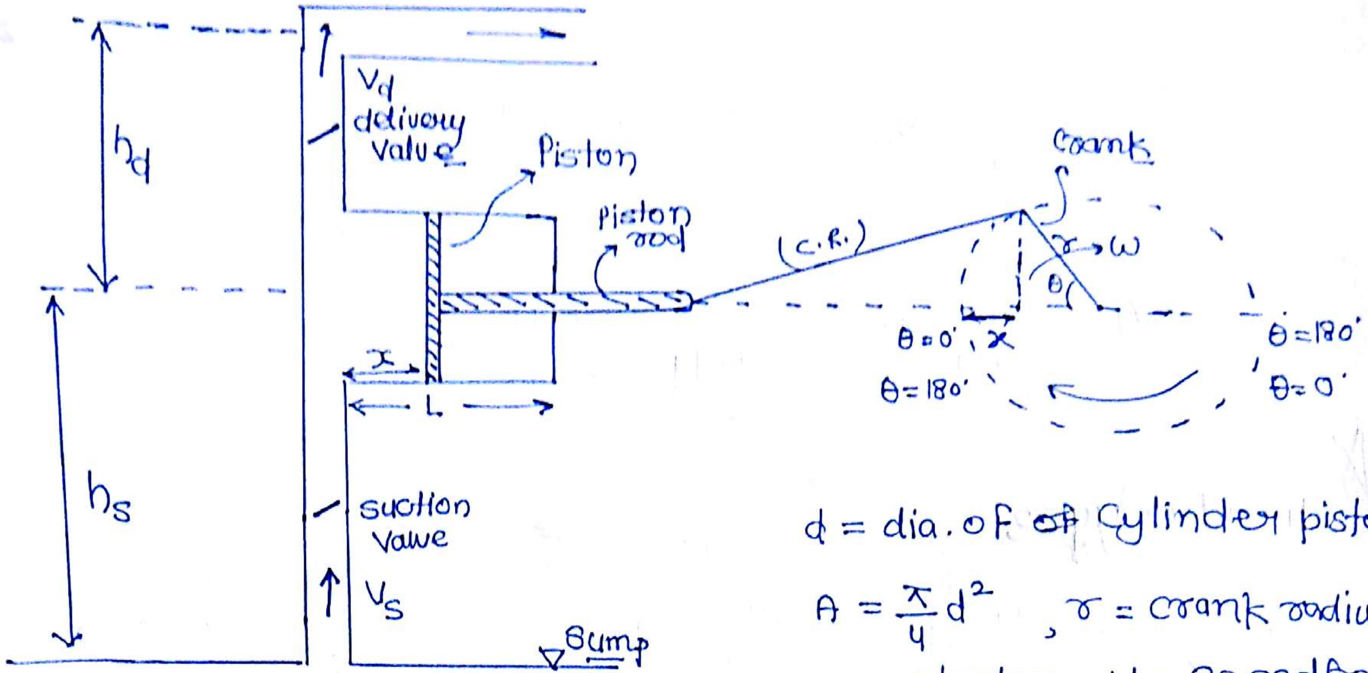
Reciprocating Pump



d = dia. of ~~of~~ cylinder piston

$A = \frac{\pi}{4} d^2$, r = crank radius

L = stroke , N = speed (rpm)

$\boxed{L = 2r}$

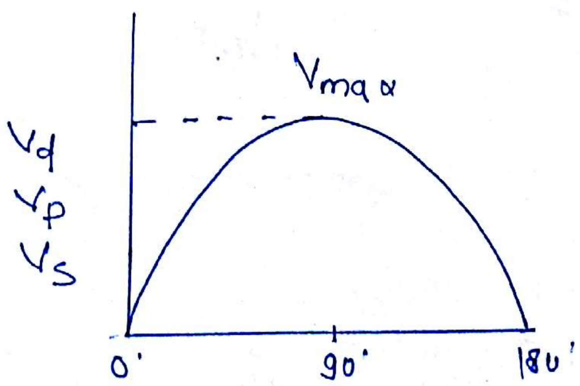
$\Rightarrow \quad x = r - r\cos\theta$

$\theta = \omega t$

$\rightarrow \quad x = r - r\cos\omega t$

$\frac{dx}{dt} = r\omega \sin\theta$

$V_p = r\omega \sin\theta$ piston Velocity



V_s, V_p, V_d Are in SHM

$$\rightarrow \quad \dot{m}_s = \dot{m} = \dot{m}_d$$

$$\rho A_s V_s = \rho A V_p = \rho A_d V_d$$

$$V_s = \frac{A}{A_s} \cdot V_p = \frac{A}{A_s} \cdot r\omega \sin\theta$$

$$V_d = \frac{A}{A_d} \cdot V_p = \frac{A}{A_d} r\omega \sin\theta$$

disadvantages

1. Pulsating Discharge
2. Variable discharge
3. $$H_f = \frac{fV^2L}{2gD} = \frac{FLV^2}{2gD}$$

$$V_s, V_d \rightarrow \max.$$

$$H_f \rightarrow \max.$$

$\Rightarrow$ Consumes more power.

