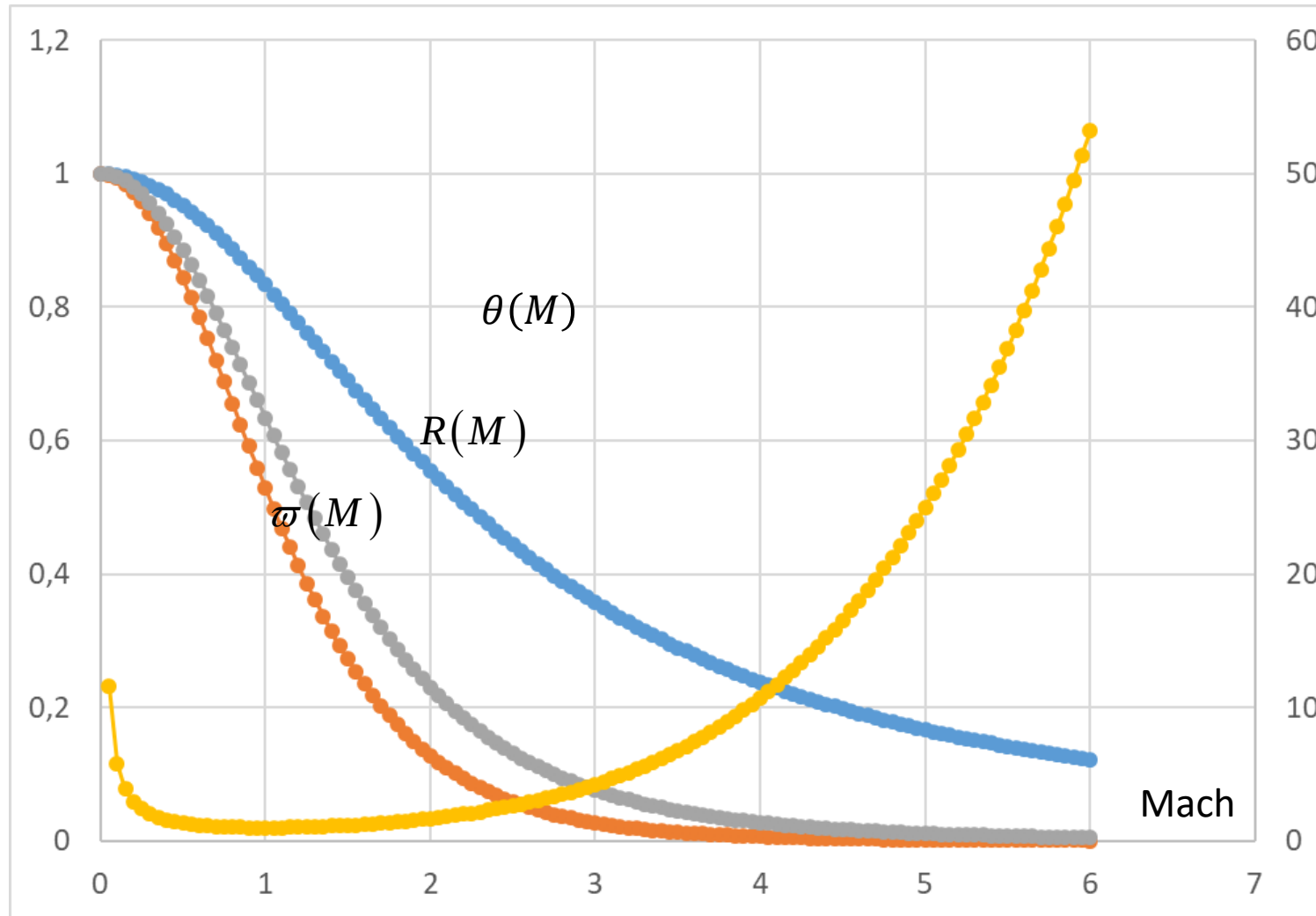


# Relations isentropiques



## Température

$$\theta(M) = \frac{T}{T_i} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{-1}$$

## Pression

$$w(M) = \frac{P}{P_i} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{\frac{-\gamma}{\gamma - 1}}$$

