Int. J. Heat Mass Transfer. Vol. 8, pp. 1259. Pergamon Press 1965. Printed in Great Britain

LETTERS TO THE EDITORS

COMMENTS ON THE PAPER BY D. BRADLEY AND A. G. ENTWISTLE "DEVELOPED LAMINAR FLOW HEAT TRANSFER FROM AIR FOR VARIABLE PHYSICAL PROPERTIES"

(*Received* 21 *May* 1965)

THE Navier–Stokes equation for the case of vertically upward flow with cooling is given in the paper [1] as equation 1. It would appear that the buoyancy term in the form ($\rho g \beta \Delta T$) has been neglected in this equation.

Equations 13 and 14 also seem to neglect the buoyancy term as it affects the value of F.

With the buoyancy term included in the Navier–Stokes equation, I believe the velocity profile curves of Fig. 4 will be on the opposite side of the dotted curve. That is, all velocities near the center of the pipe will be higher than the values shown for the uniform property curve. The consideration of variable properties alone tends to flatten the velocity profile, while the consideration of buoyancy alone would elongate the profile. The net effect of both factors being applied is to elongate the profile since the buoyancy term has more effect percentagewise.

I would appreciate the authors' comments on the above-mentioned points.

REFERENCE

1. D. BRADLEY and A. G. ENTWISTLE, Developed laminar flow heat transfer from air for variable physical properties, *Int. J. Heat Mass Transfer* **8**, 621 (1965).

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AUTHORS' REPLY

(1) The variation of ρ with temperature in the "body force" term ρg in equation (1) gives rise to the buoyancy effect.

(2) The extent of the buoyancy effect is indicated by the magnitude of the Gr/Re ratio.

(3) Equation (13) is a definition of F. The derivation of $\bar{U}_m$ in equation (14) and its dependence upon free convection effects is described on p. 631.

(4) The buoyancy effect in the velocity profiles is shown in Figs. 11 and 17. There is indeed an elongation of the profiles, although it does not necessarily result in a centre-line velocity greater than the uniform property value.

The authors wish to point out a printing error on p. 624. The third line from the bottom of the page should give Gr/Re^2 not Gr/Re.

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DISCUSSION OF HEAT TRANSFER AND AIR FLOW IN A TRANSVERSE RECTANGULAR NOTCH

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FOX RECENTLY REPORTED [1] that Korst's treatment of heat transfer in separated flows "visualized an arbitrarily shaped cutout that contained a quiescent fluid at a uniform temperature and pressure". This is not correct.

An examination of the pertinent heat-transfer literature [e.g. 2, 3], including the references referred to by Fox [4, 5], attests that Korst never suggested that the wake temperature equal the wall temperature. In order to clarify this important point, the reader is also referred to a recent detailed summary of Korst's research in this area [6].

REFERENCES

1. J. Fox, Heat transfer and air flow in a transverse rectangular notch, *Int. J. Heat Mass Transfer* **8**, 269 (1965).
2. R. H. Page and H. H. Korst, Non-isoenergetic turbulent compressible jet mixing with consideration of its influence on the base pressure problem, *Proceedings of the 4th Midwestern Conf. on Fluid Mech.*, p. 45. Purdue Univ., Engineering Experimental Station, (1955).
3. R. H. Page and R. J. Dixon, Base heat transfer in a turbulent separated flow, *Proceedings of the 5th International Symposium on Space Technology and Science*, Tokyo (1963).
4. H. H. Korst, A. theory for base pressures in transonic and supersonic flow, *J. Appl. Mech.* **23**, 593 (1956).
5. H. H. Korst and W. L. Chow, Compressible non-isoenergetic two-dimensional turbulent ($Pr_t = 1$) jet mixing at constant pressure—auxiliary integrals—heat transfer and friction coefficients for fully developed mixing profiles, Univ. Ill., *ME-TN*-392-4, *OSR-TN*-59-380 (1959). Also *ME-TR*-392-5 (1959).
6. H. H. Korst, Dynamics and thermodynamics of separated flows, *Proceedings of Rutgers Engineering Centennial Seminars*, Bur. Engng. Res. Publication No. 45, Rutgers Univ. (1965).

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