Moving Normal shock waves-

In many Physical situation a normal shock is moving This arise when an explosion occurs, a shock wave propagates through the atomosphere from the point of explosion. when a value in a gas line is suddenly closed the point of explosion. when a value in a gas line is suddenly closed. The shock wave propagates back through the gas, to treat these case it's necessary to extend procedures that have already been develed for a stationary normal shock wave.

يسمى من العمق التي قبلها

static propárties are defined a those measured with an instrument which is moving at the absolute flow velocity therfore, static propertiesare independent of the obsorver velocity, at $V_a = 0$ (air at rest)

$$P_x = P_a , P_y = P_g , T_x = T_a , T_y = T_g \quad (*)$$

The velocity and Mach Number befor and after stationary normal shock wave -

$$V_x = V_s \mp V_{wall} \quad (1)$$
$$V_y = V_s - V_g \quad (1)$$

$$M_x = \frac{V_x}{\sqrt{KRT_a}} , M_y = \frac{V_y}{\sqrt{KRT_g}} \quad (2)$$

Hence

stagnation propertes are ~~[illegible]~~ measured by bringing the flow to rest with respect to the obser~~ll~~ver and therfor they are dopendent on the observer velocity (shock velocity).

$$T_{og} - T_{oa} = T_g - T_a + \frac{V_g^2}{2C_p} - \frac{V_a^2}{2C_p}$$

$V_a = 0 \quad T_g = T_y \;,\; T_a = T_x$

$$T_{og} - T_{oa} = T_y - T_x + \frac{V_g^2}{2C_p}$$

But across stationary normal shock

$$T_{ox} = T_{oy} = T_x + \frac{V_x^2}{2C_p} = T_y + \frac{V_y^2}{2C_p}$$

$$\therefore T_y - T_x = \frac{-V_y^2}{2C_p} + \frac{V_x^2}{2C_p}$$

if $V_{wall} = 0$ therfor $V_x = V_s \;,\; V_y = V_s - V_g$

sub. V_y and V_x

$$T_y - T_x = \frac{V_s^2}{2C_p} - \frac{(V_s - V_g)^2}{2C_p}$$

Therfor

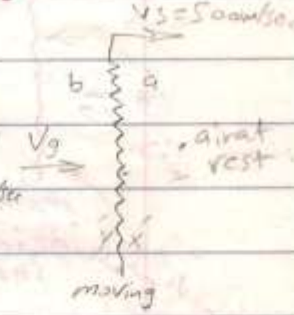
$$T_{og} - T_{oa} = \frac{V_s * V_g}{C_p}$$

① $(V_x = V_s)$ (لعدم وجود جزء) ① $(T_a = T_{oa})$

<u>Ex</u>: Normal (S.W) move at const. velocity 500 m/sec into still air with temp α air pressure 100 kP determine the static and stagnation condition $(P_g, T_{og}, \rho_g, T_g) = ?$ present in the air after pass of the wave?

(الموجودة) (مرور)

<u>Sol</u>:



$V_a = 0$ (air at rest) هواء ساكن

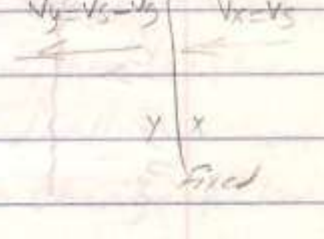
$T_a = T_x = 273\ K$, $P_a = P_x = 100\ kPa$, $V_s = V_x = 500\ m/sec$