## Masse volumique

$$R(M) = \frac{\rho}{\rho_i} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{\frac{-1}{\gamma - 1}}$$

## Loi des aires

$$\Sigma(M) = \frac{A}{A_c} = \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma + 1}{2(\gamma - 1)}} \frac{1}{M} \left(1 + \frac{\gamma - 1}{2} M^2\right)^{\frac{\gamma + 1}{2(\gamma - 1)}}$$

# Utilisation des tables isentropique

| M   | $\varpi = \frac{p}{p_1}$ | $R = \frac{\rho}{\rho_1}$ | $\theta = \frac{T}{T_1}$ | $\Sigma = \frac{A}{A_c}$ |
|-----|--------------------------|---------------------------|--------------------------|--------------------------|
| .60 | .78400E 00               | .84045E 00                | .93284E 00               | .11882E 01               |
| .61 | .77784E 00               | .83573E 00                | .93073E 00               | .11767E 01               |
| .62 | .77164E 00               | .83096E 00                | .92861E 00               | .11656E 01               |
| .63 | .76540E 00               | .82616E 00                | .92646E 00               | .11552E 01               |
| .64 | .75913E 00               | .82132E 00                | .92428E 00               | .11451E 01               |
| .65 | .75283E 00               | .81644E 00                | .92208E 00               | .11356E 01               |
| .66 | .74650E 00               | .81153E 00                | .91986E 00               | .11265E 01               |
| .67 | .74014E 00               | .80659E 00                | .91762E 00               | .11179E 01               |
| .68 | .73376E 00               | .80162E 00                | .91535E 00               | .11097E 01               |
| .69 | .72735E 00               | .79661E 00                | .91306E 00               | .11018E 01               |
| .70 | .72093E 00               | .79158E 00                | .91075E 00               | .10944E 01               |
| .71 | .71448E 00               | .78652E 00                | .90841E 00               | .10873E 01               |
| .72 | .70803E 00               | .78143E 00                | .90606E 00               | .10806E 01               |
| .73 | .70155E 00               | .77632E 00                | .90369E 00               | .10742E 01               |
| .74 | .69507E 00               | .77119E 00                | .90129E 00               | .10681E 01               |
| .75 | .68857E 00               | .76604E 00                | .89888E 00               | .10624E 01               |
| .76 | .68207E 00               | .76086E 00                | .89644E 00               | .10570E 01               |
| .77 | .67556E 00               | .75567E 00                | .89399E 00               | .10519E 01               |
| .78 | .66905E 00               | .75046E 00                | .89152E 00               | .10471E 01               |
| .79 | .66254E 00               | .74523E 00                | .88903E 00               | .10425E 01               |

- Pour les nombres de Mach < 1

La page contient sur la partie supérieure et inférieure les tables isentropiques avec une progression continue du nombre de Mach.

- Pour les nombres de Mach > 1

La page contient deux tableaux :

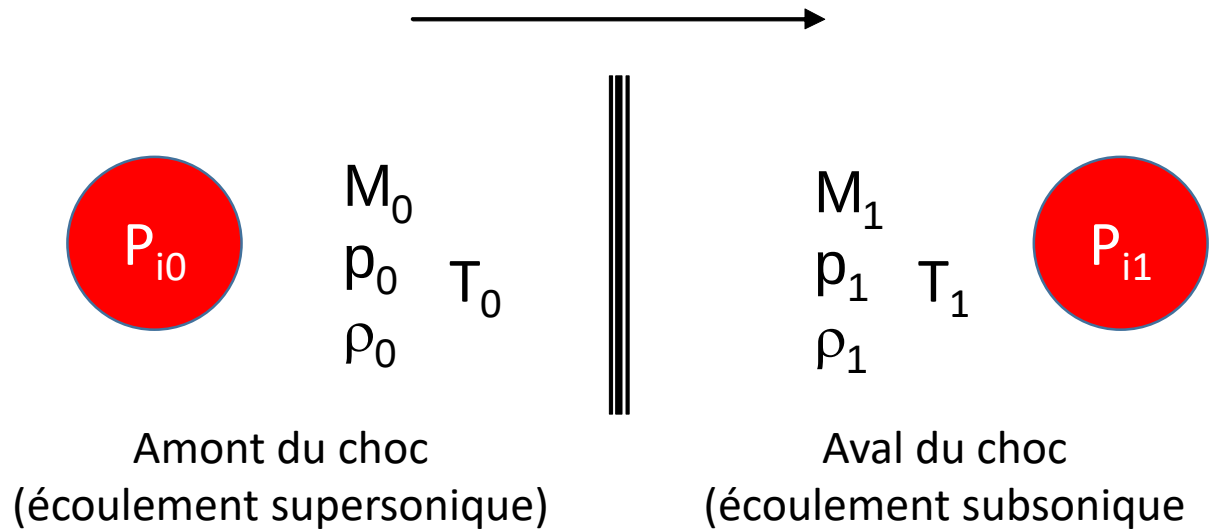
- celui de la partie supérieure correspond aux *tables isentropiques* pour les nombres de Mach indiqués
- celui de la partie inférieure correspond aux *tables de choc* pour les mêmes nombres de Mach

