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DESIGN OF WATER TREATMENT PLANT FOR DINDORI TALUKA BY KOMVEE SOFTWARE

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Abstract – *Water is the prime most factors which holds life on earth. The availability of water varies among different places.In some places the quality and quantity of water obtained is not satisfactory. Due to population explosion water demand increased to its peak limit which in turn lead to scarcity of water. Many of the places in Kerala are seriously affected by these problem due to lack of an efficient water supply system.Careful examination of water sources and proper treatment of water with an efficient water supply system can overcome these problems to a great extent. In this project we have planned to design an efficient water treatment plant which makes the water useful for drinking purpose. This project deals with the design of various components of water treatment plant at Peelarmozhi , Chalakudy. The water fromKappathodu canal is directed to the pond near the site by constructing a weir across the canal and the water undergoesproper treatment before it is dispatched.*

1. INTRODUCTION

Water is a basic human need. Providing safe and adequate quantities of the same for all rural and urban communities, is perhaps one of the most important undertaking, for the public work department indeed, the well planned water supply scheme, is a prime and vital element of a country's social infrastructures as on this peg hangs the health and well being of its people. The population in India is likely to be hundred and twenty five crores by the turn of this century, with an estimated 40% of urban population. This goes on to say that a very large demand of the water supply; for Domestic, industrial fire fighting, public uses, etc., will have to be in accordance with the rising population. Absolute pure water is never found in nature, but invariable contains certain suspended, colloidal, and dissolved impurities (organic and inorganic in nature, generally called solids), in varying degree of concentration depending upon the source. Hence treatment of water to mitigate and absolute removal of these impurities (which could be; solids, pathogenic micro-organisms, odour and taste generators, toxic substances, etc.) become indispensable. Untreated or improperly treated water, becomes unfit for intended use proves to be dangerous for life.

The design of water treatment plant for Dindori taluka situated in Nashik district of Maharashtra has been done. Dindori located on the bank of river Godavari. The latitude and longitude of the town corresponding 20.12N, 73.49E respectively. The population of the given year 2051 will be 638441. There are many industries like agricultural industries and chemical industries in the taluka so, treated water supply for domestic and industrial uses are very essential.

1.1 DESCRIPTION OF TREATMENT

MEASURESSCREENING

Most of the big and visible objects such as trees , branches,
sticks ,vegetation, fish, animal life etc, present in raw waterof surface sources can be removed by screening. The waterfrom the sump is pumped to the next unit by a centrifugal pump, which doesn't get clogged easily. A pump house at thetop controls the operation of the pump.

AERATION

Aeration is the process of bringing water and air into close contact in order to remove dissolved gases, such as CO_2, and to oxidise dissolved metals such as iron. It can also be usedto remove volatile organic chemicals in the water. Aeration is often the first major process at the treatment plant. During aeration, constituents are removed or modified

The top layer removes organic compounds ,which contribute to taste and odour. Most particles pass through surface layers but are trapped in pore spaces or adhere to sand particles. Filtration is effective if it extends into the depth of the filter .If the top layer of sand were to block all the particles the filter would quickly clog.

before they can interfere with the treatment processes.

Aerators fall into two general category. They either introduce air into the water or water into the air. The water-to-air method is designed to produce small drops of water that fall through the air. The air-to- water method creates small bubbles of air that are inducted into the water stream.

MIXING

The chemical added to the raw water is vigorously mixed and agitated by a flash mixer for its rapid dispersion in rawwater and water is then transferred to a flocculation tank provided with slow mixers. It consist of a rectangular tank provided with an impeller fixed to an impeller shaft. The impeller is driven by an electric motor, and it revolves at a high speed 100-120 rpm inside the tank. A detention time of 0.5- 2 minute is also given. The coagulant is brought by thecoagulate pipe and is discharged just under the rotating fan.The raw water is separately brought from the inlet end and is deflected toward the moving impeller by a defecting wall.The thoroughly mixed water is taken out from the outlet end.

