1 Center of Pressure:

→ objective: 1 C.O.P on the Rect. face of toroid.

2 Compare mesured Value and Theorit. Value

Pressure Force → $F = \rho g A y_c \sin\alpha = \gamma y_c A \sin\alpha$ $[m^2, Kg/m^3, m/s^2, m]$

($\rho g = \gamma$, $\sin\alpha = 1$)

Hidrostatic Force on surface — centroid.

depth of immersion is mesured by Hook gauge.

$$y_{cp} = y_c + \frac{I}{y_c A} \qquad I = \frac{bh^3}{12}$$

center of pressure position

→ Pratical Immersion: $b * h$ (العرض — ارتفاع الماء)

$y_c = \frac{y}{2}$

$y_{cp} = \frac{y}{2} + \frac{bh^3}{12(bh)(\frac{h}{2})} = \frac{2}{3}h.$

h (cm)	M (g)	Immersed Area	Theoritical Y_{cp} (cm)	exp Y_{cp} (cm)	M/h^2
				قانون طويل.	

→ Total Immersion: $h_p = (h - \frac{d}{2}) + \frac{bd^3}{12(bd)(h-\frac{d}{2})}$

y_c

h (cm)	M (g)	Theo. y_{cp}	exp. Y_{cp}	$(h - \frac{d}{2})$
			قانون طويل.	

→ Exp. Partially: $\Sigma M_o = 0$, $MgC = FL$, $h_c = \frac{h}{2}$, $A = bh$.

$I = \frac{bh^3}{12}$, ~~$L = (a + d - h + y_c$~~

$$\rho \left(\frac{h}{2}\right)(hb)\left(a + d - (h - h_p)\right) = mc$$

→ exp. total. $\rho (bd)(h - \frac{d}{2})(a + d - (h - h_p)) = mc$

بدنا الرسمة!

(2) Impact.

→ objective : [1] To determine the Force produced by water jet when it strikes a flat vane and a hemispherical cup.

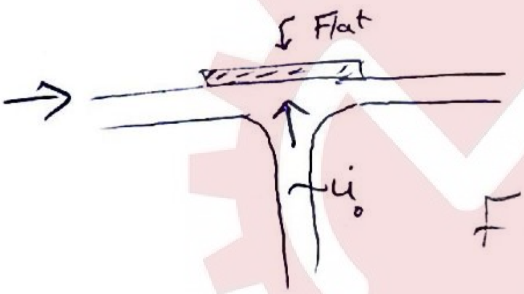
[2] compare measured value and Theo. value.

→ الاستخدامات : ① Pelton wheel to make flour.

② impulse turbine in first or second stag of steam Turbine

③ extinguish fires in high rise bulding.

④ cutting metal and debarring.



$F = \dot{m}(u_o - u_1 \cos\beta)$

$90°$ $180°$

$F = \dot{m} u_o$

$F = 2\dot{m} u_o$

$u \xrightarrow{\dot{m}} \text{cont. eq.}$ نوجدها

$u = \dfrac{\dot{m}}{\rho \frac{\pi}{4} d^2}$, $u^2 = u_o^2 + 2gS$, $S = 0.04$

$$\frac{u^2}{2g} + \frac{\cancel{P}}{\gamma} + \cancel{Z} = \frac{u_o^2}{2g} + \frac{\cancel{P_o}}{\gamma} + \cancel{Z_o}$$

$$u^2 = u_o^2 + 2gS$$

$F_{exp.} = 4g\,\Delta x$

→ الرسمة

Flat plate

m (kg)	t (s)	Δx (mm) انتبه mm	$\dot{m}$ kg/s	u m/s	u_o m/s	$\dot{m}u_o$ N	$F_{theo.}$ ($u_o \dot{m}$)	$F_{Exp.}$ ($4g\Delta x$)	Error.

راجع الرسمة

اثبات القوانين $F = 4g\,\Delta x$

→ $\Sigma M_o = 0$ كل

$\Sigma M_o = 0$ جد

3 Performance of a radial flow fan.

→ objective: the Performance of a radial flow rotor in air

1 forward 2 Backward 3 radial.

Pumping job.

→ speed not exceeding 3000 rev./min , roto Dynamic machine

→ Variable T, (H) ΔP, Q const. $\underline{N}$ speed

→ centrifugal machine → high pressure difference are required.

