القوانين المربعة

Chapter 5:-

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* (1) $\rho = \frac{m}{V}$

(2) $\rho = \frac{\dot{m}}{\dot{V}}$ → $\dot{m} = \rho \dot{V}$

compressible
$\upsilon \neq \upsilon$

لا تنسى

Ideal Gass

$$PV = mRT$$
$$P\dot{V} = \dot{m}RT$$
$$P\upsilon = RT$$

(3) $\dot{m} = \rho \forall A$ where $\forall$ is the Velocity.

(4) $\dot{V} = \forall A$

$\rho = \frac{1}{\upsilon}$

(5) at ((steady - state))

دائما $\dot{m}_{in} = \dot{m}_{out}$

[redacted]

في هذا الشابتر جميع الأجهزة (steady state) تكتبر

$\dot{V}_{in} \neq \dot{V}_{out}$ for comp.

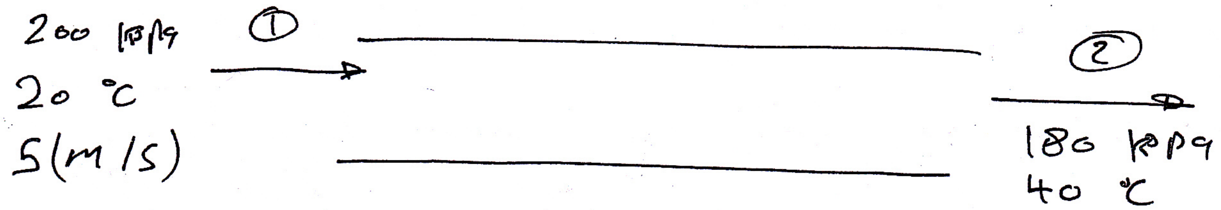
* Incompressible Flow: $\xrightarrow{\text{تكتبر}}$ (ρ, υ) is (Constant)

(liquids) water

* Area $= \frac{\pi}{4} d^2$ for circle
Area $= d * b$ for Rectangle.

in Incompressible
$\forall_{in} = \forall_{out}$

* **Example:-** Air enters a (28 - cm) diameter pipe steadily at (200 kPa) and (20°C) with a velocity of 5 (m/s). Air is heated as it flows, and leaves the pipe at 180 kPa and 40 °C. Determine (a) the Volume Flow Rate of air at the inlet, (b) the mass Flow Rate of air, and (c) the Velocity and Volume Flow Rate at the exit.



$\dot{Q} = \dot{m} \, C_p \Delta T$ for Ideal Gas only

turbin W_{out} only
compressor W_{in} only

(*) For Turbine and Nozzle and Compressor and Diffuser use this equation:- (2)

$$\dot{Q}_{in} + \dot{W}_{in} + \dot{m}(pe_1 + ke_1 + h_1) = \dot{Q}_{out} + \dot{W}_{out} + \dot{m}(pe_2 + ke_2 + h_2)$$

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$$\boxed{\dot{m} = \dot{m}}$$ ① ← لا خط

① adiabatic
② insulated → $\dot{Q}_{in,out} = 0$ اذا ②

$$\boxed{\dot{m} = \rho \forall A} \qquad \boxed{\rho = \frac{\dot{m}}{\dot{V}}}$$

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① Nozzle and Diffuser:-

(*) **Example:** Refrigerant − 134a enters a diffuser steadily as saturated vapor, at 800 kPa with a velocity of 120 (m/s), and it leaves at 900 kPa and 40 °C. the Refrigerant is gaining heat at a Rate of 2 (kJ/s) as it passes throught the Diffuser. If the exist area is (80%) grater than the inlet area Determine (a) the exist velocity and (b) the mass flow Rate of the Ref.

