April 1967

Brief 67-10058

NASA TECH BRIEF

Addition of Solid Oxidizer Increases Liquid Fuel Specific Impulse

The problem:

Hydrazine and similar fuels, while useful, exhibit undesirable properties of low specific impulse, high freezing point, low boiling point, and low density. To make such fuels more useful in low temperature bipropellant systems, it is necessary to improve these properties.

The solution:

The addition of solid oxidizers, commonly used in solid propellants, that are soluble in hydrazine and like fuels.

How it's done:

Ammonium perchlorate is dissolved in fuels such as hydrazine, UDMH (unsymmetrical dimethyl hydrazine), and Aerozine—a 1:1 mixture of hydrazine and UDMH. The addition of the oxidizer to hydrazine increases the standard specific impulse from 198 to 250 lbf-sec/lbm, lowers the freezing point from +35°F to the range of 0°F to −100°F, raises the boiling point from 236°F to above 270°F, and increases the density from 1.0 to about 1.4 g/cc, depending upon the proportion of ammonium perchlorate in the solution. Similar improvements result from addition of the oxidizer to UDMH and Aerozine. Maximum calculated specific impulses of 265 and 318 lbf-sec/lbm for standard and vacuum conditions, respectively, result from a solution containing 73% ammonium perchlorate and 27% hydrazine. The solution has a density of 1.56, but suffers the disadvantage of extreme sensitivity to impact. The following table presents the impact sensitivity of pure hydrazine and two solutions of ammonium perchlorate in hydrazine.

NH_4ClO_4 Wt. %	Sensitivity Value* = Potential Energy, kg-cm	Number of Tests	Explosion
0	300 Sensitivity value of pure N_2H_4 is above 300	15**	No
33.3***	120-126 121.5-126.5 Sensitivity value = 123	9 7	No Yes
50 50	5-120 5-150 Sensitivity value = approx. 40 (since the spread is too great the value is not accurate)	14 23	No Yes

*Impact sensitivity determined by the Drop-Weight Test ("Test No. 4") recommended by the JANAF Panel on Liquid Propellants. A sample in an amount of 0.03 cc, enclosed in a cavity (0.06 cc) and covered with a steel diaphragm, is exploded by puncturing the diaphragm with a piston onto which a weight is dropped from a certain height. The sensitivity value is the potential energy (height × weight) at which the probability of explosion is 50%.

**The impact tests with hydrazine alone include 10 tests with frozen N_2H_4 which performed in an apparatus for solid propellants.

***The freezing point of this mixture is below −100°F. At −30°F the viscosity of the mixture was low while at −100°F it was very high.

Note:

Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91103
Reference: B67-10058

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Frank J. Hendel
(JPL-861)