



## ENGINE TESTS WITH SATURATED PROPELLANTS

### SUMMARY

Spacecraft propulsion systems are often required to operate with propellants saturated with pressurant gas. This can negatively affect both engine and system performance. The NASA White Sands Test Facility (WSTF) maintains systems capable of rapid propellant saturation, verification of the gas saturation level, and capabilities for engine and system tests utilizing saturated propellants. These tests can be conducted over a wide range of conditions.

### BACKGROUND

During space flight operations, the on-board propellants can often become saturated with the pressurant gas. This condition can lead to frothing of the propellant and the accumulation of gas pockets in lines and filters due to a drop in system pressure. This can lead to a reduction in engine performance, a “soft” propellant system that is more susceptible to POGO and other feed line coupling, and can trigger engine instability as pockets of gas are swept into the combustion chamber. These problems are particularly prevalent in the lower pressure ranges using a blow-down pressurization scheme.

WSTF has developed procedures for saturation and verification of hypergolic propellants with inert gases to closely simulate in-flight conditions. These methods are reviewed in detail in the NASA Technical Note, NASA TN D-6249, “The Determination of the Helium Saturation Level of Aerozine-50 and Nitrogen Tetroxide.”

### PROCEDURE

Propellants are saturated by recirculation through a spray bar system in the high-pressure ullage gas in the propellant run tanks. Thermal conditioning can also occur during this recirculation. Saturation level is determined by drawing a sample into a lighted sight glass and slowly reducing pressure until bubbles are visible. This process can be done in real-time just prior to testing. Chemistry laboratory analysis of gas content is also available and has been used for periodic verification of the in-field method. Saturation level is maintained by sustaining desired pressure in storage and run tanks.

### CAPABILITIES

Test capabilities include the following:

- Propellants can be saturated up to 600 psi with helium or nitrogen
- Propellants can be temperature conditioned from 40 to 120 °F
- Maximum thrust capabilities – 25,000 lbf.
- Propellant capacities - up to 2000 gallon run tanks

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