Exemple M=0,65

$$P/P_i = 0,752$$

$$\text{Si } P_i = 10^5 \text{ Pa} \rightarrow P = 75200 \text{ Pa}$$

# Relations relatives aux ondes choc



$$\frac{p_1}{p_0} = \omega(M_0) = \frac{2\gamma}{\gamma+1} M_0^2 - \frac{\gamma-1}{\gamma+1}$$

$$\frac{\rho_0}{\rho_1} = \frac{\gamma-1}{\gamma+1} \left[ 1 + \frac{2}{(\gamma-1)M_0^2} \right]$$

$$\frac{T_1}{T_0} = \theta(M_0) = \left( \frac{p_1}{p_0} \right) \cdot \left( \frac{\rho_0}{\rho_1} \right)$$

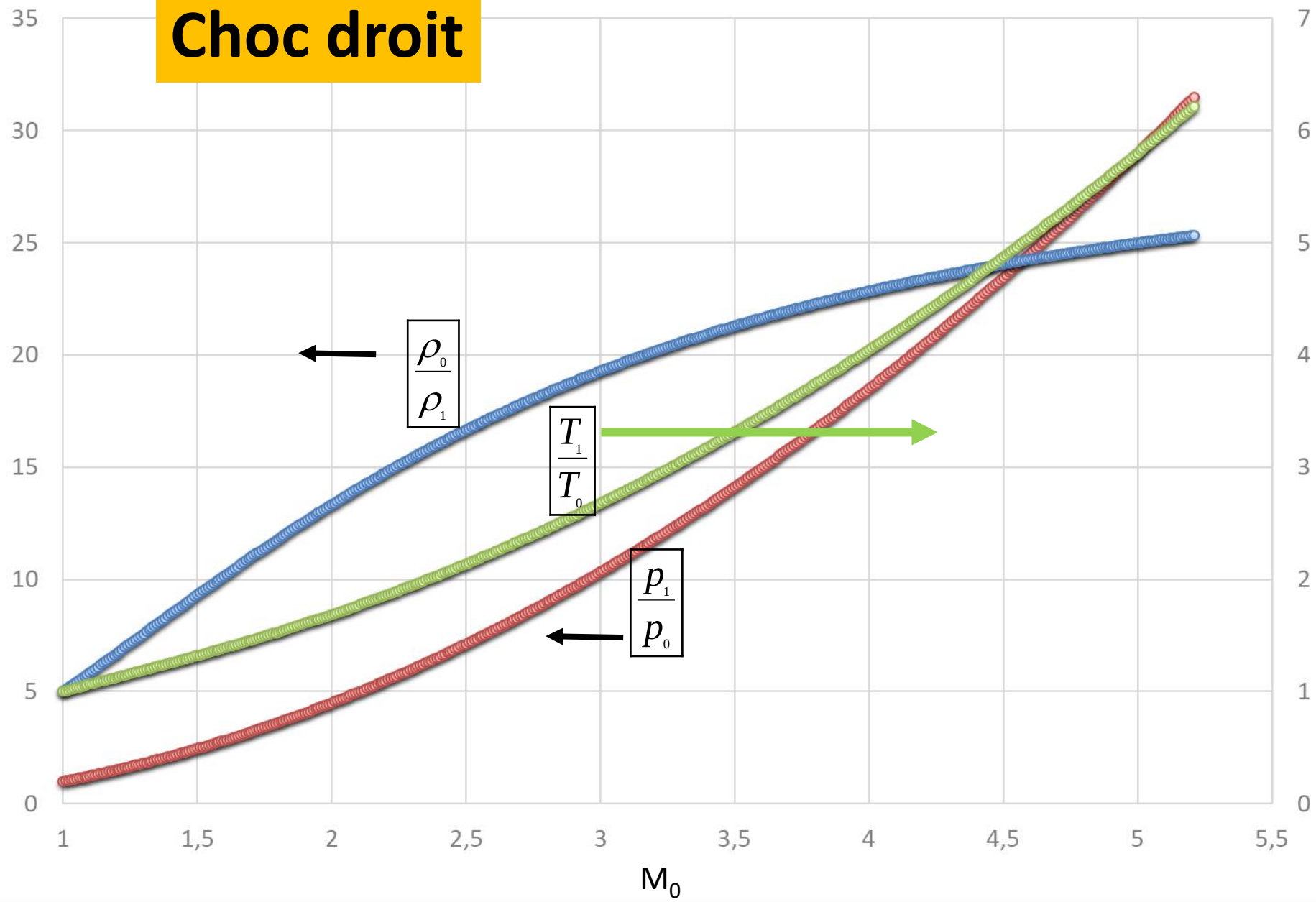
$$V_0 V_1 = c_c^2$$

$c_c$  : vitesse du son dans l'état critique



$$M_1^2 = \frac{1 + \frac{\gamma-1}{2} M_0^2}{\gamma M_0^2 - \frac{\gamma-1}{2}}$$

