PUMPS & PUMPING

1

Pump is a device for raising or moving water or any other fluid.

2

To move water, need to overcome resistance due its density, gravitational force & friction.

3

This resistance is dependent on:

- Height the water needs to be raised
- Quantity of water involved

4

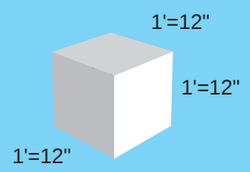
Force needs to be exerted by the pump to overcome the resistance

Force is the head which is measured in terms of the height of water - inches or feet

$$\text{Force} = \text{Mass} \times \text{Acceleration}$$
$$(lb_f) \quad (lb_m)$$

$$lb_f = lb_m$$
(per definition)

Pressure $= \frac{\text{force}}{\text{area}}$



Pressure exerted by a 1ft column of water $= \frac{62.4 \text{ lb}}{12 \text{ in} \times 12 \text{ in}} = 0.43$ psi

so 0.43 psi = 1ft (water column)

or 1 psi = 2.3ft

5

Pump will need to provided energy to raise the water

Energy = resistance force

Energy = Force x Distance

Energy units
ft-lb
KWh
Calories
Hp-h

6

Power needs to be delivered to the pump so it can provide energy. Power = Energy per time

Power Units

$\frac{\textbf{ft-lb}}{\textbf{min}}$
KW
Hp

1Hp = 0.746 kW

Watt determined that one horse on an average could lift 330lbs 100ft in one minute

$$1\text{Hp} = \frac{33{,}000 \text{ ft-lb}}{\text{min}}$$

As 1 GPM (Water) $= \frac{8.34\text{lb}}{\text{min}}$

$$\frac{\text{lb}}{\text{min}} = \frac{\text{GPM}}{8.34}$$

$$1\text{Hp} = \frac{33000 \text{ ft-lb}}{\text{min}} = \frac{33000 \text{ ft} \times \text{GPM}}{8.34 \text{ min}}$$

1Hp = 3,960 GPM-ft

1Hp is needed to raise one gallon of water 3,960 ft in one minute

Understanding the concept of power:

A 150lb person climbing 50ft will expend 7500 ft-lb of work (energy)

1) Power requirement for climbing this in 5 minutes

$$\frac{7500}{5} \frac{\text{ft-lb}}{\text{min}} = 1500 \frac{\text{ft-lb}}{\text{min}}$$

= 0.045 Hp

2) Power requirement for climbing this in 1 minute

$$\frac{7500}{} \frac{\text{ft-lb}}{\text{min}} = 0.23 \text{ Hp}$$