It is also dangerous to deliberately use the elliptic operator to account for the entropy change of a full inviscid flow; the magnitude of those sinklike terms does not necessarily correspond to that of the total pressure loss determined by the Rankine–Hugoniot relations. The application of the new shock point operator introduced by Murman[1] should certainly be considered as more correct and consistent with transonic inviscid theory, even though its resulting solution deviates more from the experimental data. There are reasons to believe that the large discrepancy between the new solution and the experimental measurement is due to the inherent drawback of the transonic potential flow theory which excludes the effects of entropy change and viscosity.

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Reply by Author to T. C. Tai

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TAI discusses the effect of shock wave strength on shock wave location and offers results showing that a weaker shock wave will be farther forward on an airfoil, everything else being equal. To the author's knowledge, this trend agrees with all experimental and theoretical evidence. It is well known that different sets of governing equations approximating the Euler equations have correspondingly different shock jump relations which provide various approximations to the strength of a Rankine-Hugoniot shock wave. In addition, the shock wave strength will be altered by interaction with the boundary layer. The weakening of the shock wave calculated by the NCR method has no basis as a rational physical or mathematical model of any of these effects. Tai is correct in bringing additional attention to this fact and that the correct solution to the equations is provided by the FCR method.

Tai's concluding statement requires some qualification. The two examples he presents are subject to nonisentropic and strong viscous effects. The shock Mach numbers, M_s, in Figs. 1 and 2 are approximately 1.44 and 1.34, respectively, which exceed the usually quoted upper bound of 1.3 for validity of the isentropic assumption. The data in both figures are for a Reynolds number of $\sim 2\times 10^6$ and laminar or transitional type of shock wave boundary-layer interaction is indicated. In many aeronautical applications, it is desired to keep $M_s \lesssim 1.3$ to avoid separation of the boundary layer by the shock wave. Hence, a potential flow model should be useful for the inviscid flow calculations. In addition the Reynolds numbers are usually large enough to produce turbulent boundary layers and the shock wave boundary-layer interaction effects will be significantly less than those in Tai's example. Certainly an accurate model of viscous effects must be included in airfoil calculations to yield dependable predictions. In this regard it should be mentioned that the author[1] and others[2] have found that, in the absence of shock wave boundary-layer separation, the reduction in circulation per se below the inviscid value (using the Kutta condition) has a dominant influence on the entire pressure distribution including the shock wave location.

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Errata

Structure of Shock Waves in Cylindrical Ducts

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THE open circles in the upper part of Fig. 9 should be solid diamond symbols corresponding to case 3. The revised Fig. 9 is presented below.

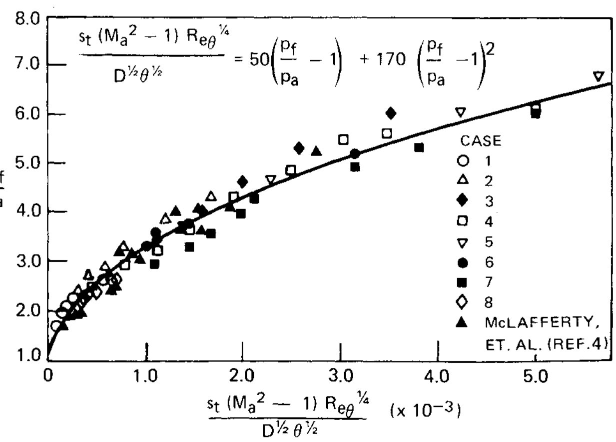

Fig. 9 Correlation of experimental data.

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