

DESIGN OF WATER TREATMENT PLANT

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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 from Kappathodu canal is directed to the pond near the site by constructing a weir across the canal and the water undergoes proper treatment before it is dispatched.

pollutant present in water, suitable treatment method can be adopted. Generally Alum is used as the coagulant. Addition of coagulant can accelerate the sedimentation process and after filtration, disinfection is done using chlorine. Treated water is again analysed to ensure the properties of water are within the permissible limit. Hence the water can be safely distributed through distribution network. Leakage in water supply networks makes up a significant loss, sometimes more than 70% of the total water losses. The best practices suggest that pressure management is one of the most effective way to reduce the amount of leakage in a water distribution system.

Through this project our aim to establish an efficient water treatment plant in a place called Peelarmozhi which is near to Chalakudy where many people are leading a miserable life due to scarcity of water.

1. INTRODUCTION

In the last decades water resources availability has been a major issue on the national agenda. Providing sufficient water of appropriate quality and quantity has been one of the most important issues in human history. In a situation of worsening scarcity of water resources and the rapidly increasing of water demands, the state of water losses management is part of man's survival on earth.

The state of Kerala is abundant with river systems originating from the Western Ghats lying along the eastern boundary of the state. The total catchment area of the rivers within the state is 37994 sq km and the utilizable yield is about 45000 mm. Even though there is scarcity of water in the state. And the concept of Water supply system can be introduced to solve these problems. Water supply system is the system through which the water from an intake source after treatment stored temporarily in a water storage tank and then distributed through distribution network wherever required.

Water treatment is necessary to obtain drinkable water from the intake source. It is process which removes polluted & pathogenic organism from water and thus making water suitable for drinking and domestic purpose. After the analysis of raw water and according to type of

1.1 DESCRIPTION OF TREATMENT MEASURES

SCREENING

Most of the big and visible objects such as trees, branches, sticks, vegetation, fish, animal life etc, present in raw water of surface sources can be removed by screening. The water from the sump is pumped to the next unit by a centrifugal pump, which doesn't get clogged easily. A pump house at the top 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 CO₂, and to oxidise dissolved metals such as iron. It can also be used to 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 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 raw water 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 the coagulate 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 deflecting wall. The thoroughly mixed water is taken out from the outlet end

CLARIFLOCCULATION

All waters, especially surface waters, contain both dissolved and suspended particles. In clariflocculator coagulation, flocculation and sedimentation takes place which separate the suspended solids portion from the water.

FILTRATION

Filtration is an operation used for the separation of solids from fluids by interposing a medium through which the fluid can pass, where the solids in the fluid are retained . It depends on the pore size and the thickness of the medium as well as the mechanism that occur during filtration. In filtration other mechanisms like direct interception, diffusion and centrifugal action also take place where in those particles, which are unable to follow the tortuous channels of the filter will also , adhere to the structure of the medium and are retained.

The most common type of filter is a rapid sand filter. Water moves vertically through the sand medium which often has a layer 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.

1.2 DISTRIBUTION SYSTEM

It is used to distribute the water to the recipients with sufficient pressure and purity.

Distribution of water can be carried out by different methods

- Gravity method
- Direct pumping
- Combined pumping and gravity

The distribution system are also in different types

- Continuous system
- Intermittent system

OVERHEAD TANK

Tanks are mainly used for storing water for distribution with sufficient head.

- Ground supported
- Overhead tank

Ground supported tanks are mainly used for collecting water. And it is also used for distributing water if the ground level is at sufficient height. Over head tanks are supported on columns constructed using steel or concrete, in which water flows through the system due to gravity.

1.3 WATER QUALITY ANALYSIS

To ascertain the treatment required for the water in a region, proper testing of the water samples collected from the area should 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.

