

# 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  $v_{w_1}$  is in direction of  $u_1$   
 $R.P = \frac{\rho g Q}{\rho} [v_{w_1} u_1 - v_{w_2} u_2]$
- Runner power when  $v_{w_1}$  is in opposite direction of  $u_2$   
 $R.P = \frac{\rho g Q}{\rho} [v_{w_1} u_1 + v_{w_2} u_2]$
- Hydraulic efficiency  $\eta_h = \frac{R.P}{HP} = \frac{v_{w_1} u_1}{gH}$  L-R-L-R
- Mechanical efficiency  $\eta_{mech} = \frac{S.P}{R.P}$  M-S-E
- Overall efficiency  $\eta_o = \eta_h \times \eta_{mech}$  O-S-L-R
- Volumetric efficiency  $\eta_{vol} = \frac{Q}{Q + \Delta Q}$   
 where  $\Delta Q$  = leakage loss  
 $Q$  = discharge entering the turbine
- Degree of reaction (R) :  $R = 1 - \frac{v_2^2 - v_1^2}{2 v_{w_1} u_1}$
- Efficiency of draft tube  $\eta_d = \frac{\frac{v_1^2 - v_2^2}{2g}}{\frac{v_1^2 - v_2^2}{2g} + h_f}$
- Pelton wheel**
- Power available at inlet of vanes =  $\frac{\rho Q v^2}{2}$
- Runner power  $R.P = \frac{\rho g Q}{\rho} [v_{w_1} - v_{w_2}] u$
- $(\eta_h)_{max} = \frac{1 - k \cos \alpha}{2}$
- Blade efficiency  $\eta_{bl} = \frac{v_1^2 - v_2^2}{v_1^2}$
- Specific speed of Turbine  $N_s = \frac{N \sqrt{P}}{H^{5/4}}$

## Model relationships for turbine / Cp

Capacity or flow  $Q$  constant,  $C_p$  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

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

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

## For regeneration in Rankine cycle

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

$$W_2 = (1-x)(h_1 - h_2) + 1(h_1 - h_3)$$

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

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

## Applying conservation of energy

# Mechanical Engineering Formula

**Tyler G. Hicks**



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**Mechanical Engineering** American Society of Mechanical Engineers, 1919 History of the American society of mechanical engineers Preliminary report of the committee on Society history issued from time to time beginning with v 30 Feb 1908

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In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is actually astonishing. Within the pages of "**Mechanical Engineering Formula**," an enthralling opus penned by a very acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve in to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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