Technical Comments

Comment on "Definition of Specific Impulse"

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THE "weight" definition of specific impulse is too practical and hardy a concept ever to be consigned to the "oblivion" that Mr. Greenwood seeks.[1] This historical concept appears to be holding strong nearly two decades after a majority of the ARS Symbols Committee in effect recommended the same thing. Yet, if questions still remain about the definition, then they should be both aired and answered without resort to aspersions.

My personal experience with the concept—under a different name—goes back even further to the pre-WWII pioneering ARS test years. In a 1941 report of a refractory-lined rocket motor test, I called it the "index of performance."[2] The 8mm motion pictures of the pertinent test stand instruments (thrust, time, and liquid oxygen/alcohol tank weights) provided data showing this index reached a record value of "220, i.e., the reaction in lb, per lb of propellant mixture consumed per second."

The results of the hazardous ARS tests were practically the only source of technical information available to the press for the education of the lay public and the almost wholly hostile scientific community. We reported the corresponding gas velocity but this parameter meant nothing to the news reporters and science editors. However, they grasped the significance of the thrust to flow rate ratio at once as a highly

$$SI = \frac{T}{\dot{w}} = \frac{\text{lb}}{\text{lb/sec}} = \frac{N}{N/\text{sec}} = \text{sec}$$

descriptive design unit. They could visualize for their readers that a 1000-lb, or a 10,000-lb, or any flight vehicle weight could be sustained feasibly against the pull of gravity by supplying sufficient propellant flow rate. In addition, this index indicated substantial progress since its first low value of 115 was reported for the 1935 ARS tests.[3]

Received March 10, 1975.
Index categories: Liquid Rocket Engines; Solid and Hybrid Rocket Engines.

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In 1942, the same performance number, although calculated differently, was introduced at the NDRC Section H (H for Dr. C. N. Hickman, its Director of Research) Jet Propulsion Research Laboratory at Indian Head, Md. where my job was supervising static testing of the bazooka and other military solid powder rockets. The total impulse imparted to a strain gage was recorded as a thrust-time trace on 35mm film. This area impulse divided by the previously recorded weight of the solid propellant charge gave the weight specific impulse in lb sec per lb, or in reduced units of "seconds", as before. Any concern over variation of local gravity could be handled along with a host of other effects in the usual instrumentation error corrections.

A dimensional check easily refutes the implication of inconsistency for the engineering system units vs consistency for the metric system units. One must only demonstrate that the units remaining on the left and right sides of the equations are the same, after canceling. Similarly, consider the beautiful universal agreement of both systems in producing the identical reduced unit for weight specific impulse in seconds:

References

[1] Greenwood, S. W., "Definition of Specific Impulse," *Journal of Spacecraft and Rockets,* Vol. 12, Jan. 1975, p. 62.
[2] Africano, A., "The Africano Motor," *Journal of the American Rocket Society,* No. 50, Oct. 1941, p. 7.
[3] Africano, A., "Empirical Rocket Design Formulas," *Journal of the American Rocket Society,* No. 34, June 1936, pp. 2-5.

Errata

Ablation of Graphite in High-Speed Air Streams

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[JSR **12**, 251-253, (1975)]

EQUATION (2) is in error in that the first plus sign should be an equal sign. The equation should read

$$\tilde{K}_{0_e}/\tilde{K}_{0_w} = B' + 1$$

Received August 7, 1975.
Index categories: Material Ablation; Thermochemistry and Chemical Kinetics.