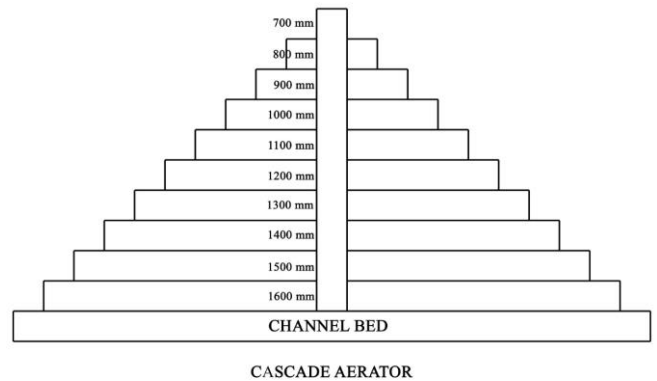
TEST RESULTS

PARAMETER	PERMISSIBLE LIMITS	OBTAINED REULTS
Alkalinity	200-600 mg/L	42 mg/L
pH	6.5-8.5 mg/L	8 mg/L
Turbidity	-	0 NTU
Chloride	250-1000 mg/L	4.99 mg/L
Sulphate	200-400 mg/L	5 mg/L
Iron	0.3-1 mg/L	3.65 mg/L
COD	-	124.97 mg/L
BOD	30 mg/L	59.17 mg/L
E.Coli	NIL/100 ml	>23

REMEDIAL MEASURES

Some of the chemical parameters exceeded the prescribed limits and the below table shows the mitigation measures for the same.

CONTAMINANTS	TREATMENT MEASURES
Iron	Aeration, filtration
BOD	Sedimentation with coagulation, filtration
E.Coli	Disinfection, continuous chlorination



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

- Water consumption rate(lpcd)
- Population to be served

Quantity = per capita demand * population

ULTIMATE WATER DEMAND

Average population = 1500

Average lpcd for rural areas = 135 lpcd

Average water demand = 135 x 1500 = 202500

Max. daily demand=1.8 x avg. daily demand

Hence we design storage tank of capacity 400 m³

1.5 DESIGN OF TRATMENT PLANT

PUMP HOUSE

The pump is working 12 hrs / day and provide two pump of 30 HP , so one is used for pumping and other is kept as stand by. The pump house can be laid over an area of 30 m² with head room height as 6m.

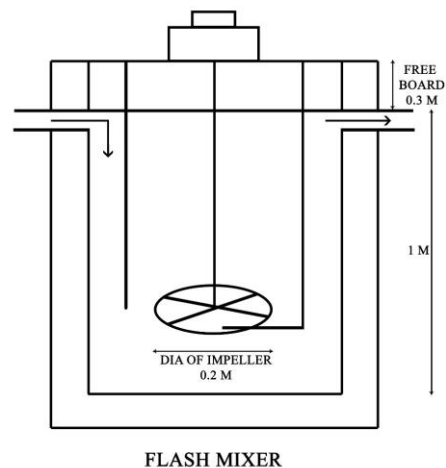
CASCADE AERATOR

Total diameter of cascade aerator is 1600 mm and Width =0.2 m & length = 0.2 m of channel bed

Outer diameter of central shaft is 600 mm

FLASH MIXER

Provide a rectangular flash mixer of c/s (0.5 x 0.55 13)m and Diameter of impeller 0.2m



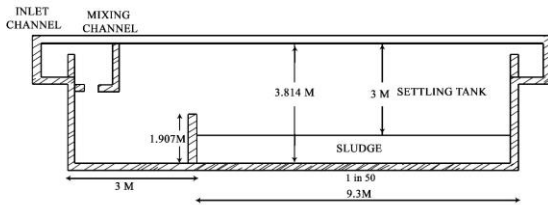
CLARIFOCULATOR

- SEDIMENTATION TANK

Dimension of sedimentation tank is 9.3m x 2.5 m x 4.5m

- FLOC CHAMBER

Dimension of floc chamber is 3m x 2.5m x 1.907m



• WALL OF SEDIMENTATION TANK

i) Reinforcement for long wall

$A_{st} = 4092 \text{ mm}^2$

Provide 20 mm dia bar @ c/c spacing

ii) Reinforcement for short wall

1) Horizontal slab

$A_{sb} = 592 \text{ mm}^2$

Provide 16 mm f @ 340 mm c/c

2) For middle of non-cantilever:

Provide 16 mm f @ 425 mm c/c

3) Cantilever portion of short wall

$A_{st} = 410 \text{ mm}^2$

Provide 16 mm f @ 450 mm c/c

• SLAB OF SEDIMENTATION TANK

Dimension of sedimentation tank is 9.3 x 2.5 m x 3m

$A_{st} = 320 \text{ mm}^2$

$S_v = 245 \text{ mm}$

Provide 10 mm dia bar

FILTER UNIT

4% of filtered water is used for backwashing and every day backwashing are done for 30 minutes.

