

## **An analysis of dissolved O<sub>2</sub> release from simulated Aviation Fuel using a Photochromic Technique**

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The propensity of aviation fuels to dissolve large quantities of atmospheric air has historically made the task of aircraft fuel system design, challenging. Reducing air pressure above the fuel surface promotes the release of dissolved air from the fuel. The rate of air release is primarily driven by the degree of fuel agitation. Under near-quiet conditions the rate of air release is slow; however, the effect of operating pumps and other fuel agitating equipment can lead to gases being released at high rates, sufficient to cause foaming. Air released from fuel can have deleterious effects on the performance and safe operation of a fuel system. The sudden release of air under certain conditions can very quickly lead to the formation of flammable fuel/air mixtures in the ullage space of fuel tanks. The instantaneous release of air within aircraft wing tanks has also led to fuel tank over-pressurisation issues. Despite ongoing efforts to manage the effects of released air within aircraft fuel systems many problems still exist.

To study this phenomenon a series of experiments were conducted using a Photochromic method. The Photochromic method relies on phosphorescence quenching of a pigment with oxygen and light irradiation. With low levels of O<sub>2</sub> dissolved in kerosene the pigment appears bright red under UV light, whilst an air saturated sample at ambient pressure appears dull pink. The method was selected as it allows in-situ sample measurement, giving a rapid analysis time, reducing error associated with sample removal. The method is very sensitive and allows detection of O<sub>2</sub> at low concentration levels (ppm). The experiments were conducted using apparatus which subjected agitated kerosene samples to a pressure-altitude range of 5000 to 45000 ft. Photodiode voltage shift, measuring phosphorescence intensity, as a function of time, provided data from which correlation with dissolved O<sub>2</sub> levels in the kerosene samples could be calculated. O<sub>2</sub> degas profiles of the kerosene samples over a range of pressure altitudes and agitation levels were obtained.

The results have indicated very clearly that the effects of reducing atmospheric pressure and increasing agitation yield a significant increase in O<sub>2</sub> evolution rate. The degas profiles were non-linear and exhibited asymptotic behaviour over time. Initial attempts to represent the degas profile with a first order exponential decay model have been largely successful, yielding satisfactory correlation coefficients.

Further work is planned to explore the effects of kerosene temperature on O<sub>2</sub> evolution rate under similar experimental conditions to further develop mathematical models.