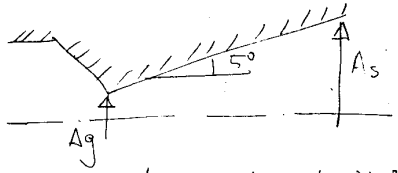
PROBLEMA 1 (IF) / PROBLEMA 1



$A_s/A_g = 2.25$

1 $\frac{A_s}{A_g} = \frac{1}{M_s}\left(\frac{2+(\gamma-1)M_s^2}{\gamma+1}\right)^{\frac{\gamma+1}{2(\gamma-1)}} \Rightarrow \begin{cases} M_s^{(1)} = 0.2684 \\ M_s^{(2)} = 2.3282 \end{cases}$

$\left(\frac{P_0}{P_s}\right)_{BS} = \left(1+\frac{\gamma-1}{2}M_s^{2(1)}\right)^{\frac{\gamma}{\gamma-1}} = 1.0513$ (1.05 *)

$\left(\frac{P_0}{P_s}\right)_{ADAP} = \left(1+\frac{\gamma-1}{2}M_s^{2(2)}\right)^{\frac{\gamma}{\gamma-1}} = 13.0682$

(figura *)

TABLAS flujo isentrópico $\Rightarrow$ $M_s^{(1)} = 0.2689$, $M_s^{(2)} = 2.3279$

A/A*	$M^{(1)}$	A/A*	$M^{(2)}$
2.317 - 0.26		2.193 - 2.30	
2.166 - 0.28		2.295 - 2.35	

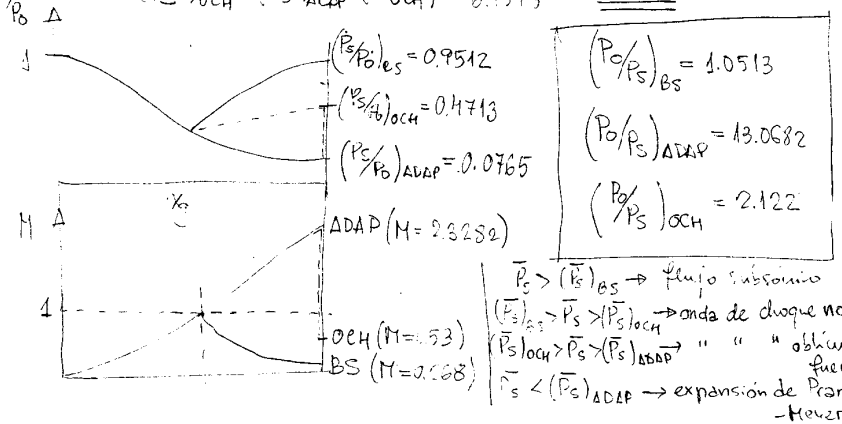
▷ ONDA DE CHOQUE A LA SALIDA $\begin{cases} P_1 = P_{ADAP}\ ;\ P_2 = P_{OCH} \\ M_1 = M_s^{(2)} \xrightarrow{\text{TABLAS}} P_2/P_1 = 6.1578 \end{cases}$

Figura: $\rightarrow \left(P_0/P_\infty\right)_{OCH} \simeq 2.125$

flujo isent $M_2 = 0.530$

2.30 - 6.005 0.5344
2.35 - 6.276 0.5266
P_2/P_1

$\left(\frac{P_0}{P_s}\right)_{OCH} = \left(\frac{P_0}{P_s}\right)_{ADAP}\left(\frac{P_{ADAP}}{P_{OCH}}\right) = \frac{13.0682}{6.1578} = 2.1222$



$\left(P_0/P_s\right)_{BS} = 1.0513$

$\left(P_0/P_s\right)_{ADAP} = 13.0682$

$\left(P_0/P_s\right)_{OCH} = 2.122$

$\bar{P}_0 > (\bar{P}_s)_{BS}$ → flujo subsónico

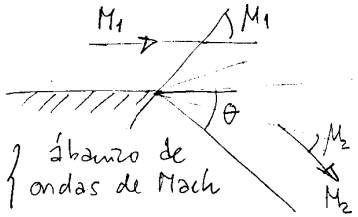
$(\bar{P}_s)_{es} > \bar{P}_s > (\bar{P}_s)_{OCH}$ → onda de choque normal

$(\bar{P}_s)_{OCH} > \bar{P}_s > (\bar{P}_s)_{ADAP}$ → " " " oblícua fuera

$\bar{P}_s < (\bar{P}_s)_{ADAP}$ → expansión de Prandtl-Meyer

2 $P_s/P_0 = 0.8\left(\frac{P_s}{P_0}\right)_{ADAP} = 0.0612$

$P_s/P_0 < \left(P_s/P_0\right)_{ADAP} \Rightarrow$ ondas de expansión de Prandtl-Meyer a la salida de la tobera (localmente planas)



2.30 - 34.28
2.35 - 35.53

$\begin{cases} M_1 = M_s^{ADAP} = 2.3282 \rightarrow \nu_1 = 34.985° \\ P_1/P_0 = \left(P_s/P_0\right)_{ADAP} = 0.0765 \end{cases}$

$\frac{P_2}{P_0} = 0.0612 \rightarrow M_2 = 2.4713$ (flujo isentrópico)

2.45 - 37.95
2.50 - 39.12

$\nu_2 = 38.448°$

$M_2 = \left\{\frac{2}{\gamma-1}\left(\left(\frac{P_2}{P_0}\right)^{-\frac{\gamma-1}{\gamma}} - 1\right)\right\}^{1/2} = 2.4713$

$(P_0/P_2 = 16.3398)$

$\theta = \nu_2 - \nu_1 = \boxed{3.463°}$

$\begin{cases} 2.45 - 15.81 \\ 2.50 - 17.09 \end{cases} \rightarrow M_2 = 2.4707$ (TABLAS)

3 $NPR = P_0/P_s = 2$ $\quad \left(P_s/P_0\right)_{OCH} < \frac{P_s}{P_0} = 0.5 < \left(P_s/P_0\right)_{BS} \Rightarrow$

$\Rightarrow$ onda de choque normal en el tramo divergente

gráfica $A_s/A_g = 2.25 \Rightarrow \frac{A_s}{A_{s_2}^*} = \frac{P_{0_2}}{P_0} \sim \boxed{0.6} \Rightarrow$ (TABLAS) $\Rightarrow$

0.6055 2.25 5.740 0.5406
0.5833 2.30 6.005 0.5344
P_{0_2}/P_{0_1} M_1 P_2/P_1 M_2

$\boxed{M_1 = \sim 2.25}$ $\quad \boxed{M_2 = 0.5406}$

$P_2/P_1 = 5.74$

$\boxed{A_{OCH}/A_g = 2.096}$

$M_1 \rightarrow$ TABLAS $\rightarrow P_0/P_1 = 11.56$; $\frac{P_2}{P_0}\frac{P_0}{P_1} = 5.740 \Rightarrow$

$\Rightarrow \boxed{\begin{array}{l} P_1/P_0 = 0.0965 \\ P_2/P_0 = 0.4965 \end{array}}$