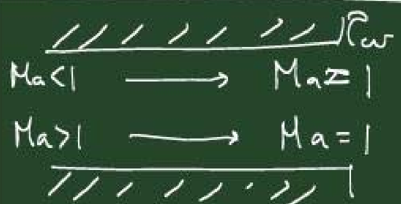
노트 제목 2010-05-27

- There was an explanation on the panel method to get the potential-flow solution.

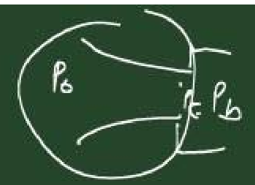


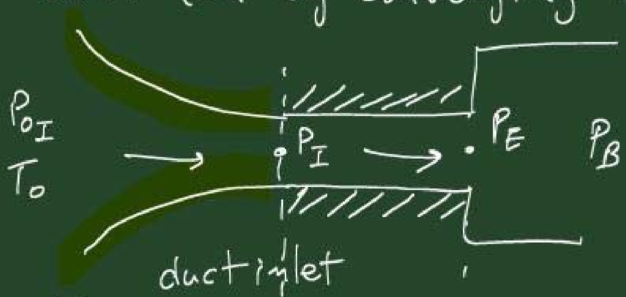
choking

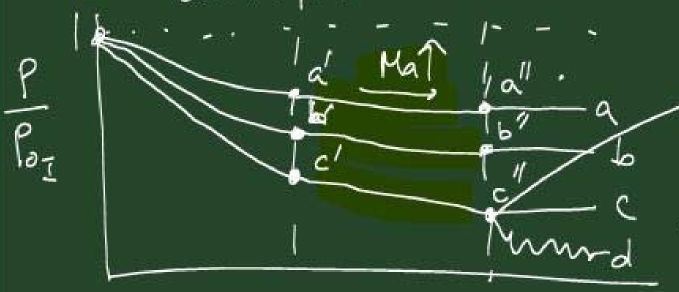
due to friction,

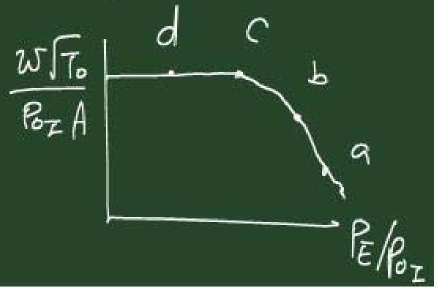
	M<1	M>1
p	↓	↑
M	↑	↓
V	↑	↓
T	↓	↑
ρ	↓	↑
p_0	↓	↓

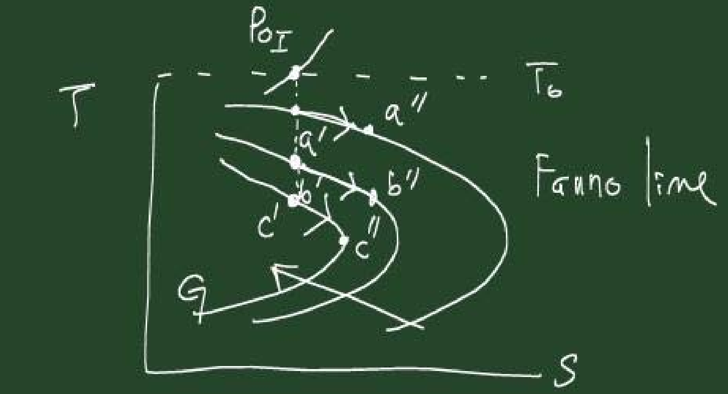
- Duct fed by converging nozzle



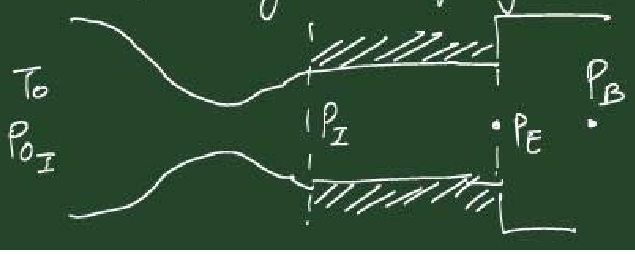








duct fed by converging - diverging nozzle



more complex than the converging-nozzle case.

2. Isothermal flow in long ducts

energy eq. $dQ = c_p dT + d\left(\frac{V^2}{2}\right) = c_p dT_0$

Isothermal $\ast T,\ T_0$ $\quad T_0 = T\left(1+\frac{k-1}{2}M^2\right)$

Take diff'l & $dT = 0$

$$\rightarrow \frac{dT_0}{T_0} = \frac{(k-1)M^2}{2\left(1+\frac{k-1}{2}M^2\right)}\frac{dM^2}{M^2}$$

Eq. of state $p = \rho RT \rightarrow \frac{dp}{p} = \frac{d\rho}{\rho}$ for $dT = 0$

Mach number $M^2 = \frac{V^2}{kRT} \rightarrow \frac{dM^2}{M^2} = 2\frac{dV}{V}$

$$\rightarrow \frac{dP}{P} = \frac{d\rho}{\rho} = -\frac{dV}{V} = -\frac{1}{2}\frac{dM^2}{M^2} = -\frac{kM^2}{2(1-kM^2)} \cdot 4f\frac{dx}{D}$$

$\left(f = \frac{\tau_w}{\frac{1}{2}\rho V^2} \right.$ and D : hydraulic diameter$\left. \right)$

$$\frac{dP_0}{P_0} = \frac{kM^2\left(1-\frac{k+1}{2}M^2\right)}{2(kM^2-1)\left(1+\frac{k-1}{2}M^2\right)}4f\frac{dx}{D} \quad \Rightarrow M = \sqrt{\frac{1}{k}}$$

$$\frac{dT_0}{T_0} = \frac{k(k-1)M^4}{2(1-kM^2)\left(1+\frac{k-1}{2}M^2\right)}4f\frac{dx}{D}$$

	$M < 1/\sqrt{k}$ (subsonic)		$M > 1/\sqrt{k}$ (subsonic supersonic)	
P	$\downarrow$		$\uparrow$	
ρ	$\downarrow$		$\uparrow$	
V	$\uparrow$		$\downarrow$	$\Rightarrow M \rightarrow \frac{1}{\sqrt{k}}$
M	$\uparrow$		$\downarrow$	
T_0	$\uparrow$	heat added to fluid	$\downarrow$	heat rejected from the flow
P_0	$\downarrow$		$\uparrow$	for $M < \sqrt{2/(k+1)}$
			$\downarrow$	$M >$ 〃

⊙ Flow in ducts with heating or cooling