CLARIFLOCCULATION

All waters, especially surface waters, contain both dissolvedand suspended particles. In clariflocculator

FILTRATION

Filtration is an operation used for the separation of solids from fluids by interposing a medium through which the fluidcan pass, where the solids in the fluid are retained . It depends on the pore size and the thickness of the medium aswell as the mechanism that occur during filtration. In filtration other mechanisms like direct interception, diffusion and centrifugal action also take place where in those

sThe most common type of filter is a rapid sand filter. Watermoves vertically through the sand medium which often has alayer of activated carbon or anthracite coal above the sand

.The top layer removes organic compounds ,which contribute to taste and odour. Most particles pass through surface layers but are trapped in pore spaces or adhere to sand particles. Filtration is effective if it extends into the depth of the filter .If the top layer of sand were to block all the particles the filter would quickly clog.

1.4. WATER QUANTITY ESTIMATION

The quantity of water required for municipal uses for which the water supply scheme has to be designed requires following data

Expected population after 40 years=638441

Average rate of water supply=265

LPCD=169.18 MLD

Average daily draft= 265 x 638441= 169.18 MLD

Maximum daily draft= 1.8 x 169.18= 304.52 MLD

Maximum hourly demand= 270% of q Of maximum day=270/100x169.18=456.786

Coincident draft= maximum daily draft + fire demand = 304.52 + 86.4= 390.92 MLD

(Coincident draft < maximum hourly draft)
As maximum Hourly demand of Maximum day is greater than coincident draft.
Therefore, Distribution system should be design for **456.786 MLD**

1.2 WATER QUALITY ANALYSIS

To ascertain the treatment required for the water in a region, proper testing of the water samples collected from the areashould be conducted. This is to ensure the safety of public health and utility. It therefore becomes imperative upon the planners and designers of the public water supply schemes, to thoroughly check, analyse and treat the raw water available. The water present in the intake is of low quality. Therefore water is tested to get details about their chemical properties. Drinking water should satisfy the specified limits recommended by IS code.

	Characteristics	Obtained results
1	Turbidity (NTU)	0.07
2.	Taste and Odour	Unobjectionable
3.	PH	8
4.	Total Dissolved Solids (mg/L)	450
5.	Total hardness (mg/l as caco3)	170

1.3 Design of Water Treatment Plant

Water Demand

Present Population of the city (P0) = 380000
Growth Rate of population per Decade (r/100) = 15 %
Number of Decades (n)= 4
future population After 'n' Decades (P_n)=
WD = 89.72 MLD
Fire Demand (FD) =
FD = 2.58 MLD
Discharge (Q) =
Q = 99.00 MLD
Total Water demand per Day = 99.00 MLD

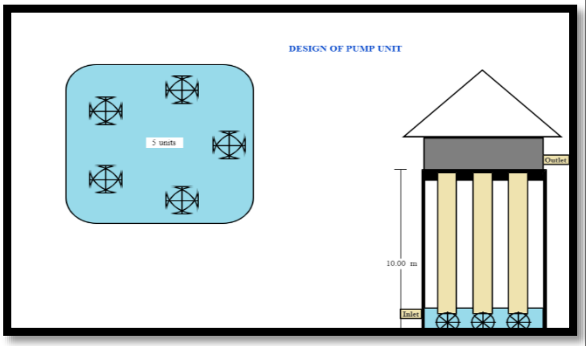
Intake Well

Quantity of water required per day (Q') = 99.00 MLD
Velocity of water at inlet opening (V)= 0.75 m/Sec
Discharge Required per sec (Q) =
Q = 1.15 m^3/sec
Area required for opening in the screen (A)=
A = 1.52 m^2
Half area is required for placing of bars, total opening area is (Ah) =
= 1.52 m^2
Providing bars of diameter = 20 mm
providing Spacing of Bars (S)= 20 mm
Width of screen (W)= 2 m
Height of Screen (h) =
h = 0.76 m