# Choc droit



# Utilisation des tables de choc

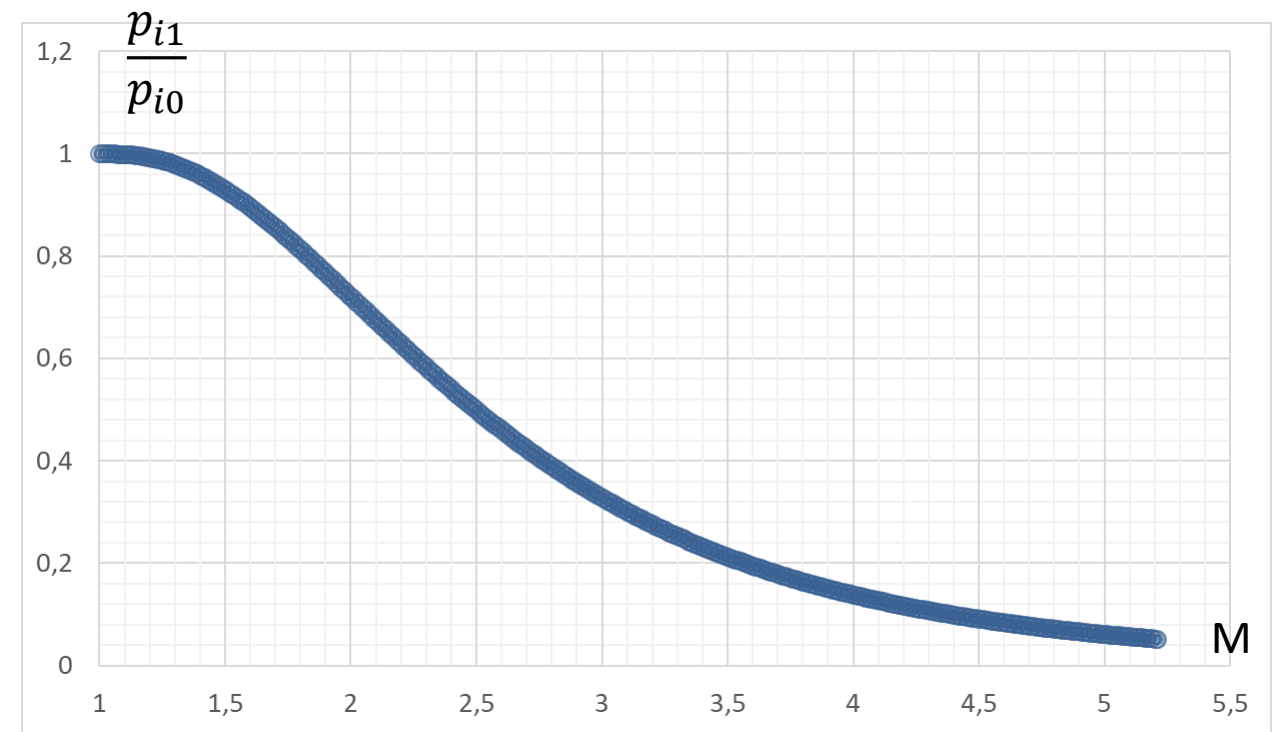
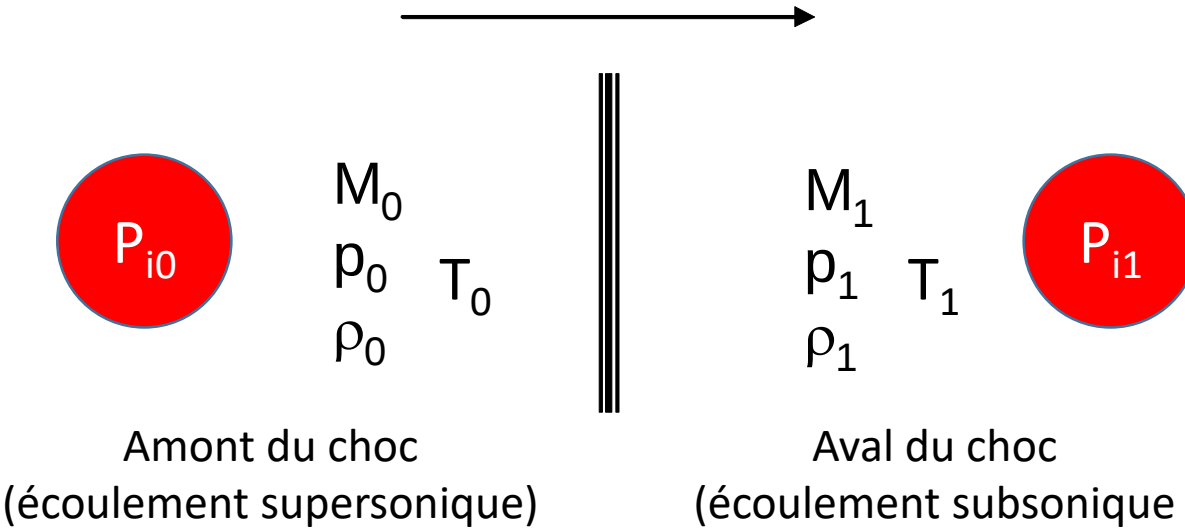
|          |       |        | Rapport des pressions génératrices | Rapport des pressions statiques | Rapport des masses volumiques | Rapport des températures |                      |        |
|----------|-------|--------|------------------------------------|---------------------------------|-------------------------------|--------------------------|----------------------|--------|
|          |       | $M_0$  |                                    |                                 |                               |                          |                      | $M_1$  |
| $\omega$ | $\mu$ | $Mn_0$ | $\frac{P_{11}}{P_{10}}$            | $\frac{P_1}{P_0}$               | $\frac{\rho_1}{\rho_0}$       | $\frac{T_1}{T_0}$        | $\frac{P_{11}}{P_0}$ | $Mn_1$ |
| 14.860   | 38.68 | 1.60   | .89520E 00                         | .28200E 01                      | .20317E 01                    | .13880E 01               | .38050E 01           | .6684  |
| 15.156   | 38.40 | 1.61   | .89145E 00                         | .28574E 01                      | .20485E 01                    | .13949E 01               | .38456E 01           | .6655  |
| 15.452   | 38.12 | 1.62   | .88765E 00                         | .28951E 01                      | .20653E 01                    | .14018E 01               | .38866E 01           | .6625  |
| 15.747   | 37.84 | 1.63   | .88381E 00                         | .29330E 01                      | .20820E 01                    | .14088E 01               | .39278E 01           | .6596  |
| 16.043   | 37.57 | 1.64   | .87992E 00                         | .29712E 01                      | .20986E 01                    | .14158E 01               | .39693E 01           | .6568  |
