Hydraulic and Structural Design of Water Treatment Plant

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Abstract - *Design of a water treatment plant concerns the location, population, future changes in demand and various other factors. Therefore, in order to ensure proper designing of water treatment plant, data with great precision is required. As previous decade's population is available at governmental bodies, population can be forecasted. Water requirement is calculated based of the forecasted population. Survey is done from intake well to treatment plant and the level difference is obtained. Length of the pipe is also calculated. Hydraulic design is based on the water requirement, level difference and length of pipe. Designing of each component is done using Water Supply Manual. Structural design of clariflocculator is also completed. Conventional method is used in the design process. Hydraulic and structural drawings are prepared in Auto-CADD.*

Key Words: Aerator, Flash Mixer, Clariflocculator, Rapid Sand Filter, Chlorinator, Clear Water Reservoir

1. INTRODUCTION

Water is one of the essential requirements for life. All living things need water for their survival. The water supply scheme to Thodupuzha Municipality was commissioned in the year 1981 and subsequently improved the scheme in 1992 by increasing the production from 3.5MLD to 12 MLD. The Raw water is collected from Thodupuzha River. This river was perennial in character. The intake well is at Mooppilkadavu which is very closer to the town. The existing pump sets are very old and not sufficient to meet present demand. Installations of new pump sets are very essential for the uninterrupted supply of the water. The existing treatment plant is of conventional type 1400m away from the intake well. Water is distributed directly from the sump at plant site through the distribution gravity lines. Due to the high elevated and undulated topography area it is not possible to feed water in so many areas. Acute scarcity of water is experienced in that area. In low level area where water is sufficiently available consumption rate may be high and not predictable due to increase in the consumption than our design norms, hence scarcity occurs in the high level areas. Thus a new plant is designed in addition to the already existing one taking into consideration the above stated issues.

Water Quality Analysis

The water quality analysis was done on the water sample collected from the source for ensuring the safety of public health. From the water quality tests conducted it was found that water sample showed positive results only for MPN, all the rest of test results are within the permissible limits.

1.2 Survey

The survey was conducted from the river intake (Muppilkadavu) to the proposed plant site at Thodupuzha. The total length of survey was 2246 meters. We took a total of 64 points out of which 27 were change points (station points). From the results of the survey it was found that site terrain is undulating. From the levels obtained, it is understood that the level difference between intake and the proposed site is about 50 meters. This provides adequate head for pumping and distribution. Site development should take advantage of existing site topography. The topography of the area ensures that gravity flow can be maintained between the different plant components This provides further advantage while laying out of distribution system with minimum pumping

2. POPULATION FORECAST AND DEMAND CALCULATION

The population of past four decade's was collected and population was forecasted using geometric increase method.Demand was calculated using forecasted population and the obtained demand of the water treatment plant was 22MLD.

3. HYDRAULIC DESIGN

Raw water to be pumped for the required demand is 23.1MLD.The design is done based on this discharge.

INTAKE WELL

The diameter of the intake well is taken as 9m.

The height of well=24.9m

RAW WATER PUPMING MAIN

Diameter of pipe=0.6m

Providing two numbers of pumps with 100% standby

The capacity of each pump=135lps

Total head of pump=79m

AERATOR

Diameter of central shaft=0.9m

Number of trays=5

Diameter of last tray=6.5m

Width of each tray=0.52m

FLASH MIXER

Diameter=4m

Number of blades=2

Dimension of blade is 1m x 0.1m

Power required=2.86Kw

CLARIFLOCCULATOR

Diameter of inlet pipe=0.72m

Diameter of central shaft=1m

Provide 4 numbers of ports of 0.25 x 1.1m

Diameter of flocculator zone=14.35m

Depth of flocculator wall=3.9m

Provide two number of flocculator with 100% standby

Diameter of clarifier=32.5m

Side water depth=3.15m

Provides 12 blades of 0.15m x 2 m

RAPID SAND FILTER

Provide 8 numbers of beds of 5.8m x 4.4 m

Sand depth=0.7m

Total depth of gravel layer=0.5m

Provide 24 numbers of 90mm pipe for laterals with 816 orifices

Provide central drain of 0.7m x 0.7m

Provide wash water trough with 3 number of trough per bed of 0.35m x 0.45m

Number of beds provided for backwashing=2

Time taken for single backwashing=7minutes

CHEMICAL HOUSE

Alum dosage=40ppm

Weight of alum required=32.24Kg/hr

Capacity of alum tank=6.2m^3

Lime dosage=20ppm

Weight of lime required=19.24Kg/hr

Capacity of lime tank=3.1m^3

Total area required for storing alum and lime=100m^2

CLEAR WATER RESERVOIR

Storage time for clear water reservoir=1hr

Provide channel of 1.1m x 0.55m

CHLORINATOR

Capacity of chlorine=6Kg/hr

Provide 1 chlorinator with 100% standby

4. STRUCTURAL DESIGN (CLARIFLOCCULATOR)

SIDE WALL OF CLARIFIER

Thickness of side wall=210mm

Effective depth=160mm

Provide 10mm dia bars @200mmc/c and 12mm dia bars @ 125mm c/c on the outer and inner face respectively as vertical reinforcement

Provide 12mm dia bars @200mm c/c in the inner and outer face as horizontal reinforcement

SIDE WALL FOOTING

Provide 10mm dia bars @200mm c/c for toe and heel slab

BASE SLAB OF CLARIFIER

Base slab thickness=200mm

Provide 8mm dia bar @ 200mm c/c on both top and bottom face

FLOCCULATOR WALL

Thickness of flocculator wall=125mm

Provide 8mm dia bars @160mm c/c on both horizontal and vertical direction along 3m height of flocculator wall

COLUMN SUPPORTING FLOCCULATOR WALL

Column size=250mm x 250mm

Provide 4 number of 16mm rods as main bar and 8mm torr stirrups @ 100mm c/c

CENTRAL SHAFT

Thickness of side wall=200mm

Provide 8mm bar @ 200mm c/c on both horizontal and vertical faces on both side

CENTRAL SHAFT FOOTING

Diameter of footing=1.8m

Provide 15 bars of 10mm dia in both directions @ bottom

WALKWAY SLAB

Thickness of walkway=120mm

Provide 8mm dia radial bars @ 240mm c/c and 8mm distributor circumferential bar @ 240mm c/c

5. CONCLUSION

The complete hydraulic and structural (clariflocculator) design of the water treatment plant is done in various steps. Water quality tests are done to determine the type of treatment process to be used. The design period is taken as 30 years and the population of Thodupuzha municipality is forecasted from the population data obtained from previous decades. Water requirement is calculated for the obtained population, incorporating the future demand. Surveying is done and level difference and length, connecting intake well and treatment plant, is calculated.Hydraulic design of water treatment plant components are completed using Water Supply Manual. Structural design of clariflocculator is completed using IS 3370 (Part II and Part IV). The structural detailing and the hydraulic flow line diagram is done using Auto CADD

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