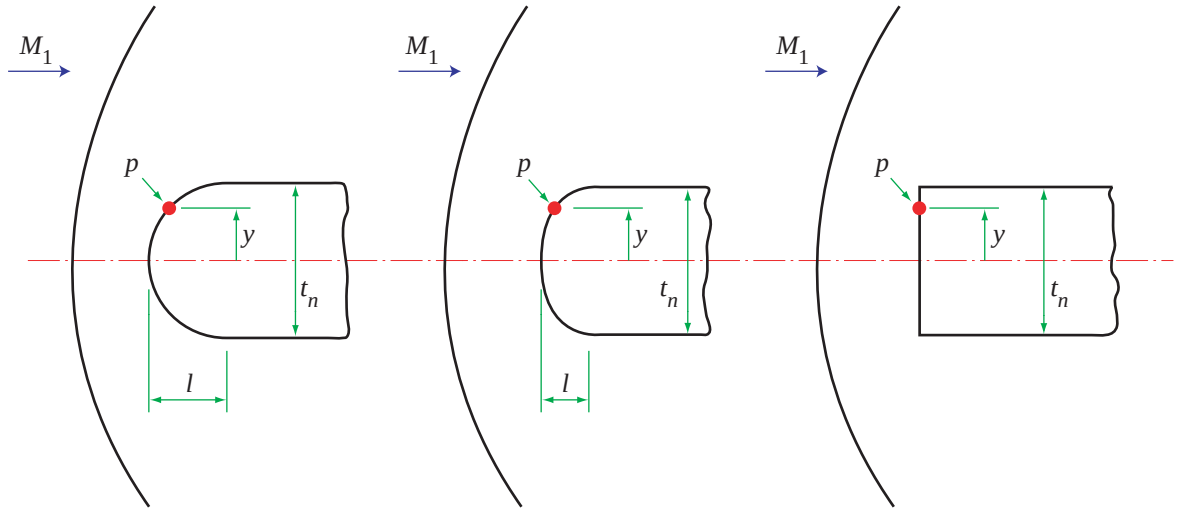
PRESSURE DISTRIBUTION ON BLUNT NOSES OF TWO-DIMENSIONAL SECTIONS AT ZERO INCIDENCE IN SUPERSONIC FLOW

1. NOTATION AND UNITS

		SI	*British*
C_p	static pressure coefficient, $(p-p_1)/\frac{1}{2}\gamma p_1 M_1^2$		
C_{pH}	total (or stagnation) pressure coefficient, $(p_{H2}-p_1)/\frac{1}{2}\gamma p_1 M_1^2$		
l	length of nose, see Sketch 1.1	m	ft
M_1	free-stream Mach number		
p	static pressure at point on nose surface defined by ordinate y, see Sketch 1.1	N/m^2	lbf/ft^2
p_{H2}	total (or stagnation) pressure behind normal shock wave with upstream Mach number M_1	N/m^2	lbf/ft^2
p_1	free-stream static pressure	N/m^2	lbf/ft^2
t_n	maximum thickness of nose, see Sketch 1.1	m	ft
y	thickness ordinate of nose, measured from centre line, see Sketch 1.1	m	ft
γ	ratio of specific heat capacities, taken as 1.4 for air		
Λ	sweepback angle of wing leading edge	degree	degree
ϕ	slope of nose surface at point defined by ordinate y, measured from free-stream direction	degree	degree



(a) $2l/t_n = 1.0$ (Semi-circular leading edge)

(b) $2l/t_n = 0.5$

(c) $2l/t_n = 0$ (Flat leading edge)

Sketch 1.1

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2. NOTES

Figure 1 gives the pressure distribution on the blunt noses of two-dimensional sections at zero incidence. The three leading edge profiles considered are:

(i) semi-circular $(2l/t_n = 1.0)$ see Sketch 1.1a,

(ii) semi-elliptical $(2l/t_n = 0.5)$ see Sketch 1.1b,

and

(iii) flat $(2l/t_n = 0)$ see Sketch 1.1c.

The values of p/p_{H2} for the semi-circular leading edge show a slight variation with Mach number as $y/t_n \to 0.5$, *i.e.* as the shoulder of the section is approached. The curve shown is given for a Mach number of about 2.0 (Derivations 1, 3, 5 and 7); for $M_1 = 1.0$ at $y/t_n = 0.5$ the value of p/p_{H2} is about 0.03 above that given by the curve whilst for $M_1 = 4.0$ the value is about 0.03 below the curve. Data given in Derivation 6 suggest that a further increase of Mach number to about 6.0 may reduce the value p/p_{H2} over the range $0.25 \le y/t_n \le 0.45$ to about 0.07 below the curve.

For nose shapes defined by $2l/t_n = 0$ and 0.5 results are available only over the range $1.0 \le M_1 \le 2.0$ (Derivation 5) and within this range the values of p/p_{H2} appear to be independent of Mach number. It is anticipated, however, that these two curves would apply with a satisfactory degree of accuracy at Mach numbers somewhat above the range covered by the experimental data.

The dotted portion of the curve for the flat nose shape covers a region where experimental pressure measurements are not available. This extrapolation has, however, been carried out in the light of other experimental evidence. It is anticipated that change in the shape of the section downstream of the shoulder would have only a small effect on the pressure in this region.

The value of p_{H2} corresponding to a free-stream Mach number M_1 may be determined either from Item No. Aero S.00.03.15, or from Derivation 4, or from the relation

$$\frac{p_{H2}}{p_1} = \left[\frac{\gamma + 1}{2\gamma M_1^2 - (\gamma - 1)}\right]^{1/(\gamma - 1)} \left[\frac{(\gamma + 1)M_1^2}{2}\right]^{\gamma/(\gamma - 1)}, \qquad (2.1)$$

which, with $\gamma = 1.4$, becomes

$$\frac{p_{H2}}{p_1} = \left[\frac{6}{7M_1^2 - 1}\right]^{2.5} \left[\frac{6M_1^2}{5}\right]^{3.5}. \qquad (2.2)$$

Due to the slight variation of p/p_{H2} with Mach number for the semi-circular leading edge, the drag due to pressure on this nose shape may be determined slightly more accurately by using Item No. Aero W.S.02.03.10 rather than by integration of the pressure distribution given by this Item.

It has been found that the pressure distribution on elliptic leading edges with values of $2l/t_n > 1.0$ cannot be represented by a single curve for a range of Mach numbers. For data over a limited Mach number range reference may be made to Derivation 5. However, for these and other nose shapes with values of $2l/t_n$

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