How to calculate the Hydraulic shaft power of Pumps to raise the required water to the required levels?

$$P = \frac{Q\rho H}{75\eta}$$

Where,

P is the Power in Hp (Horse Power)

Q is the discharge in cum/sec

ρ is the density of fluid in kg/cum

H is the level difference in meter

η is the efficiency of the pump

We are using this equation to calculate the power.

Here,

The efficiency of pump is taken as ***65%*** and the density of water is ***1000 kg/cum***

So we need to concern about the Discharge (Q) and Level difference (H).

Level Difference (H) = Normal Head + Frictional Head + Minor Heads (bends etc.)

Normal Head = Level difference between the Ground levels of Storage Reservoir and Water source (Open Well) + Height of Tank + Depth of Source

For frictional head, we need to know the length and inner diameter of the pipe used for pumping.

We all know many formulae to calculate frictional head, Frictional Head, $H_f = \frac{flv^2}{2gD}$ (Darcy-Weisbach equation)

Frictional Head, $H_f = \frac{10.65LQ^{1.85}}{C^{1.85}d^{4.87}}$ (Hazen Williams equation)

where

H_f = head loss in meters (water) over the length of pipe

L = length of pipe in meters

Q = volumetric flow rate, m3/s (cubic meters per second)

C = pipe roughness coefficient

d = inside pipe diameter, m (meters)

We use the Hazen Williams Equation here.

And so the Total Head can be calculated as

Total Head = Normal Head + Frictional Head + Minor Heads.

Here we took 20% of Frictional Head as Minor head to consider. So,

Total Head = Normal Head + 1.20 x Frictional Head

Here we need to take care of the diameter of pipe used for pumping.

For that we made a condition that the Frictional head never go beyond 20% of the Total Head.

Frictional Head < 20% of Total Head

From this condition, we can fix the pumping main diameter here. *(Design of pumping main is beyond the scope. For that we need to consider the economical sizing of pipe, water hammer check etc.)*

Then we need Discharge (Q) which is connected with the capacity of tank and pumping hours.

Discharge is the quantity of water we need to fill the tank in unit time. So

Discharge (Q) = Tank size (Required Water) in liter / Pumping hours

We got this in liter/hour. But we need this as cum/sec. So in SI unit,

$$\text{Discharge } Q = \frac{Tank\ Size/_{1000}}{Pumping\ hour\ \ \times 60 \times 60} \text{ cum/sec}$$

In Addition, If we had a doubt to find out the water demand of a community,

We can fix the tank size by knowing the demand of water and pumping frequency in a day. If the community is ready to pump twice in a day, the capacity of tank may be fixed as the half of the water demand of the community for a day.

In order to calculate the Water Demand of the community for a day,

Demand = Population x per capita demand

If we design the water supply for a design period of 20 years, we need the projected population instead of present population.

Projected Population = Present Population x Decadal Population Growth

(for 10 years)

Then for another 10 years, ie 20 years,

(Present Population x Decadal Population Growth) x Decadal Population Growth

ie. $Proj\ Population = Pres. Population\ \times\ (1 + Decadal\ Growth)^{Design\ Period/_{10}}$

For calculating Present population,

Present Population = Average family size x No. of House holds in the community

Where we take an average family size as 5.

From these calculations, I made the LSGD WSS app for easy use of these calculations at the time of preparing WSS for communities. You can download this android app free of cost from this link below:

https://play.google.com/store/apps/details?id=appinventor.ai_angelthrixis.LSGD_WSS

or

(Click on the Image below)

Thanking You,

Neville Williamson

FGO, LSGD Section

Koothattukulam Municipality