Finally, it is not correct[3] to infer that the finite difference form of Eq. (2) is

$$\pi_K = \frac{\sigma_p + \pi_C}{1 - n} = \frac{1}{1 - n_B}\left[\frac{\ln(c_B/c_A)}{T_2 - T_1} + \ln p_A \frac{n_B - n_A}{T_2 - T_1} + \pi_C\right] \tag{13}$$

since Eq. (2) *can only involve* points A and C. The expression should be

$$\pi_K = \frac{\sigma_p + \pi_C}{1 - n} = \frac{1}{1 - n_C}\left[\frac{\ln(c_C/c_A)}{T_2 - T_1} + \pi_c\right] \tag{14}$$

since Eq. (7) eliminates the exponent term. On the other hand, the RHS of Eq. (13) is the correct expression[3] for Eq. (1).

Therefore, the two π_K equations are different. Equation (1) can predict rocket motor performance; Eq. (2) cannot. In summary, it may be concluded that the criticisms of Ref. 1 are incorrect.

References

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Comment on "Design of Axisymmetric Channels with Rotational Flow"

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KOUMANDAKIS et al.[1] have written an interesting paper on the "target pressure" problem. They use an inverse technique for the design of a duct with steady, inviscid flow. In particular, their paper deals with the subsonic, axisymmetric, rotational flow of a perfect gas, in which the Clebsch formulation is used.

The purpose of this Comment is to point out that the substitution principle[2] should provide a useful adjunct to their formulation. The two approaches appear to be complementary. For example, the basic assumptions are the same, both utilize the steady Euler equations for irrotational or rotational flows. Moreover, the substitution principle also uses a condition that is analogous to Eqs. (14) and (15) in Ref. 1. To the author's knowledge, the relationship between these two techniques has not been explored.

Since the substitution principle is not well known in fluid dynamics, we briefly outline this approach. The principle is a transformation of the dependent variables[2]

$$p = p_b, \qquad \rho = \lambda^{-1}\rho_b, \qquad h = \lambda h_b, \qquad w_i = \lambda^{1/2} w_{bi}$$

where p, ρ, h, and w_i are the pressure, density, enthalpy, and velocity components, respectively. A b subscript denotes an irrotational or rotational baseline solution of the steady Euler equations, which may be analytical, computational, or experimental. The unsubscripted variables represent a new, one-parameter family of solutions. The λ parameter must satisfy a streamline condition $D\lambda/Dt = 0$, where D/Dt is the substantial derivative. Typically, λ is the stagnation enthalpy or entropy, and to be useful, must vary in the directions transverse to the streamlines. If the flow contains shock waves, the additional restriction of a perfect gas is required. The new solutions satisfy the same wall-tangency condition as the original solution. Thus, the duct might first be designed for an irrotational flow.

While the principle holds for two-dimensional and axisymmetric flows, it also holds for three-dimensional flows that may contain supersonic regions with shock waves. Consequently, the principle may prove useful for obtaining three-dimensional solutions with or without shock waves, or for extending the number of such solutions.

References

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