Diameter of Intake Well (D)= 5 m
Depth of Well Below Water level is (d_1) = 3 m
Depth of Well Above water level is (d_2) = 5 m

Gravity Main (GM)

Velocity of water in gravity main (v) = 1 m/sec
Discharge Required per sec (Q) = 1.15 m^3/sec
Cross Sectional Area of Gravity main (A) = ?
A
= 1.15 m^2
Diameter of Gravity main (Dia)=
Dia = 1.20 m

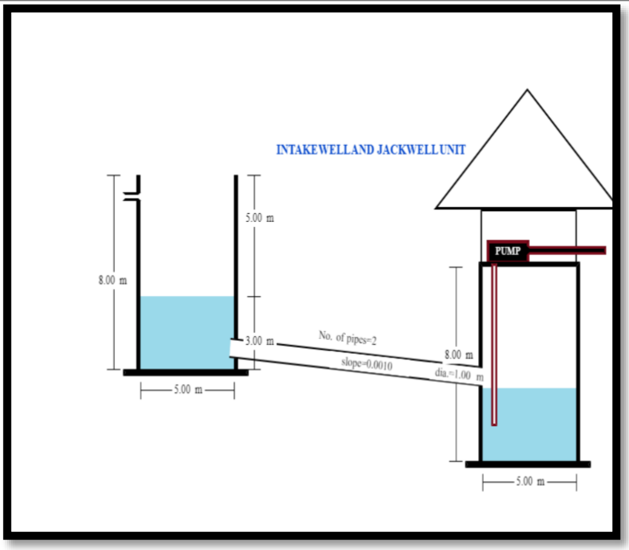


Maximum Diameter of pipe = 1 m
Perimeter of Gravity Main (P) =

P = 3.80 m
Hydraulic Radius (R) =
R = 0.30 m
No of pipes =
1.9532 ....[roundoff]
Slope of energy line (S) =
S= 0.0010

Jack Well

Diameter of jack well= 5.00 m
Depth of jack well below gravity main = 3.00 mDepth of jack well above gravity main to pump deck depends on topography and power of pump = 5.00 m



Pump design

Input:
Required Discharge (Q)= 1.15 MLD
Discharge range of pump (q) = 0.5 m^3/sec
Assume velocity of flow in pipe (V) = 0.75 m/sec
Provide Number of stands by pump (n) = 2 Units
Required static suction head (H) = 10 m

Output:
Diameter of pipe (d):
d = 0.92 m
Number of pumps (N_p):
Np = 3 Pumps
Total Number of pumps (N_t):
N_t = 5 Pumps
Minimum clearance between two pumps foot valve (S):
S = 1.84 m

Pre-sedimentation Tank

General:
Overflow rate (Q) = 30 $m^3/m^2/d$
Minimum side water depth (h) = 2.5 m

Hydraulic Design

Input:
Discharge (Q) = 99.00 MLD
Duration of pumping per day (t) = 23 hrs.
Detention period (T) = 2 hrs.
Effective depth (H') = 3.5 m
Free board (h)= 0.5 m
Ratio of length and width is 3:1 to 5:1 (H) = 5:1
Provide width of tank (W) = 8 m

Output:
Total inflow in pre-sedimentation tank is (Q'):
q = 4304.35 MLD
Total Volume required (V):

V = 8608.70 m3
Length of tank is given by considering length to width ratio (L):
L = 40 m
Volume of one tank is (v):
v = 1280 m^3
Area of one tank (A):
A = 320 m2
Number of tanks required (No):
No = 7 Tanks

Influent Structure

Input:
Width of influent structure (w) = 0.7 m
Depth of influent structure (d) = 0.6 m
Width of tank (W) = 8 m
Spacing of influent structure (S) = 1 m
Width of orifice (w') = 0.2 m
Depth of orifice (d') = 0.2 m

