Calculations For Plant Water System Pumps

1.0 Purpose and Scope

The purpose of this calculation is to calculate the capacity and head of Plant water system pumps

2.0 Design Input

2.1 Plant water - Consumption Details

Capacity of each Overhead Tank one located at the roof of GIS Building & another at the roof of Control and Relay Building = 2.5 m^3/hr

Total Plant water consumption is = 2 x 2.5
=5.0 m^3/hr

3.0 Methodology and Acceptance Criteria

The Plant water pump capacity is selected based upon the Plant water requirements and head is selected based upon the head loss through the system.

4.0 Calculations

4.1 Pump capacity calculation

From Clause 2.1 above, Total Plant water consumption is = 2 x 2.5
=5.0 m^3/hr

Hence, capacity of pump selected = 5.0 m^3/hr

No. of Pumps = 2 (1W + 1S)

4.2 Pump head calculation

4.2.1 Pump suction line

Flow rate, Q = 5 m^3/hr

Pipe I.D, D = 0.053 m

Velocity, $V = \frac{4 \times Q}{\Pi D^2 \times 3600}$ m/sec Where,
Q is flow rate in m^3/hr
D is pipe I.D in meters

$$= \frac{4 \times 5}{\Pi \times 0.053^2 \times 3600} \text{ m/ sec}$$

= 0.63 m/sec

i. Frictional Head Loss in Pipe

$$H_{L\,(s)} = 6.815 \times \left(\frac{V}{C}\right)^{1.852} \times \frac{1}{D^{1.167}}$$

Where,

V is velocity in m/sec
D is pipe I.D in meters
C is co-efficient of friction = 120

$$H_{L\,(s)} = 6.815 \times \left(\frac{0.63}{120}\right)^{1.852} \times \frac{1}{0.053^{1.167}}$$

$$= 0.013 \text{ mwc/m length of pipe}$$

For a pipe length of 5 meters $H_{L(s)}$ = 0.06 mwc

ii. Head Loss due to Fittings

$$H_{L\,(f)} = \frac{KV^2}{2g}$$

Where,
$H_{L\,(f)}$ is frictional head loss in pipe in mwc / metre
V is velocity in m/sec.
g is Acc. due to gravity = 9.81m/sec^2
K is resistance coefficient

Fittings

Gate Valve	-	1	No.	K	= 0.152
Strainer	-	1	No.	K	= 2.5
Entry	-	1	No.	K	= 0.5
Total				**K**	**= 3.152**

$$H_{L(f)} = \frac{KV^2}{2g}$$

$$= \frac{3.152 \times (0.63)^2}{2 \times 9.81}$$

$$H_{L(f)} = 0.064 \text{ mwc}$$

iii. Total Pressure Drop = $(H_{L(S)} + H_{L(f)})$

= 0.06 + 0.064

= 0.124 mwc

4.2.2 Head loss in discharge pipeline for DN 50

Flow rate, Q = 5 m^3/hr

Pipe I.D, D = 0.053 m

Velocity, $V = \frac{4 \times Q}{\Pi D^2 \times 3600}$ m/sec Where,

Q is flow rate in m^3/hr

D is pipe I.D in meters

$= \frac{4 \times 5}{\Pi \times 0.053^2 \times 3600}$ m/ sec

= 0.63 m/sec

i. Frictional Head Loss in Pipe

$H_{L(p)} = 6.815 \times \left(\frac{V}{C}\right)^{1.852} \times \frac{1}{D^{1.167}}$

Where,

V is velocity in m/sec

D is pipe I.D in meters

C is co-efficient of friction = 120

$H_{L(p)} = 6.815 \times \left(\frac{0.63}{120}\right)^{1.852} \times \frac{1}{0.053^{1.167}}$

= 0.013 mwc/m length of pipe

For a pipe length of 135 meters $H_{L(p)}$ = 1.755 mwc

ii. Head Loss due to Fittings

$H_{L(f)} = \frac{KV^2}{2g}$

Where ,

$H_{L(f)}$ is frictional head loss in pipe in mwc / metre

V is velocity in m/sec.

g is Acc. due to gravity = 9.81m/sec^2

K is resistance coefficient

Fittings

Gate Valve - 1 No. K = 0.152

Elbows	-	10	Nos.	K	= 5.7
Check Valve	-	1	No.	K	= 2.5
Tees	-	2	Nos.	K	= 0.76
Total				**K**	**= 9.112**

$$H_{L(f)} = \frac{KV^2}{2g}$$

$$= \frac{9.112 \times (0.63)^2}{2 \times 9.81}$$

$H_{L(f)}$ = 0.184 mwc

iii. Total Pressure Drop = $(H_{L(P)} + H_{L(f)})$

= 1.755 + 0.184

= **1.939 mwc**

Pump discharge head = Pump suction head + Pump suction pipe losses + Discharge pipe losses +Static Head + Residual pressure

= 4 + 0.116 + 1.939 +10 + 5

= 21.055 m

Consider 10% margin on friction loss

Head selected = 25 MWC

5.0 Results

- Quantity = 2 (1 W+ 1 S) for Ittin Sub-Station
  = 2 (1 W+ 1 S) for Al-Qarm Sub-Station
- Capacity of each Pump = 5.0 m^3/hr
- Selected Head = 25 MWC