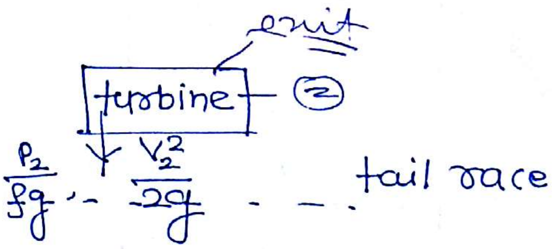
Draft tube:

it is a diverging tube fitted at the runner exit, used to convert kinetic energy into pressure energy in order to increase the efficiency of turbine

without draft tube:



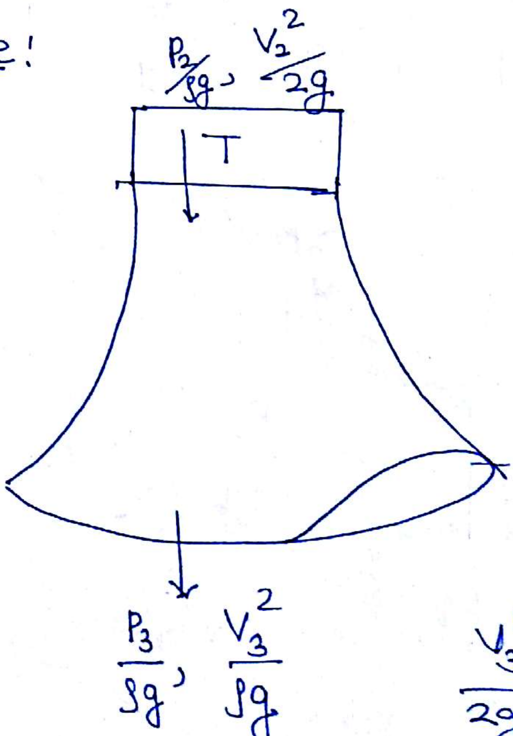
$$\frac{P_2}{\rho g} = \frac{P_{atm}}{\rho g}$$

$$\frac{V_2^2}{2g} \Rightarrow \text{waste}$$

With draft tube:

$$\frac{P_3}{\rho g} = \frac{P_{atm}}{\rho g}$$

$$\frac{P_2}{\rho g} < \frac{P_{atm}}{\rho g}$$



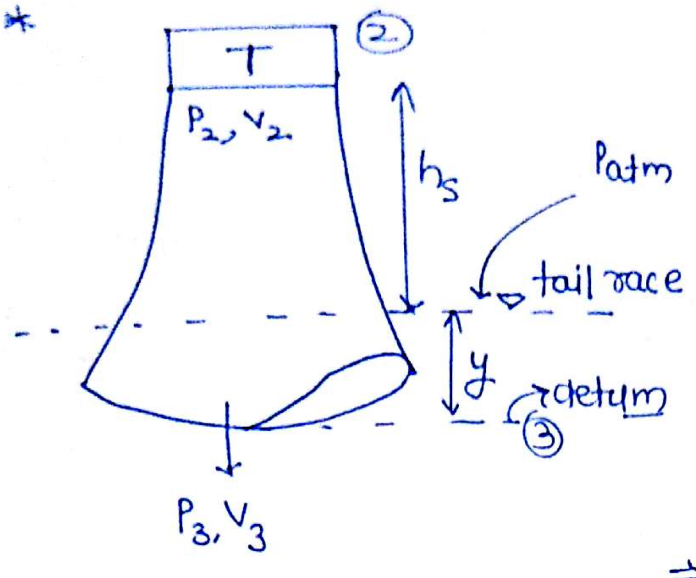
tailrace (3)

⇒ D.T. helps to maintain low pressure at the outlet of turbine which increas output.

$$\frac{V_3^2}{2g} \leq \frac{V_2^2}{2g}$$

⇓ waste.

*



energy eqn at ② & ③

$$\Rightarrow \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + h_s + y = \frac{P_3}{\rho g} + \frac{V_3^2}{2g} + 0 + h_f$$

$$\Rightarrow \frac{P_3}{\rho g} = \frac{P_{atm}}{\rho g} + y$$

So $$\frac{P_2}{\rho g} = \frac{P_{atm}}{\rho g} + y + \frac{V_3^2}{2g} - \frac{V_2^2}{2g} - h_s - y + h_f$$

$$\frac{P_2}{\rho g} = \frac{P_{atm}}{\rho g} - \underbrace{\left(\frac{V_2^2}{2g} - \frac{V_3^2}{2g} - h_f + h_s\right)}_{+ve}$$

$$\frac{P_2}{\rho g} = \frac{P_{atm}}{\rho g} - \underbrace{\left(\frac{V_2^2}{2g} - \frac{V_3^2}{2g} - h_f + h_s\right)}$$

there fore $$\frac{P_2}{\rho g} < \frac{P_{atm}}{\rho g}$$

$$\left.\frac{P_2}{\rho g}\right|_{min} > \frac{P_v}{\rho g}$$ (to avoid Cavitation)

* in kaplan (Axial flow turbine) cavitation occurs at turbine exit

efficiency of Draft tube

$$\eta_{D.T.} = \frac{\frac{V_2^2}{2g} - \frac{V_3^2}{2g} - h_f}{\left(\frac{V_2^2}{2g}\right)}$$

To avoid flow sepration ⇒ Diverging Angle $\not> 5^\circ - 7^\circ$

$P_3 > P_2$ $\quad \frac{dp}{dx} > 0, \frac{du}{dx} < 0$