Output:
Number of influent structures (no):

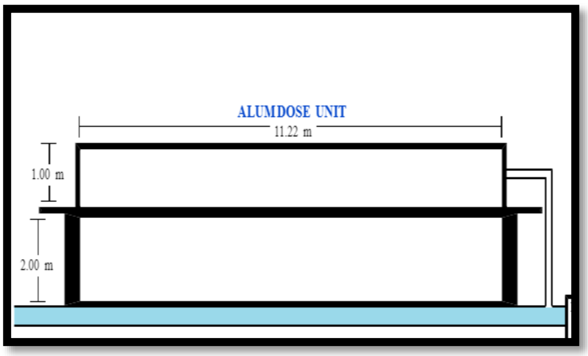
No = 5 Units
Spacing of orifices (S'): S' = 1.90 m

Effluent Structure

Input:
Assume weir loading (w) = 454.37 m^3/day/m
Number of launder troughs provided (no) = 8 Unit
Width of central launder trough (W_c) = 0.3 m

Output:
Net outflow (Q'):
L = 37.89 m
Spacing of launder trough (S'):
S' = 0.96 m

Alum required per day (W):
So, W = 50 x 99.00
W = 4950.00 kg
Total Alum required for n months (W_t):
Formula:
Wt = 891000.00 kg
volume of tank (V_1):
V1 = 333.46 m3
Volume for Provision of drainage, mixing, and stirring is 10% (V_2):
V = 366.80 m3
Diameter of tank (dia.):
Dia. = 11.22 m
Square Platform with one side (l):
l = 11.97 m



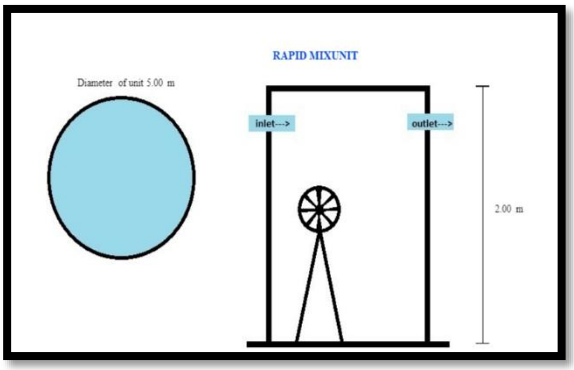
Rapid Mix Unit

Input:
Discharge (Q): 99.00 MLD
Detention time (t): 50 hrs
Assume height of tank considering free board (H): 2 m
Ratio of tank height to diameter 1.5:1:1.5
Ratio of impeller diameter to tank diameter 0.4:1:0.4
Rotational speed of impeller (n): 120 rpm
Power rate (p): 2 watts/m^3/hrs
Motor of 1HP is required for treating water 6.31 MLD: 1 HP

Output:
Design flow (Q'):
Q'= 1.15 m3/s
Capacity of tank (C):
C = 57.29 m3
Diameter of tank (D):
D = 5.00 m
V = 39.29 m3
Number of rapid mix units (no):
no = 1.46 = 2 Units ____ [Roundoff]

