$$\frac{V_f}{V_p} = 1 - \frac{\left(\dfrac{S}{w}\right)\left(\dfrac{\sin(\varepsilon\pi/n)}{\cos(\bar{\theta}/2)} - \dfrac{f}{l}\right)^2}{\pi\left(1 + \dfrac{\sin(\varepsilon\pi/n)}{\cos(\bar{\theta}/2)}\right)^2 - \left(\dfrac{\sin(\varepsilon\pi/n)}{\cos(\bar{\theta}/2)} - \dfrac{f}{l}\right)^2\left(\dfrac{A_{p_i}}{w^2}\right)} \tag{5}$$

$$\frac{R_m}{w} = \left[\cos\frac{\varepsilon\pi}{n} + \frac{f}{l\sin(\bar{\theta}/2)} - \sin\frac{\varepsilon\pi}{n}\cot\frac{\bar{\theta}}{2}\right] \Big/ \left[\frac{\sin(\varepsilon\pi/n)}{\cos(\bar{\theta}/2)} - \frac{f}{l}\right] \tag{6}$$

References

[1] Vandenkerchkhov, J. A., "Internal Burning Star and Wagon-Wheel Designs for Solid Propellant Grains," USAF–ARDC Contract S.61(052) 58-13, 1958, Publication de l'Institut d'Aeronautique, Université Libre de Bruxelles.

[2] Barrère, M., Jaumotte, A., Venbeke, B. F., and Vandenkerckhove, J., "Rocket Propulsion," Elsevier Publ. Co., Amsterdam, 1960, pp. 301–308.

[3] Stone, M. W., "A Practical Mathematical Approach to Grain Design," *Jet Propulsion*, Vol. 28, No. 4, April 1958, pp. 236–244.

[4] Williams, F. A., Barrère, M., and Huang, N. C., "Fundamental Aspects of Solid Propellant Rockets," Technivision Services, Slough, England, 1969, pp. 211–221.

[5] Krishnan, S., "Characteristics of Neutral Burning Star Grains," AE-TN-R2, March 1974, Dept. of Aeronautical Engineering, Indian Institute of Technology, Madras, India.

Definition of Specific Impulse

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SPECIFIC impulse is a widely-used parameter in space vehicle performance computations. Although the concept is extremely simple it appears to have acquired a mystique that often baffles even those who frequently employ it.

An impulse imparted by an applied force T operating between times 0 and t is defined as

$$I \equiv \int_{s=0}^{s=t} T\,ds \tag{1}$$

If the force T is constant over the time interval, the impulse becomes

$$I = Tt \tag{2}$$

It is evidently a favorable performance characteristic to have a high value of I imparted to a vehicle by a motor. A price must be paid, however, and it is necessary to specify some expended quantity that results in the generation of I, so that I may be related to it in specific terms.

The motor thrust may be written

$$T = \dot{m}\bar{u}_e \tag{3}$$

where $\dot{m}$ is the propellant mass flow rate and $\bar{u}_e$ is the effective exhaust velocity. The equality in Eq. (3) necessitates the use of a Consistent System of Units in computations from this form of statement of Newton's Second Law of Motion.

If the mass flow rate is constant over the time interval t, the mass flow rate can be written

$$\dot{m} = (m/t) \tag{4}$$

where m is the mass of propellant expended.

We define specific impulse SI as the ratio of the impulse imparted to the vehicle to the mass of expended propellant.

$$\mathrm{SI} \equiv (Tt/m) \tag{5}$$

Combining Eqs. (3–5) we have

$$\mathrm{SI} = \bar{u}_e \tag{6}$$

We see that, provided we have used a consistent system of units, the specific impulse is simply the effective exhaust velocity. In trajectory analysis and computation the latter is the more convenient variable, the concept of specific impulse then becoming superfluous. This becomes immediately apparent when we note that the units for SI in the SI System of Units (The International System) are:

$$(\text{Newton}\cdot\text{sec/kg}) \equiv (\text{meter/sec})$$

In conclusion it must be emphasized that any gravitational force exerted on the expended propellant (i.e., the weight of the expended propellant) has no relationship to the generation of I. It is therefore a nonsense to make I specific in regard to the expenditure of propellant weight, at one standard Earth gravity or any other condition. Let us therefore consign the so-called "weight" definition of SI to the oblivion it has always deserved, and recognize that the "mass" definition of SI is simply the familiar parameter, the effective exhaust velocity.

Received June 19, 1974; revision received July 24, 1974.

Index categories: Lunar and Interplanetary Trajectories; LV/M Propulsion System Integration.

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Desorptive Transfer: A Mechanism of Contaminant Transfer in Spacecraft

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Introduction

CONTAMINATION in spacecraft has received much attention recently, particularly as it relates to contamination on critical optical surfaces. On such surfaces, contamination usually leads to increased absorption and scattering of light, which results in a degradation of the optical devices. For those surfaces that are exposed to the sun, such as solar cell covers and thermal control coatings, there is the additional effect of UV-irradiation of the contaminants, which may result in further optical changes. It can be readily appreciated that a film with a thickness of only a few hundred angstroms can affect the optical properties of a surface significantly.

The control of contamination requires an analysis of potential sources and transfer mechanisms. Likely sources include materials with appreciable vapor-pressure and the exhaust from engines. The mechanism of contaminant transfer commonly considered is an assumed line-of-sight transfer between source and collector. In this assumption, it is implicit that if an optical surface views only surfaces made of materials with negligible outgassing, then that optical surface will not be contaminated. It is the purpose of this Note to point out that desorption processes can lead to an apparent non-line-of-sight transfer. Thus, the optical surface mentioned above may very well receive contaminants generated elsewhere, with the surfaces that it views acting as transfer surfaces.

Received July 8, 1974. This work was supported by the U.S. Air Force Space and Missile Systems Organization (SAMSO) under Contract F-04701-73-C-0074.

Index categories: Spacecraft Temperature Control Systems; Thermal Surface Properties, Spacecraft Sterilization.

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