∴ Provide two filter units of 1.15 x 1.55 m

UNDER DRAINAGE SYSTEM

Total area of perforations in under drainage system to one entire filter area as 0.3%

Provide 40mm \emptyset laterals @ 15 mm c/c each having perforation 12mm \emptyset

DESIGN OF SLAB OF FILTER BED

Reinforcement is

$A_{st} = 1131.21 \text{ mm}^2$

Provide 12 mm \emptyset bars @ 100mm c/c spacing

CHLORINATION

Taking Chlorine dosage of 3 ppm and ultimate water demand 400m³ /day

Bleaching powder required for chlorination per day is 4 kg

RECTANGULAR WATER STORAGE TANK

• SIDE WALL MOMENT

FOR LONG WALL

$A_{st} = 5956.5 \text{ mm}^2$

Provide 20 mm \emptyset bars @ 55 mm c/c spacing

SHORT WALL

$A_{st} = 6044.87 \text{ mm}^2$

Provide 20 mm \emptyset bars @ 60 mm c/c spacing

• CENTER MOMENT

FOR LONG WALL

$A_{st} = 4532.82 \text{ mm}^2$

Provide 20 mm \emptyset bars @ 70 mm c/c spacing

FOR SHORT WALL

$A_{st} = 1680.15 \text{ mm}^2$

Provide 20 mm \emptyset bars @ 200 mm c/c spacing

CIRCULAR OVER HEAD TANK

• TOP DOME

Provide 8 mm dia bar @ 150mm c/c

- TOP RING BEAM

Provide 12 mm dia bar @ 150 mm c/c for hoop tension

Provide 8 mm 2 legged vertical stirrup @ 225 mm c/c for minimum shear

- BASE SLAB

Provide 25 mm dia bar @ 110mm c/c for moment

Provide 16 mm dia bar @ 150 mm c/c at ring ring beam (radial)

Provide 20 mm dia bar @ 130 mm c/c at ring beam (circumferential)

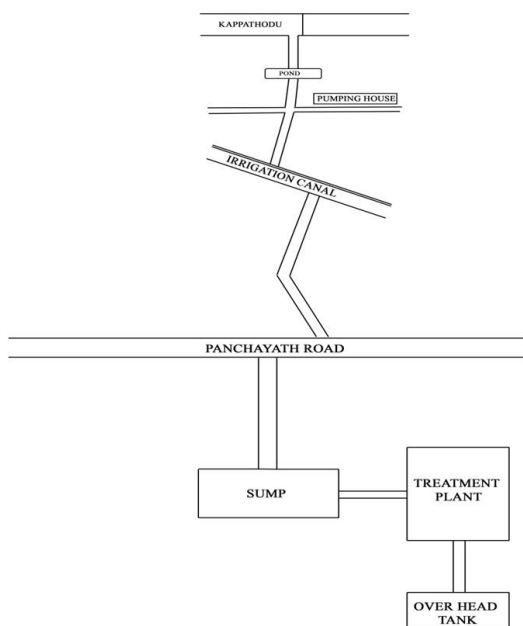
- BOTTOM RING BEAM

Reinforcement at support

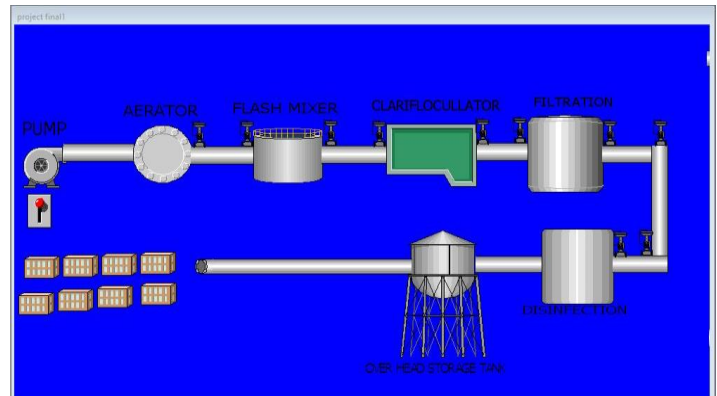
Provide 28 mm @ 140 mm c/c for tension

Provide 20 mm @ 160 mm c/c

1.6 LAYOUT OF TREATMENT UNIT



1.7 TREATMENT UNIT IN SCADA



2. CONCLUSIONS

The design of water treatment plant for Peelarmozhi village has been completed. Water quality analysis showed excess amount of iron and MPN 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, rapid sand filter, water storage tanks (ground level & overhead tank). A working model of treatment unit in SCADA software marked the end of the project.

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

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