Hence, to treat volume of tank required motor power (HP):
HP = 15.69 HP

Diameter of impeller (d): d = 2.00



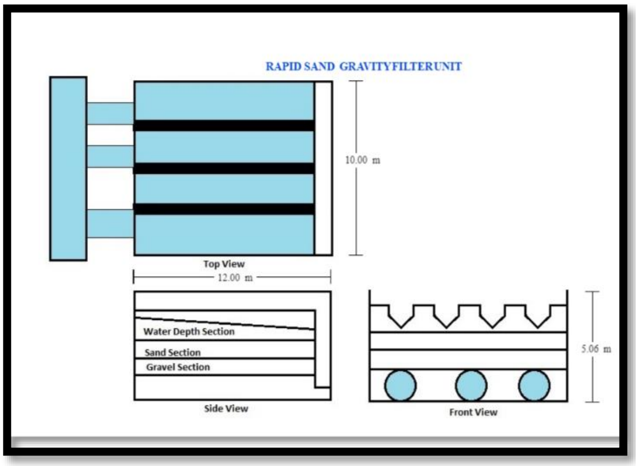
Flocculator Design

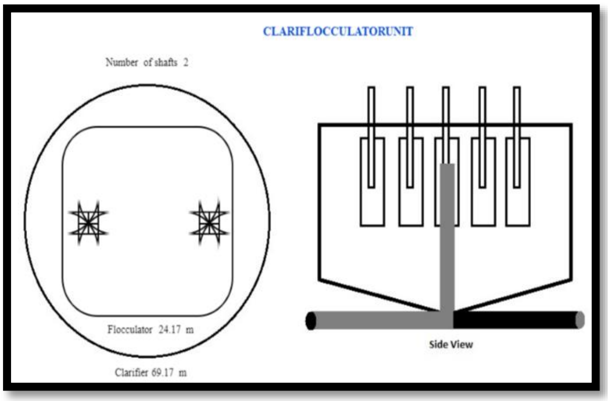
Input :
Detention Period (t): 50 min
Velocity Gradient (G): 50 S^{-1}
Provide a water depth (H): 4.5 m
Diameter of inlet pipe (d): 1 m
Number of Tanks (n): 1 m
Output :
Design average outflow (Q):
Q = 68.75 m3/min
Volume of circular Flocculator (V):
V = 11.97 m3
Plan area for flocculator (A):
A = 458.33 m2
Diameter of flocculator (D):
D = 24.17 m

Dimensions of paddles

Input :
For volume, Total power input to flocculator (V'): 87 m^3
Newton's co-efficient of drag : 1.80
Density of water at 25degree C : 997 kg/m^3
Velocity of tip of blades: 0.40 m/s
Using above formula area of paddle is (Ap'): 1.5149 m^2
Number of shafts provided (Ns): 2 Units
Each shaft supports n no of paddles (Nes): 4 Unit
Provide length of each paddle (l): 2 m
Width of each paddle (w): 0.4 m
Output :
Area of paddle for volume 1459.167 is (Ap):
Ap = 35.92 m2
Paddle area (a):
a = 1.5149 m2
Shaft distance from central line of clariflocculator (s):
s = 13.59 m
total no of paddles (T_{no}):
Formula :

$$\mathbf{T_{no} = N_s + N_{es}}$$





Where,

(N_s) = 2 Units

(N_{es})= 4 Unit

So, T_{no} = 2 x 4

Tno = 8 Units

Clarifier

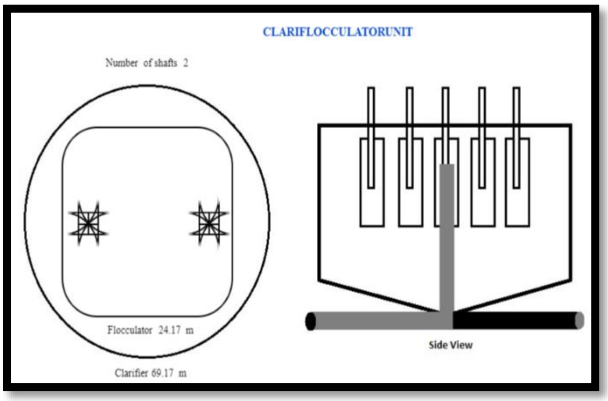
Input :
Assume surface overflow rate (R): 30 $m^3/m^2/d$
Assume detention period (t): 4 hrs
Assume free board (b): 0.5 m