| 16.338   | 37.31 | 1.65   | .87599E 00                         | .30096E 01                      | .21152E 01                    | .14228E 01               | .40110E 01           | .6540  |
| 16.633   | 37.04 | 1.66   | .87201E 00                         | .30482E 01                      | .21318E 01                    | .14299E 01               | .40531E 01           | .6512  |
| 16.928   | 36.78 | 1.67   | .86800E 00                         | .30870E 01                      | .21484E 01                    | .14369E 01               | .40953E 01           | .6485  |
| 17.222   | 36.53 | 1.68   | .86394E 00                         | .31261E 01                      | .21649E 01                    | .14440E 01               | .41379E 01           | .6458  |
| 17.516   | 36.28 | 1.69   | .85985E 00                         | .31654E 01                      | .21813E 01                    | .14512E 01               | .41807E 01           | .6431  |
| 17.810   | 36.03 | 1.70   | .85572E 00                         | .32050E 01                      | .21977E 01                    | .14583E 01               | .42238E 01           | .6405  |
| 18.103   | 35.79 | 1.71   | .85156E 00                         | .32448E 01                      | .22141E 01                    | .14655E 01               | .42672E 01           | .6380  |
| 18.396   | 35.55 | 1.72   | .84736E 00                         | .32848E 01                      | .22304E 01                    | .14727E 01               | .43108E 01           | .6355  |
| 18.689   | 35.31 | 1.73   | .84312E 00                         | .33250E 01                      | .22467E 01                    | .14800E 01               | .43547E 01           | .6330  |
| 18.981   | 35.08 | 1.74   | .83886E 00                         | .33655E 01                      | .22629E 01                    | .14873E 01               | .43989E 01           | .6305  |
