

Fluid Machinery & Steam Generator

Francis turbine

- Area of flow $A_{f1} = K \pi D_1 b_1$
- Discharge through the runner $Q = A_{f1} V_{f1}$
- Hydraulic power $[HP = \rho g Q H]_{\text{wh}}$
- Runner power when v_{w1} is in direction of u_1
 $R.P = \frac{\rho g Q}{\rho} [v_{w1} u_1 - v_{w2} u_2]$
- Runner power when v_{w1} is in opposite direction of u_2
 $R.P = \frac{\rho g Q}{\rho} [v_{w1} u_1 + v_{w2} u_2]$
- Hydraulic efficiency $\eta_h = \frac{R.P}{HP} = \frac{v_{w1} u_1}{gH}$ L-R-L-R
- Mechanical efficiency $\eta_{mech} = \frac{S.P}{R.P}$ M-S-E-S
- Overall efficiency $\eta_o = \eta_h \times \eta_{mech}$ O-S-L-R
- Volumetric efficiency $\eta_{vol} = \frac{Q}{Q + \Delta Q}$
 where ΔQ = leakage loss
 Q = discharge entering the turbine
- Degree of reaction (R) : $R = 1 - \frac{v_2^2 - v_1^2}{2 v_{w1} u_1}$
- Efficiency of draft tube $\eta_d = \frac{\frac{v_1^2 - v_2^2}{2g}}{\frac{v_1^2}{2g}} = \eta_f$
- Pelton wheel**
- Power available at inlet of vanes = $\frac{\rho Q v^2}{2}$
- Runner power $R.P = \frac{\rho g Q}{\rho} [v_{w1} - v_{w2}] u$
- $(\eta_h)_{max} = \frac{1 - k \cos \alpha}{2}$
- Blade efficiency $\eta_{b, max} = \frac{v_1^2 - v_2^2}{v_1^2}$
- Specific speed of Turbine $N_s = \frac{N \sqrt{P}}{H^{5/4}}$

Model relationships for turbine / Cp

Capacity or flow Q constant, speed N constant

$$\left[\frac{Q}{ND^3} \right]_1 = \left[\frac{Q}{ND^3} \right]_2 \quad \left[\frac{gH}{N^2 D^5} \right]_1 = \left[\frac{gH}{N^2 D^5} \right]_2$$

Power P constant

$$\left[\frac{P}{N^3 D^5} \right]_1 = \left[\frac{P}{N^3 D^5} \right]_2$$

Brayton cycle or Joule cycle:- [G.M.P.P]

$$\eta = 1 - \frac{1}{(r_p)^{\gamma}}$$

$$T_2 = T_4 = \sqrt{T_{max} \cdot T_{min}}$$

$$(r_p)_{optimum} = \left(\frac{T_{max}}{T_{min}} \right)^{\frac{1}{\gamma-1}}$$

$$(r_p)_{optimum} = \sqrt{(r_p)_{max}} \quad (r_p)_{max} = \left(\frac{T_{max}}{T_{min}} \right)^{\frac{1}{\gamma-1}}$$

$$\text{Back work Ratio} = \frac{W_c}{W_T}$$

$$\text{Work Ratio} = \frac{W_{net}}{W_T} = \frac{W_T - W_c}{W_T} = 1 - \frac{W_c}{W_T}$$

Rankine vapour power cycle (or) steam power cycle

$$\text{Specific steam consumption } SSC = \frac{3600}{W_{net}} \frac{\text{kg}}{\text{kwhr}}$$

$$\eta_{Rankine} = 1 - \frac{Q_{out}}{Q_{in}} = 1 - \frac{T_c}{T_h} = \frac{W_{net}}{Q_{in}} = \frac{Q_2 - Q_1}{Q_1} = 1 - \frac{Q_2}{Q_1}$$

For regeneration in Rankine cycle

$$W_1 = (1-x)(h_1 - h_2) + (1-y)(h_1 - h_2)$$

$$W_2 = (1-x)(h_1 - h_2) + (1-y)(h_1 - h_2)$$

$$W_{net} = W_1 - W_2$$

$$Q_2 = (1-x)(h_2 - h_3)$$

Applying conservation of energy

Mechanical Engineering Formula

Mr Sanjay Jeswani



Mechanical Engineering Formula:

Mechanical Engineering Formula Book Review: Unveiling the Magic of Language

In an electronic era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its power to stir emotions, provoke thought, and instigate transformation is really remarkable. This extraordinary book, aptly titled "**Mechanical Engineering Formula**," published by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we shall delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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