Hint: $\frac{A_{in}}{A_{out}} = \frac{1}{1.8}$

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turbine + compressor ⇒ inlet always superheated

Turbine and Compressor:- (Good Question)

Example: Steam Flows steadily through an adiabatic Turbine, the inlet conditions of the steam are 10 MPa. 450°C and 80 m/s and the exit conditions are 10 (kPa) 92 percent quality and 50 m/s. the Mass flow Rate of the steam is 12 (kg/s)

Determine:- (a) the change in Kinetic Energy.
(b) the power output and,
(c) the turbine inlet Area. $\dot{m}$

*Example: Carbone dioxide enters an insulated Compressor at 100 kPa and 300 °K at a rate of 0.5 (kg/s) and leaves at 600 kPa and 450 °K. Neglecting kinetic energy changes,

→ Determine: (a) the Volume Flow Rate of the Carbon dioxide at the Compressor Inlet

(b) the Power input to the Compressor.

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* Important hint:- $\Delta h = \frac{\Delta \bar{h}}{M}$

$\Delta u = \frac{\Delta \bar{u}}{M}$

Molar Mass

From $T_1 = 300\ K \rightarrow \bar{h}_1 = 9431\ kJ/kmole$

$T_2 = 450\ K \rightarrow \bar{h}_2 = 15483\ kJ/kmole$

this is an Ideal Gas:

$$Pv = RT$$

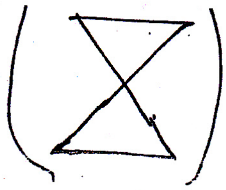
$$v_1 = \frac{RT_1}{P_1} = \frac{0.1889 * 300}{100\ kPa}$$

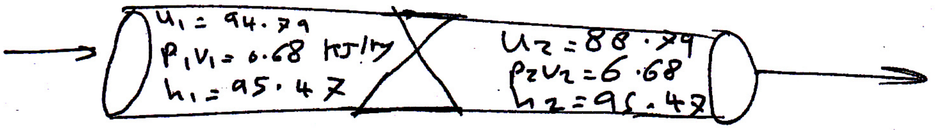
$$= 0.5667\ m^3/kg$$

$$\dot{V} = \dot{m} V_1 = 0.5 * 0.5667 = 0.283\ (m^3/s)$$

(b) $\dot{Q}_{in} + \dot{W}_{in} + \dot{m}(\quad) = \dot{Q}_{out} + \dot{W}_{out} + \dot{m}(\quad)$

⑤ throutling Value :-





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in throutling Value: $h_1 = h_2$ always

(*) only on Ideal Gas $T_1 = T_2$, $h_1 = h_2$

(*) Example Ref. R-134a at 800 kPa and 25°C
(1) is throuttled to a Temp. of −20°C. Determine
(a) the Pressure and the internal energy of the Ref at the final state.

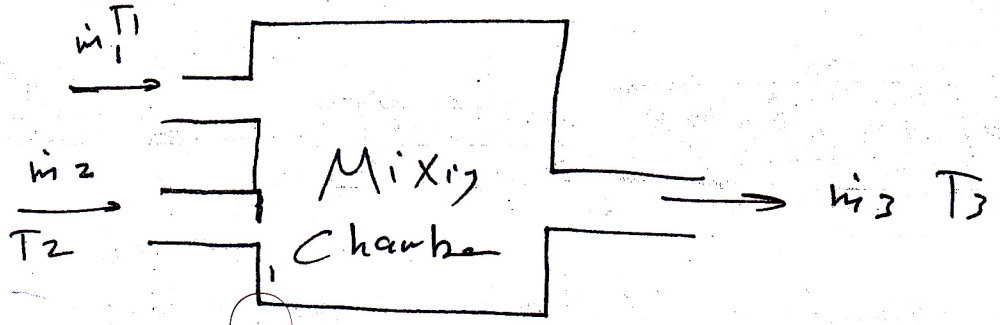
$$h_1 = h_2$$

T_2
h_2 $h_f \leq h_2 \leq h_g$
X_2

$$u_2 = u_f + x\,u_{fg}$$

finish

(4) Mixing chamber:-



$\dot{E}_{in} = \dot{E}_{out}$

في حالة الغرفة مغلقة ميكانيكية

$$\dot{M}_3 = \dot{M}_1 + \dot{M}_2$$

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3$$

(*) Example: A Steam at Ref. (134-a) is at 1 MPa and 12 °C is Mixed with another Stream at 1 MPa and 60 °C. If the Mass flow Rate of the Cold stream is twice that the hot one, determine:-

(a) the temprature and ~~Pressure~~ Quality at the exit Stream.