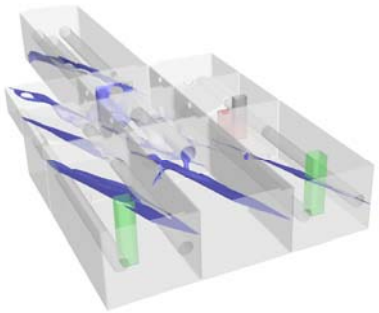

Figure 2: CFD image of the oil free surface at a later time, showing heater elements uncovered.

For more information, please contact **customercontact@fnc.co.uk** or visit **www.fnc.co.uk**

FRAZER-NASH CONSULTANCY