| 19.273   | 34.85 | 1.75   | .83457E 00                         | .34062E 01                      | .22791E 01                    | .14946E 01               | .44433E 01           | .6281  |
| 19.565   | 34.62 | 1.76   | .83024E 00                         | .34472E 01                      | .22952E 01                    | .15019E 01               | .44880E 01           | .6257  |
| 19.855   | 34.40 | 1.77   | .82589E 00                         | .34884E 01                      | .23113E 01                    | .15093E 01               | .45330E 01           | .6234  |
| 20.146   | 34.18 | 1.78   | .82151E 00                         | .35298E 01                      | .23273E 01                    | .15167E 01               | .45782E 01           | .6210  |
| 20.436   | 33.96 | 1.79   | .81711E 00                         | .35714E 01                      | .23433E 01                    | .15241E 01               | .46237E 01           | .6188  |
| 20.725   | 33.75 | 1.80   | .81268E 00                         | .36133E 01                      | .23592E 01                    | .15316E 01               | .46695E 01           | .6165  |
| 21.014   | 33.54 | 1.81   | .80823E 00                         | .36554E 01                      | .23751E 01                    | .15391E 01               | .47155E 01           | .6143  |
| 21.302   | 33.33 | 1.82   | .80376E 00                         | .36978E 01                      | .23909E 01                    | .15466E 01               | .47618E 01           | .6121  |
| 21.590   | 33.12 | 1.83   | .79927E 00                         | .37404E 01                      | .24067E 01                    | .15541E 01               | .48084E 01           | .6099  |
| 21.877   | 32.92 | 1.84   | .79476E 00                         | .37832E 01                      | .24224E 01                    | .15617E 01               | .48552E 01           | .6078  |