$M_x = \frac{V_x}{\sqrt{KRT_a}} = \frac{500}{\sqrt{1.4 * 287 * 273}} = 1.51$

at M_x from table A3

$\frac{T_y}{T_x} = 1.327$, $\frac{P_y}{P_x} = 2.493$, $M_y = 0.6976$

$\frac{P_{oy}}{P_{ox}} = 0.9266$, $\frac{P_x}{P_{oy}} = 0.2898$



$T_y = 273 * 1.327 = 362.27\ K$

$P_y = 100 * 2.493 = 249.3\ kPa$

$P_{oy} = \frac{100}{0.2898} = 345\ kPa$

$P_{ox} = \frac{345}{0.9266} = 372.328\ kPa$

$V_y = M_y \sqrt{KRT_y} = 0.6976 \sqrt{1.4 * 287 * 362.27} = 266.15\ K$

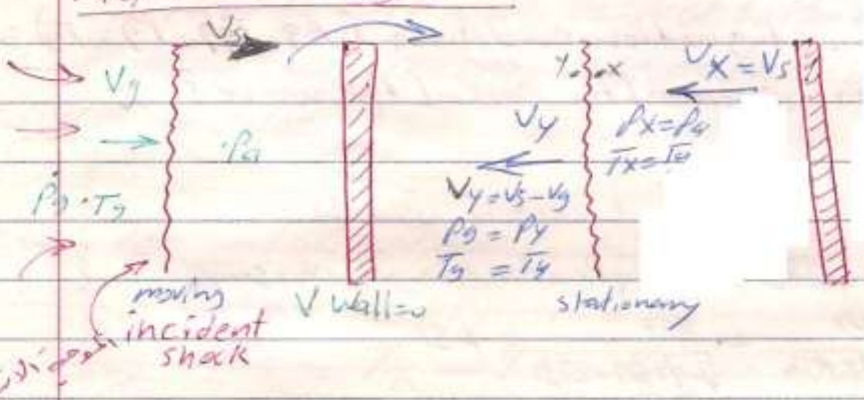
$V_g = V_s - V_y$ or $\frac{\rho_y}{\rho_x} = \frac{V_x}{V_y} = \checkmark$

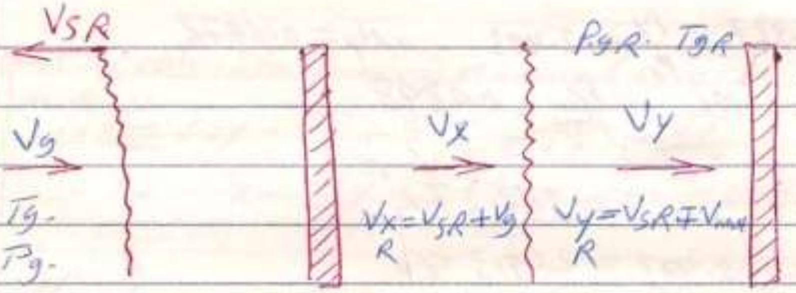
$= 500 - 266.15$ $\quad V_y = \checkmark$

$= 233.849\ m/sec$

المرتدة

Reflected Moving shocks:-





Q - 92 ← Page

find ① $V_{SR} = ?$, ② $P_{SR} = ?$

$V_{x_i} = V_s + V_{Piston}$

$$M_x = \frac{V_x}{\sqrt{KRT_x}} = \frac{V_s + V_P}{\sqrt{KRT_x}} = \frac{600 + 60}{\sqrt{1.4 * 287 * 300}}$$

from tables of shockwave at M_x find M_y =

$$\frac{V_x}{V_y} = \frac{\rho_y}{\rho_x}$$

$$\frac{V_x}{V_y} = \frac{\rho_y}{\rho_x} =$$

and $\frac{T_y}{T_x}, \frac{P_y}{P_x} = ,$

$P_{gi} = P_{xR}$

$V_y = \quad \Rightarrow V_g = V_s - V_y$

$T_y = T_{gi} = 1 \qquad \frac{P_y}{P_x} = \frac{P_g}{P_x} \Rightarrow P_g$

$$\frac{V_{xR}}{V_{yR}} = \frac{(K+1)M_{xR}^2}{(K-1)M_{xR}^2 + 2}, \quad M_{xR} = \frac{V_{xR}}{\sqrt{KRT_{gi}}}, \quad V_{xR} = V_{sR} + V_g$$

$$\frac{V_{sR} + V_g}{V_{sR} - V_p} = \frac{(K+1)\frac{(V_{sR}+V_g)^2}{1.4 * 287 * T_{gi}}}{(K-1)\frac{(V_{sR}+V_g)^2}{1.4 * 287 * T_{gi}} + 2} \therefore V_{sR} =$$

$$M_{xR} = \frac{V_{sR} + V_g}{\sqrt{KRT_{gi}}}$$

and from tables at M_{xR}

find $\frac{P_y}{P_x} = \frac{P_R}{P_g} \Rightarrow P_R = P_{sR} =$