ME 323: FLUID MECHANICS-II

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Lecture - 09

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Problems on Supersonic Nozzle Operation

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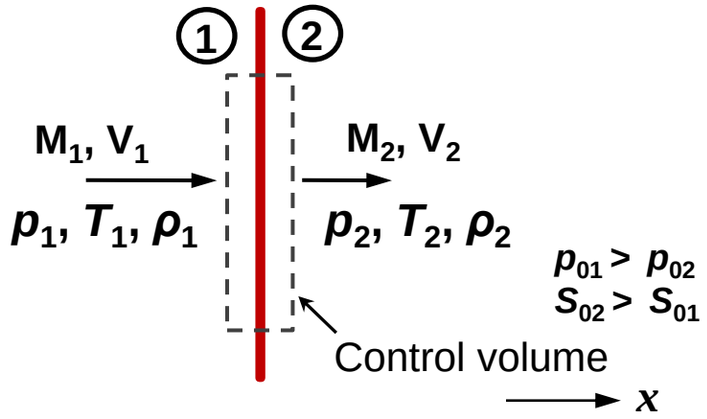
Normal shock relations

$$\Rightarrow M_2^{\,2} = \frac{(k-1)M_1^{\,2}+2}{2kM_1^{\,2}-(k-1)}$$

$M_2 = f(M_1)$

$$\Rightarrow \frac{p_2}{p_1} = \frac{2kM_1^{\,2}}{k+1} - \frac{k-1}{k+1}$$

$M_2 = f(M_1)$



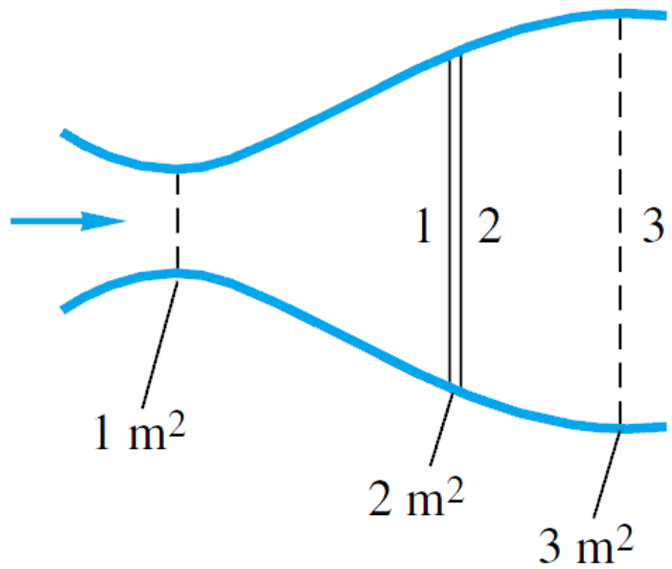
Normal shock wave

1. **Conditions just upstream of the shock**
2. **Conditions just downstream of the shock**

Problem

Air flows from a reservoir where pressure is kept at 300 kPa and T = 500 K through a throat to section (1) where there is a normal shock wave as shown in figure below. Compute:

a) p_1
b) p_2
c) Shock strength
d) Total pressure loss
e) p_{03}
f) M_3
g) p_3
h) NPR and Thrust at this condition (overexpansion/off-design)
i) Design NPR
j) Design thrust

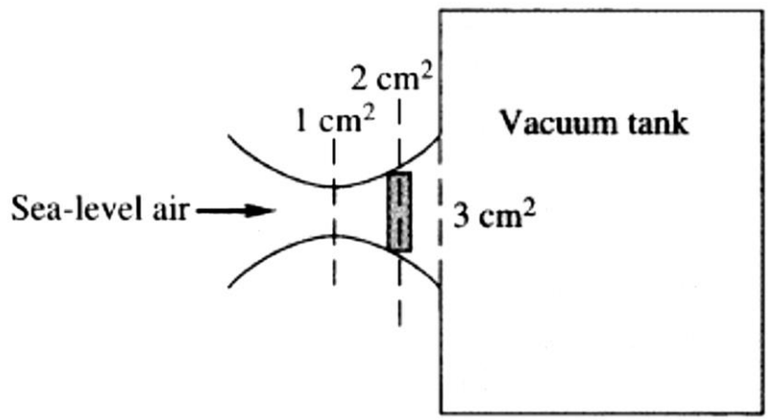


Solution:

Follow Class Note

Problem

Sea-level standard air is sucked into a vacuum tank through a nozzle, as shown in Fig. A normal shock stands where the nozzle area is 2 cm^2, as shown. Estimate (a) the pressure in the tank, and (b) exit Mach number, and (c) mass flow.

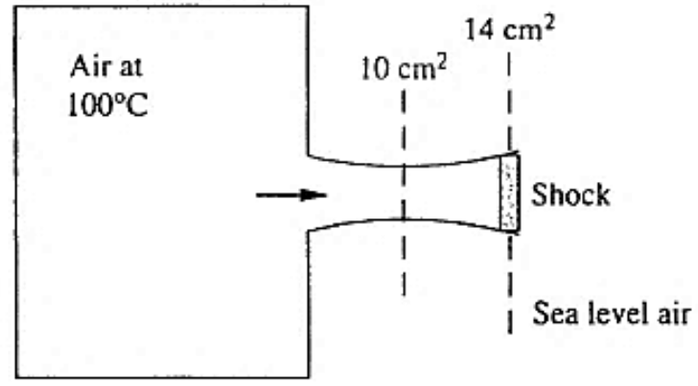


Solution:

Follow Class Note

Problem

Air flows from a tank through a nozzle into the standard atmosphere, as shown in Fig. A normal shock stands at the exit of the nozzle as shown. Estimate (a) the tank pressure, (b) exit Mach number, and (c) mass flow.



Solution:

Follow Class Note