• Pour les nombres de Mach >1

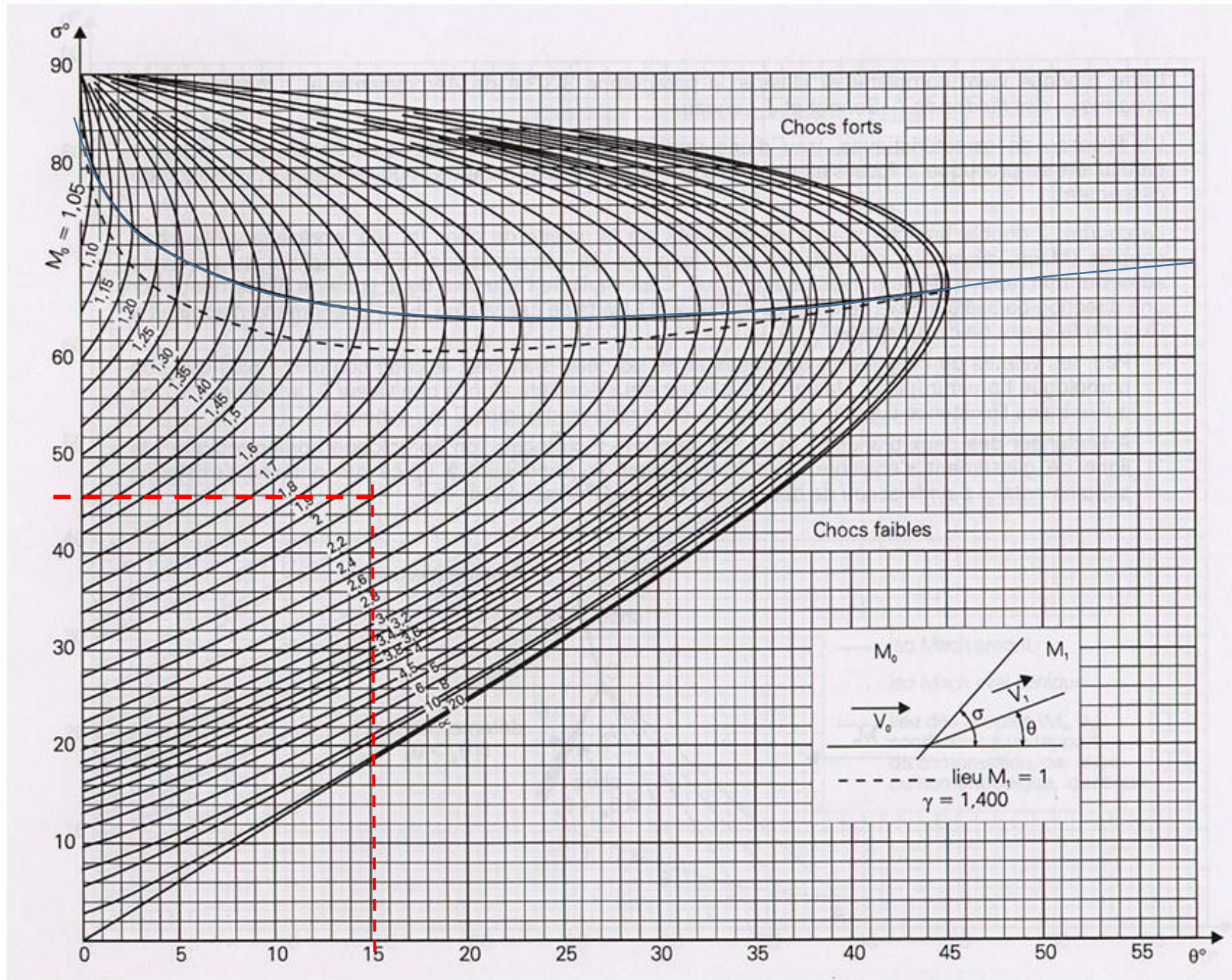
La page contient deux tableaux :

- celui de la partie supérieure correspond aux *tables isentropiques* pour les nombres de Mach indiqués
- celui de la partie inférieure correspond aux *tables de choc* pour les mêmes nombres de Mach

# Rapports des pressions génératrice



$$\frac{p_{i1}}{p_{i0}} = \pi(M_0) = \left(\frac{p_1}{p_0}\right)^{\frac{1}{\gamma-1}} \left(\frac{\rho_0}{\rho_1}\right)^{\frac{\gamma}{\gamma-1}}$$



Ex-

$M_0 = 2$   
 $\theta = 15^\circ$   
 $\rightarrow \sigma = 46^\circ$