4. low discharge

Slip

$$\Rightarrow \quad Q_{th.} = \frac{ALN}{60} \quad m^3/s$$

$$\text{slip} = Q_{th} - Q_{act.}$$

if $Q_{act} > Q_{th}$.

"Negative slip Condition"

→ ① High speed

→ ② Short delivery pipe.

3. long suction pipe

Coefficient of Discharge

$$C_d = \frac{Q_{act}}{Q_{th}}.$$

$$\%\ slip = \frac{Q_{th} - Q_{act}}{Q_{th}}.$$

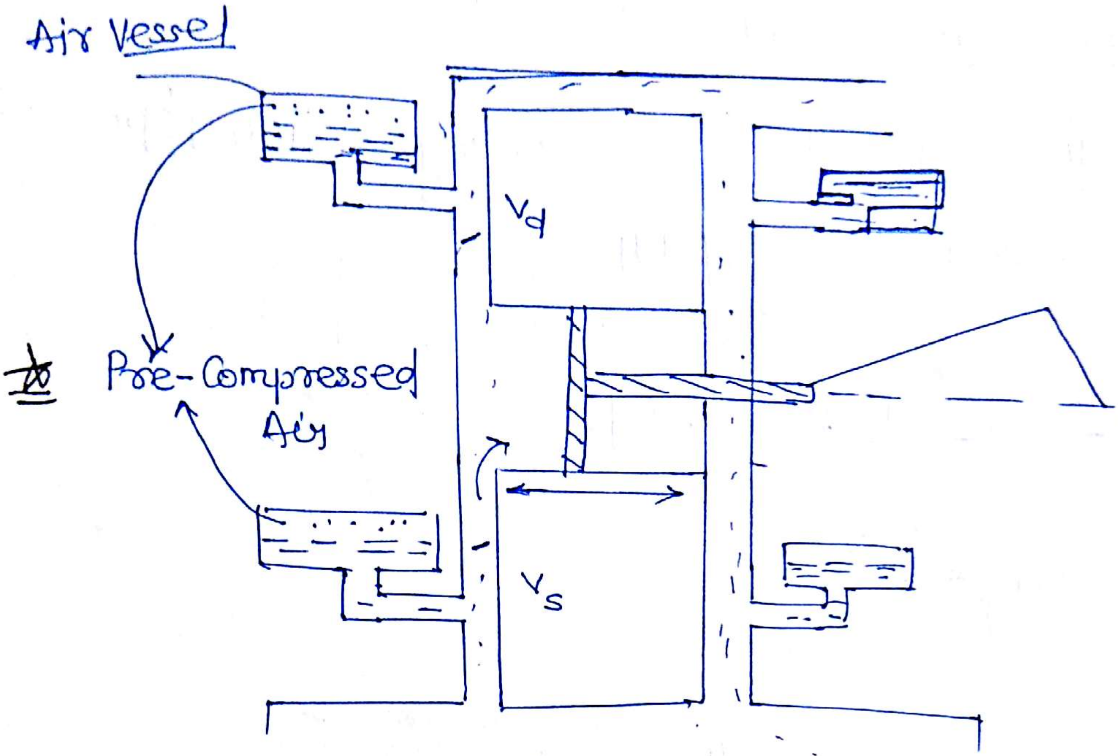
$$\boxed{\%\ slip = 1 - C_d}$$

Power

$$P_{th} = \rho g Q_{th}(h_s + h_d) = \rho g Q_{th}(h_s + h_d)$$

$$P_{act} = \frac{P_{th}}{\eta}$$

→ Air Vessel



it is the reservior of water placed Near to pump in suction and delivery pipe.

Advantages:

~~In suction and delivery pipe~~

① To maintain constant & contineous discharge.

② To reduce the power input to pump.

③ it also helps to increase discharge.

☆ Single cylinder Double acting reciprocating pump.

$$Q_{th} = \frac{2LN}{60} \ m^3/sec.$$

* Runaway Speed :-

When the load on the turbine becomes zero suddenly, the speed becomes 2-3 times of normal speed the speed known as runaway speed.

The runner and it's component should be designe # to remain safe at runaway speed.

load factor

$$\text{Load Factor} = \frac{\text{kWh}}{\text{kW} \times \text{No. of days} \times 24}$$