JOURNAL OF PROPULSION AND POWER
Vol. 24, No. 5, September–October 2008

Technical Comments

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Reply by the Authors to W. H. Heiser and D. T. Pratt

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DOI: 10.2514/1.37838

THE applicability of the simple formula in [1] (referred to as the Sato formula hereafter), shown as Eq. (22) in [2], was recognized in [2]. The Sato formula is unexpectedly accurate and useful. It should, however, be noted that the specific impulse predicted by the Sato formula diverges to infinity as the fueling fraction approaches zero. This is clearly unphysical, and the applicable parameter range of the Sato formula is unknown.

The physical meaning of the Sato formula can be explained by simple energetic considerations, as described in [1]. However, the explanation needs an important assumption that the thermal efficiency of a simplified pulse detonation engine (detonation tube) does not depend on the fueling fraction. The validity of this assumption was not proved, and in that sense, the Sato formula was called empirical in [1]. This assumption is probably not valid when the fueling fraction is small.

The performance of a simplified pulse detonation engine (detonation tube) is somewhat lower than that calculated by a thermodynamic analysis because part of the gas is exhausted with a high enthalpy in a simplified pulse detonation engine (PDE). Further, we have to be careful when the performance of a partially fueled PDE is evaluated by a thermodynamic analysis. In a partially fueled PDE, the partially filled inert gas is compressed by a strong shock wave and its entropy is increased. It is not easy to treat this entropy increase in a thermodynamic analysis. If this entropy increase is neglected, the evaluated performance will be the upper limit. And we suppose that this entropy increase lowers the thermal efficiency, which was assumed constant in the explanation of the physical meaning of the Sato formula.

References

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[2] Endo, T., Yatsufusa, T., Taki, S., Matsuo, A., Inaba, K., and Kasahara, J., "Homogeneous-Dilution Model of Partially Fueled Simplified Pulse Detonation Engines," *Journal of Propulsion and Power*, Vol. 23, No. 5, 2007, pp. 1033–1041. doi:10.2514/1.21223

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Received 2 April 2008; accepted for publication 6 April 2008.

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