FLUID SLOSH STUDY IMPROVES SATELLITE EFFICIENCY

The Dutch satellite Sloshsat carried out an eight-day experimental mission in 2005, to gain insight into the complexities of fluid sloshing in space.

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Fluid loads aboard spacecraft display erratic sloshing patterns. Precision forecasts of these patterns are especially crucial during docking maneuvers and orbit adjustments. The Dutch Sloshsat satellite was launched on February 12, 2005, to gain better insight into and control over fluid motion in space. This is the first time that slosh experiments have been conducted on this scale. NLR initiated, developed and constructed its mini-satellite with financial support from ESA and the Dutch government.

The satellite conducted fluid motion experiments over a period of eight days. Twelve exterior control rockets were used to move Sloshsat in any given direction, at any given thrust. Gyroscopes and accelerometers offered full insight into the satellite's movements. Fluid sensors in the cylindrical tank recorded the exact position of the contents. Although these sensors proved not to be sufficiently precise, NLR was still able to gather 80% of the required data. The exact position of the fluid could also be indirectly concluded from this data.

The data obtained served to validate a computer model simulating fluid slosh patterns. Many of the results have already been compared with the ComFlo computer model developed by Groningen University. Initial conclusions indicate that, generally speaking, there is a correspondence between the model's calculations and the experimental data. However, especially in the case of high-speed fluid motion, the model has been shown to exaggerate the damping of the fluid's motion. At low satellite rotation speeds and when fluid motion is minimal, fluid adhesion to the tank walls has been found to be an important factor, due to the absence of gravity. The model is now being revised on the basis of the experimental data.

Groningen University's computer model should result in more efficient designs for spacecraft with fluid loads. Until now, satellite engineers have worked around the slosh problem.

The experimental data will also be utilized to develop a much simpler and faster model: the Sloshsat Motion Simulator. As this model does not require extensive computation, it can be easily integrated into the system that regulates the satellite's orientation in space. This allows the satellite to save fuel, and thus reduce the overall satellite weight at time of launch.