Readers' Forum

Brief discussions of previous investigations in the aerospace sciences and technical comments on papers published in the AIAA Journal *are presented in this special department. Entries must be restricted to a maximum of 1000 words, or the equivalent of one* Journal *page including formulas and figures. A Discussion will be published as quickly as possible after receipt of the manuscript. Neither the AIAA nor its editors are responsible for the opinions expressed by the correspondents. Authors will be invited to reply promptly.*

Comment on "The Influence of Acceleration on Laminar Similar Boundary Layers"

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REFERENCE 1 presents a parametric study of compressible, self-similar boundary layers, employing the assumption of a constant density-viscosity product and Prandtl number of unity. The pressure gradient parameter β ranges up to 1000, wall/total enthalpy ratios range from 0.2 to 1, and elaborate correlations are presented on the basis of the claimed utility of the computed results.

It is the purpose of this Comment to point out that the highly simplified fluid properties used in Ref. 1 lead to irrelevant results, even with the limited utility of self-similar solutions. Further, the range of pressure parameters exceeds, by orders of magnitude, the values that could be found in actual engineering systems.

In a comprehensive parametric study aimed at illustrating the critical influence of fluid properties on highly accelerated boundary layers, Ref. 2 studied self-similar boundary layers with β ranging up to 20. It should be noted that at spherical and cylindrical stagnation points, the values of β are 0.5 and 1.0, respectively. Because of boundary-layer effects, even sharp junctions on hypersonic missiles indicate β's of about 5. Similarly, extremely short rocket nozzle throats have β's of the same order of magnitude. Calculations for values of β up to 1000 are therefore most unrealistic, and the use of $Pr=1$ and linear viscosity variation with temperature are unnecessary and inaccurate simplifications.

As an example of the critical influence of fluid properties on the surface shear stress parameter, Fig. 1 (Fig. 3a in Ref. 2) shows the influence viscosity-temperature relations for a range of β. In this figure, E is the Eckert number $u^2_e/(2H_e)$ and ω is the exponent in the viscosity-enthalpy relationship. The other terms are as defined in Ref. 1. Similar significant differences between the simplified case of $Pr=1$, $\omega=1$ used in Ref. 1 and more realistic variations are shown for the heat-transfer parameter in a range of β and the Mach number parameter E in Fig. 2 (Fig. 6 in Ref. 2). Any resemblance between the results of Ref. 1 and those of Ref. 2 must be viewed as coincidental.

It is now generally accepted that engineers have almost universal access to computers, and enormous gains have been made because of the enhanced computational capabilities. Demonstrations of abilities to use computers to solve relatively simple mathematical problems are no longer necessary. A redirection of the effort toward surveys of the literature and critical evaluation of the ultimate utility of the calculated results could produce more lasting contributions.

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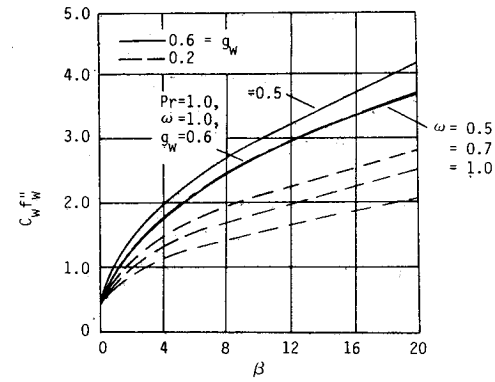

Fig. 1 Nondimensional shear stress as a function of β: effect of ω for $E=0$, $f_w=0$, $Pr=0.715$ unless otherwise specified.

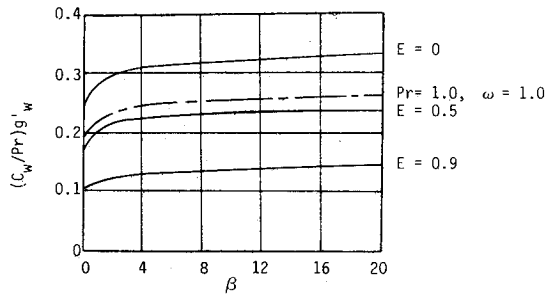

Fig. 2 Nondimensional heat-transfer rate as a function of β: effect of E for $g_w=0.6$, $f_w=0$, $Pr=0.740$, $\omega=0.5$ unless otherwise specified.

References

[1]Pade, O., Postan, A., Anshelovitz, M., and Wolfshtein, M., "The Influence of Acceleration on Laminar Similar Boundary Layers," *AIAA Journal*, Vol. 23, Oct. 1985, pp. 1469-1475.

[2]Wortman, A. and Mills, A. F., "Highly Accelerated Compressible Laminar Boundary Layer Flows with Mass Transfer," ASME Paper 70-HT/SpT-34: *Journal of Heat Transfer*, Ser. C., Vol. 93, Aug. 1971, pp. 281-289.

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WORTMAN'S criticism of Pade et al.[1] may be divided into two parts: 1) the simplifications used (the model fluid and the similarity solution) are so severe that the results

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