

Atout Process Ltd; Real Time Multi-Phase Mass and Density Measurement in zero gravity

Executive Summary

This document reports on a feasibility study into the application of Atout Process Electrical Capacitance Tomography (ECT) multi-phase imaging technology to zero g measurement of propellant (or oxidizer and other liquids). It was proposed that in zero g, the distribution of propellant in liquid and gas phases can be measured, displayed in 3D, with accurate determination of total mass.

ECT may be ideally suited to space borne liquid measurement applications. Measurements are independent of and unaffected by orientation or levels of g. The electronics and sensor arrays can be extremely low mass, and critically the technique does not dissipate heat into the propellant, which makes it intrinsically safe, and suitable for cryogenic liquids.

A number of future applications are proposed for ECT based systems, these include:

- Real time imaging of propellant within tanks, giving continuous true total mass indications, regardless of the distribution of gas and liquid enabling
 - Direct calculation of slosh torque exerted on spacecraft
 - Leak detection and location (e.g. caused by a micrometeorite penetration).
 - Long term fluid monitoring
- Real time metering of true mass during propellant transfer in zero g, enabling orbital and deep space refuelling between docked spacecraft.
- True multi-phase mass flow metering within a rocket motor, to enable the design of robust zero g start up motors without the need for settling impulse or positive displacement.

For this study terrestrial instrumentation designed for flow measurement was used. With a specially fabricated tank and some simple shake and orientation tests, basic feasibility and 2% accuracy has been demonstrated.