→ Example for multi stage fan → The air compressor for a jet engine

→ fan rise the pressure. @ const. velocity.

$$\Delta P = 98.1\,(h_3 - h_2) \quad N/m^2$$

$1\ bar = 10^5\ Pa$

$$Q = 1.006 \sqrt{\frac{h_1\, T}{P_a}}$$

h_1 → cm H_2O, T → K°, P_a → atm. pressure

$$\text{Power}_{air} = \overbrace{98.1\,(h_3 - h_2)}^{\Delta P}\, Q$$

$$\text{Power}_{shaft} = T\,\omega = \frac{F\,r\; 2\pi N}{60}$$

T = F r, r → cm, ω = $\frac{2\pi N}{60}$, N → rev./min

$$\eta = \frac{\text{Total Air Power}}{\text{shaft Power}}$$

→ variable speed D.C

→ measure the pressure by manometer

→ rotating element is impeller.

→ rotodynamic machiene.

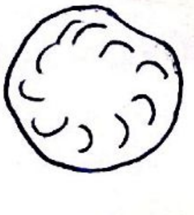
radial → multi radial. use to very high pressure

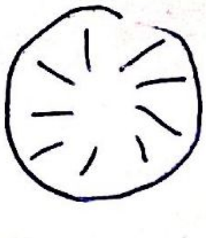
centrifugal (mix) → High pressre differance.

e.x Air compressor for a jet engine.

→ losses
ارجعلها من الرسمة
7.5

ارجع الرسمة





4] Comparison of Pump characteristics

(1) Positive (single cylinder double acting pump) displacement reciprocating pump.

(2) Centrifugal pump (horizontal).

→ Water Power (pump) $= \rho g \dot{Q} h_p 10^{-3}$ KW , $h_p = \dfrac{\Delta P}{\rho g 10^{-5}}$

$\Delta P = P_d - P_s$

→ Break Power $= 2\pi \omega F R 10^{-3}$ KW $= T\omega$

ω → rev/s , F → spring load ×9.81 = N , R → arm length

→ $\eta_o = \dfrac{\text{Water Power}}{\text{Break Power}}$ $\eta_v = \dfrac{\dot{Q}\ \text{measu.}}{\dot{Q}\ \text{calc}}$

→ $\dot{Q}_c$ $\xrightarrow{\text{For positive}}$ $\dot{Q}_c = 2 A_p L \omega$ → rev/s , $\omega = \dfrac{\text{motor speed}}{5}$

$\xrightarrow{\text{For Centri.}}$ $\dot{Q}_c = 0.06 \times 10^{-3}\, \omega$, $\omega = 2$ (motor speed).

→ we are measurement of speed, torque, $\dot{Q}$ Flow rate, Pressure

→ Pump work to add energy to the transport fluid.

→ Driving motor DC → max current 5 amp.

→ Apparatus Name: universal Pump Test.

Hydrolic pench 201

→ Positive → 0.45 liter/s output

→ Head 53 m

→ max speed 4 rev/s

→ $\dfrac{\text{motor}}{\text{Pump speed}} = \dfrac{5}{1}$

centrifugal

→ 0.75 liter/s

→ Head 4.06 m

→ maxspeed 12.5 rev/s

→ $\dfrac{\text{motor}}{\text{Pump}} = \dfrac{1}{2}$

	centrifugal	Positive.
$\dot{Q}$	High	low
h_p	low	High
presser	low	High
speed	High	low
uses	Home	industrial.
price	~~High~~ low.	High
type of flow	continuose	dis cont.
motion	Horizontal	reciprocating (vertical)