Output :
Surface area of clarifier (Ac):
Ac= 3300.00 m2
Diameter of clariflocculator (D'):
D'= 69.17 m
Length of weir (L):
L = 217.88 m
Weir loading (F):
F = 454.37 m3/m/d
Depth of tank (d):
d = 5.00 m
Depth for sludge accumulation (d_1):
d1 = 1.25 m
Total depth at center of tank (d'):
d' = 6.75 m

<u>Launder/Collecting channel (RCC)</u>

Input :
Provide n number of Launders (N_l): 2 Units
Velocity of flow through launder (V'): 1 m/s

Output :
Discharge flow for 1 unit (q):
a'= 0.57 m2
Perimeter of launder (P):
P = 2.68 m
Hydaulic mean radius (R):
R = 0.21 m
Slope of channel (S): 0.001337
S = 0.001337



Rapid sand Gravity Filter

General provision:
Input :
required inflow (Q): 99.00 MLD
Time lost during backwashing (t'): 50 min
Working hours of filter per day (T): 23 hrs
Rate of filtration (r): 5 $m^3/m^2/hrs$
Length:Width ratio: 1.25

Size of perforation (Q_p): 10 mm

Filter bed dimension
Input:
Provide width of filter bed (w): 10 m
Provide length of filter bed (l): 12 m

Q1 = 205.58 MLD
Design flow for filter after accounting for backwash water and time lost (Q1):
24 / 23
Q1 = 205.58 MLD
Area of filter required (A):
A = 1713.13 m2
The number filter beds (morell and wallace) (no):
no = 18 Unit
Area of each filter (A'):
A'= 95.17 m2

Design of under-drainage system

Input :
Diameter of perforator (Q_p): 10 mm
Assume Spacing for laterals (S_l): 0.15 m
Assume diameter of lateral (Q_l): 0.06 m

Output :
Total area of perforation (a):
a = 0.36 m^2
Total number of perforations (num):
num = 4582 Unit

Total c/s area of laterals (a'):
Formula :
a'= 1.08 m2
Area of central manifold (Am):
Am = 2.16 m2
Diameter of manifold (Q_m):
Qm = 1.66 m
Number of laterals on one side considering spacing (N_l):
Nl = 58 Unit
Laterals on both sides on one manifold (N_{bl}):
Nbl = 116 Unit
Total Number of required laterals (T_{nl}):
Tnl= 383 Unit
Total Number required manifold in one filter (T_m):
Tm = 2 Unit
Spacing of manifold along width of filter (S_m):
)
Sm = 2.73 m
Length of each lateral (Ll):
Ll = 1.67 m

Number of perforations per lateral (N_p):
Np = 12 Unit
spacing of perforators along width of filter (S_p):
Sp = 0.14 m

Design of wash water trough

Input :
Assume Wash water rate (R_w): 30 $m^3/m^2/hr$
Assume spacing for wash water trough along width of filter (S_t): 1.5 m
Assume width of trough (W_t): 0.5 m
Assume free board for trough (b_t): 0.2 m
Bottom of trough from sand bed is given as: 0.7 m

Output :
Wash water discharge for 1 filter (Q_w):
So, Qw = (30 x 12 x 10) / (60 x 60)
Qw = 1.00 m3/sec
Total number of trough (N_t):

Nt = 5 Unit
Discharge per unit trough (Qt): 0.20 m^3/sec
Qt = 0.20 m3/sec
Trough depth is given by formula Q= 1.376 $b_h^{(3/2)}$ (Dt):
Dt = 0.44 m
Water depth at upper end in the trough considering free board (d_{ut}):

dut = 0.64 m

Computing of total depth of filter box

Input :
Minimum depth required for sand is given by Hudson's formula in metric unit (d_1): 0.7 m
Depth of water while filtering (d_2): 1.5 m
Depth of water while backwashing (d_3): 0.7 m
Depth of gravel at bottom (d_4): 0.7 m
Free board for rapid gravity filter (d_6): 0.5 m

Output :
Depth of underdrainage system (d_5):
d5 = 1.66 m
Total depth of rapid gravity filter (D):
D = 5.06 m

