written while NAC was Jerome C. Hunsaker Visiting Professor in the Department of Aeronautics and Astronautics of MIT and the help of Ms. D. Parks in the MIT Gas Turbine Laboratory in preparing the diagrams is gratefully recorded.

References


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This paper adds to the literature some important data that can be used to help estimate the effects of leading edge contour on turbomachine performance. Although it provides guidance to designers who specify edge shapes, a more important use of these data will be in the assessment of the consequences of manufacturing imperfections and imperfections that result from injudicious rework of edges that have been damaged in service.

The authors show that the bluntness of a circular edge is harmful compared to that of a 1.89:1 ellipse, but in practice edges considerably blunter than circular may be encountered. Test results for such edges would be useful, but lacking these this discusser offers below a means to estimate them.

The extreme of bluntness is a square edge. It is reasonable to assume that the pressure distribution over such an edge, at subsonic Mach numbers, is nearly the same as that given by the Kirchhoff free-surface theory of the flow around a lamina placed normal to the stream; see Fig. 19. Since the pressure behind the lamina is ambient, the force on the lamina is equal to the integral of the pressure over the upstream face, and it is given by Lamb (1932) to be

\[ F = 0.440 \rho U^2 \]

A control volume analysis over the forward part of our square-edged plate (back to \( s = 17(t/2) \)) yields, if we assume that the net shear stress on the sides of the plate is negligible in that region,

\[ \rho U \theta = F/2 \]

yielding

\[ \frac{2\theta}{t} = 0.440 \]

for the square-edged case. This can be compared with 0.133 for the circular edge and 0.078 for the elliptic edge, obtained from Figs. 17 and 18 at zero incidence.

It is of interest to know what the loss penalty is for not having a "perfect" edge. An aerodynamically perfect edge would be one shaped such that there would be very little excess velocity at or near where the edge blends into the plate. Inspection of Fig. 12 suggests that, for the present test series, this condition is approached when the elliptic-edged plate is placed at an incidence between -1 and -2 deg, and in this range Fig. 18 gives approximately 0.06 for \( 2\theta/t \) accepting this as the "perfect edge" value, we then subtract it from the values given above for the three edges considered to obtain their \( \Delta \theta \) penalty values. The results are plotted in Fig. 20, where engineering judgment has been used to interpolate and extrapolate around the three data points. It is hoped that this will be useful when estimating the performance penalties associated with different degrees of bluntness.

References


Authors’ Closure

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