Improved Method: Short-term Determination of Low Corrosion Rates in Hydrazines

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The NASA White Sands Test Facility (WSTF) must frequently assess the corrosion rates of materials proposed for the fabrication of aerospace systems wetted by fuels such as monopropellant hydrazine (MPH) and monomethylhydrazine (MMH). Corrosion rates describe the deterioration of a material caused by general corrosion, sometimes referred to as uniform corrosion, and can be used to predict the stability of metal/fluid systems over long periods of time. These rates can be determined by many methods, but only a few of them are suitable for use with hydrazine (N_2H_4) fuels; historically, they require months of immersion. Chemical characteristics such as toxicity, reactivity, low conductivity, and sensitivity to contamination by atmospheric carbon dioxide (CO_2) and moisture must be considered when working with N_2H_4 fuels. WSTF has addressed these issues using a method that combines relatively short immersion times with the high sensitivity afforded by inductively coupled plasma-mass spectrometry (ICP-MS).

Proposed materials, in coupon form with known surface areas, are immersed in the fluid of interest for several days. Immersion occurs in sealed vessels under a nitrogen pad to preclude atmospheric contamination. After 6 days, we remove the coupons and the fluid is evaporated. The immersion vessel is then rinsed with hot 5% nitric acid (HNO_3) to solvate corrosion residue. The HNO_3 rinsates are then analyzed by ICP-MS for elements specific to the coupon alloy. ICP-MS can detect elements in concentrations as low as parts per trillion. The ICP is depicted in figure 1.

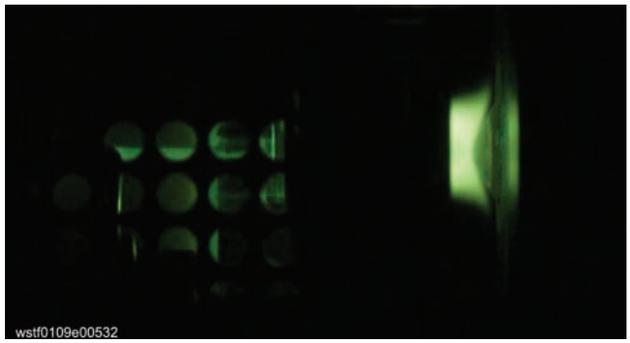

Fig. 1. *The ICP-MS.*

While other techniques require months to complete, this method allows for the determination of very low corrosion rates – on the order of 10^{-3} mil per year – in a matter of days. In addition, we have used this method to study the effects of fluid contaminants such as CO_2, water, and oxygen on corrosion rates by introducing known quantities of them into the immersion vessel. Finally, this method is not limited to MPH and MMH, but can be used for a variety fluids.

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