Main Gutter

Input :
Assume rise/min backwash rate (h): 70 m/min
Flow per filter bed considering wash water rate (q): 2 m^3/sec
Width of main gutter is found by using formula

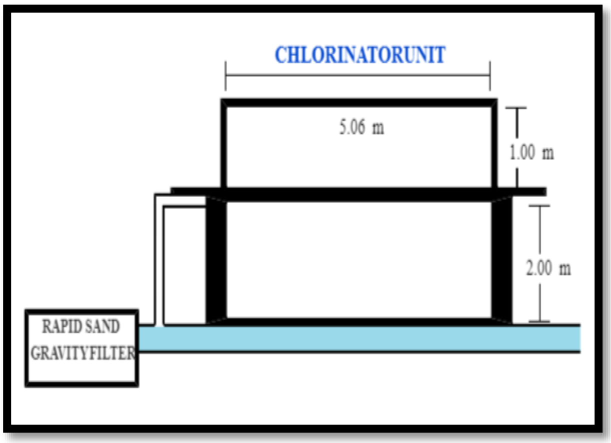
Q = 1.376 $bh^{3/2}$ (b):
Q = 0.44 m

Wash water Tank

Input :
Required flow for backwash (Q_b): 1 m^3/m^2/min
Duration of backwash for 2 filter bed (T_b): 30 min
Output :
Volume of tank (V):No Tank = 9 Unit

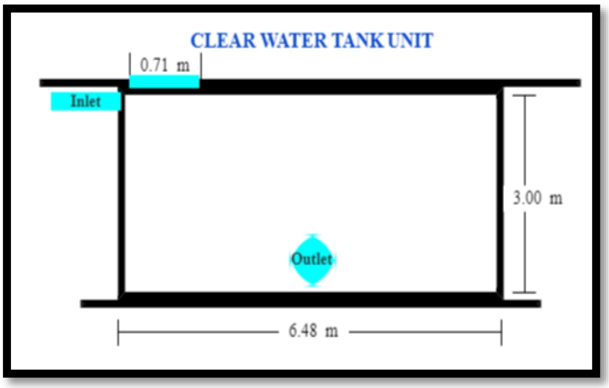
Chlorinator

Input :
Volume of water : 99.00 MLD
Liquid Chlorine applied (pre_{chl}) : 1.4 mg/lit
Residual liquid chlorine ($post_{chl}$) : 0.2 mg/lit



Required for months (n): 6 Unit
Height of tank (H): 1 m
Height of platform from top level of rapid sand gravity filter: 2 m
Density of liquid chlorine (d): 1562.5 kg/m^3

Output :
Total Liquid Chlorine applied (ppm):
R= 6.60 kg/hr
Chlorine per day (W):
W= 158.40 kg
Total Chlorine required for n months (W_t):
Wt = 28512.00 kg
Volume of tank :(V_1)
V1 = 18.25 m3
Volume for Provision of drainage, mixing, and stirring is 10% (V_2):
V_2 = 1.82 m^3
Total volume (V):
V = 20.07 m3
Diameter of tank (Dia):
)
Dia = 5.06 m



Clear Water Tank

Input :
Volume of tank : 99.00 MLD ________ From Water Demand
Depth of tank: 3 m

Output :
C/S area of tank (A):
A= 33.00 m2
Diameter of tank (d):
d = 6.48 m

1.4 CONCLUSIONS

The design of water treatment plant for Dindori Taluka has been completed. Water quality analysis showed excess amount of iron andMPN value.They can be mitigated by aeration , sedimentation, and filtration and disinfection. All other chemical parameters were within the limits.Design of treatment plant consist of pump house , cascade aerator, flash mixer, clariflocculator, rapidsand filter ,water storage tanks. etc.

With this project the utilizable water scarcity and related issues of the people of Dindori Takula has been nullified.

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