Comment on "Convective and Radiative Heat Transfer to an Ablating Body"

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THE treatment of the momentum equation in Ref. 1 is identical to that employed in Ref. 2, where additional details are presented. In this regard, boundary conditions are applied at the vehicle wall and immediately behind the shock. The shock-boundary conditions used are the usual Rankine-Hugoniot relations expressed by Eqs. (23) of Ref. 2.

The validity of these boundary conditions appears to be questionable for the following reasons. Physically, the Rankine-Hugoniot relations are valid only if the flowfield downstream as well as upstream of the shock is in translational equilibrium. Since the flowfield behind the shock is assumed viscous in Refs. 1 and 2, it is out of translational equilibrium. The Rankine-Hugoniot relations are therefore not strictly applicable here. Mathematically, Bush,[3] as well as Cheng,[4] has already ruled out the "viscous layer" regime, in which the viscous shock-layer equations are solved subject to the Rankine-Hugoniot relations at the outer edge.

A clarification of this point seems to be desirable.

References

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Reply by Authors to H. T. Yang

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PROFESSOR Yang has brought up an interesting and valid point on the use of inviscid boundary conditions in a viscous shock layer. He points out that "the Rankine-Hugoniot relations are therefore not strictly applicable here." The authors are well aware of this point (see Ref. 1); their reasons for considering the shock layer to be completely viscous in the subject paper were quoted in a previous paper (Yang's Ref. 2):

> An important physical mechanism in the shock-layer flow is the coupling between the inviscid and viscous regions created by radiant energy transfer. This coupling is taken into account by considering the entire flow region between the shock and the body simultaneously. The advantage of this approach is that it eliminates the necessity of matching the frequency dependent radiation flux at the inviscid-viscous interface.

The shock layer is considered to be viscous to avoid the tedious matching of the radiative flux, not because of low Reynolds number effects. In fact the Reynolds numbers are of the order of 10^5 to 10^6, based on nose radius, freestream velocities, and flow properties behind the shock.

Although the derivation of the thin shock-layer equations is based on the assumption that the shock layer is completely viscous, these equations are also applicable when the outer portions of the shock layer are nearly inviscid. The numerical results presented in the subject paper would not be significantly affected by the use of the proper viscous boundary conditions.

References

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Comment on "Radiation from Conical Surfaces with Nonuniform Radiosity"

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BOBCO[1] presents two graphs giving the shape factor from a receiver to a conical frustrum, shown in Fig. 1 and in Figs. 2–9. He indicates that these graphs can be fit with an exponential and that they can then be differentiated and inte-

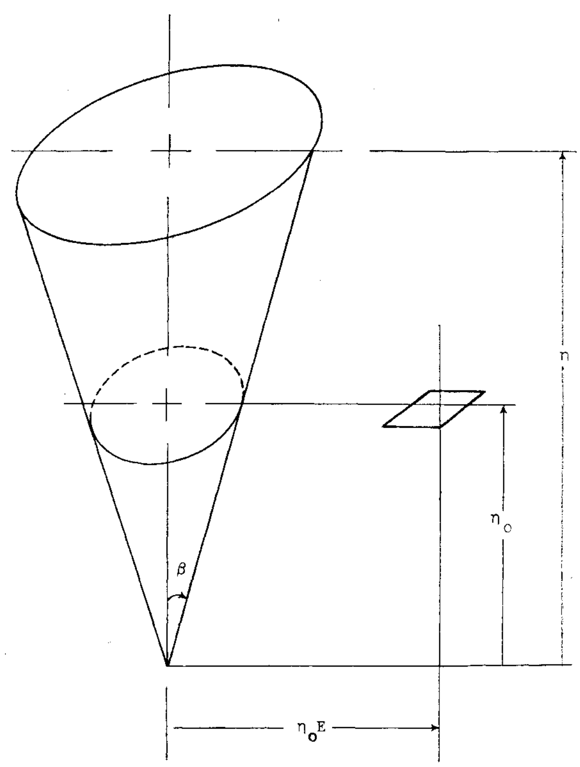

Fig. 1 Cone and receiver.

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