③ Hydrolic jump in open channel :-

$$E = y + \frac{q^2}{2gy^2} \qquad q = \frac{Q}{b = 7.62\,cm} \quad , \quad M = \frac{q^2}{gy} + \frac{y^2}{2} \text{ Per unit width}$$

$$Q = \frac{\dot{m}}{\rho t}$$

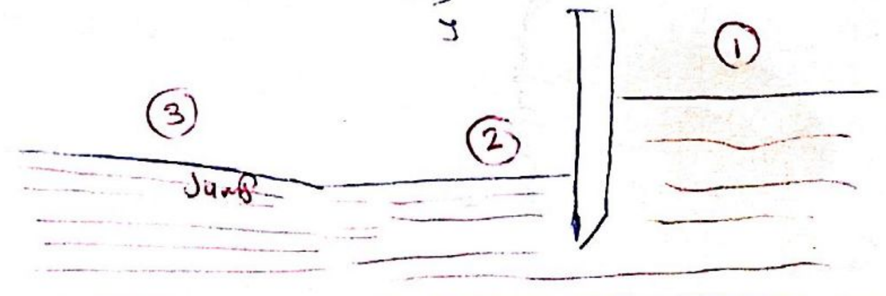
$E_1 = E_2$

$M_1 - M_2 = \frac{P}{\rho g}$ → Force

$M_2 = M_3$

$dE = E_2 - E_3$

Power in jump = $\rho g Q dE$



$$F_{r_2} = \frac{q}{\sqrt{g y_2^3}}$$

(5) losses in pipe :

→ objective: (1) Variation of friction facotor and Ry. No.

(2) total Head loss and Flow rate for the pipe. h_L and $\dot{m}\,\forall$

(3) loss coeff for each fitting.

→ loss in internal flow → major losses : shear stress → h_f — h_L

→ minor losses : fitting. Value, bends, elbows, .. → h_m

→ $\boxed{\text{major}}$ h_f :-

$$h_f = \boxed{f}\,\frac{L}{D}\,\frac{U_m^2}{2g}$$

main Velocity

h_f ↳ Darcy friction factor.

→ $\boxed{\text{minor}}$ h_m :-

$$h_m = \Delta h + \left[\frac{U_1^2 - U_2^2}{2g}\right] - h_f$$

Δh → $h_1 - h_2$

minor head less $K = \dfrac{h_m}{U^2/2g}$, U : Velocity in the smaller Pipe.

Pressure chang across each of the component is mesured by pair of Pressurized $\boxed{\text{Piezometer tube}}$

but in Value used $\boxed{\text{U-tube}}$ manometer containing mercury (Hg).

pipe made from copper

$\frac{\rho u d}{\mu} = \frac{u d}{\nu}$ → Re

* major [Dark blue].

No.	m kg	Time s	Δh = h_f m	h_3 m	h_4 m
1	7.5	29	–	–	–

No.	$\dot{m}$ Kg/s	V m/s	Re	type	f
				laminar Turbulent	

* minor [light blue]

No.	m (Kg)	t (s)	Expantion			Contraction			bend J			bend A			bend G.			U tube		
			7	8	Δh	9	10	Δh	11	12	Δh	13	14	Δh	15	16	Δh	h_1	h_2	Δh

Scanned by CamScanner

$\Delta K = 0$ $\quad$ $h_f = 0$, $\Delta K = 0$

No.	$\dot{m}$ kg/s	Re $\frac{\rho V d}{\mu}$	f	Expantion			Contraction			Bend			Globe Value		
				Δh	h_f	h_m	Δh	h_f	h_m	Δh	h_f	h_m	Δh	h_f	h_m

$$h_m = \Delta h + \underbrace{\left[\frac{V_1^2 - V_2^2}{2g}\right]}_{\Delta KE} - h_f \qquad f\,\frac{L}{D}\,\frac{V^2}{2g}.$$

(6) Flow Visualization :-

④ * Performance of turbine:

→ used to extract mechanical power out of fluid at high pressure or high elevation.

→ working fluid → water → hydraulic Turbine.
→ gas → gas Turbine.
→ air → $\boxed{\text{air Turbine}}$.

impulse

completely expands in the Nozzle of the stator and hits the rotor @ High speed and High impuls.

Reaction.

fluid expantion in the Nozzle of the stator and other part in the rotor.

$$\text{Ratio (degree of reaction)} = \frac{\text{ex. rotor}}{\text{ex. whole}}.$$

$$P_{mech} = \omega T, \quad \omega = \frac{2\pi n}{60} \; (n \text{ in rev/min}), \quad T \text{ in N.m}$$

$$P_{hyd} = P_d \dot{V}, \quad P_d \text{ in (Pa)}, \quad \dot{V} \text{ in } m^3/sec$$

$$\eta = \frac{P_{mech}}{P_{hyd.}} \times 100\%$$

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