International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 02 | Feb-2018 www.irjet.net p-ISSN: 2395-0072

Study on Design of Water Treatment Plant at Paingottoor

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Abstract - *Paingottoor Panchayath is situated in Kothamangalam Taluk in Ernakulam District. This Panchayath faces acute shortage of water. Thus, the Water Authority of Kerala has decided to implement a water supply scheme to the people in this area. Thus a study is conducted on the design of water treatment plant for this new water supply scheme. The proposed water treatment plant has a capacity of 3 mld (million litres per day) and the design is based on rapid sand filtration technique with proper sedimentation and disinfection components. The treatment includes various processes such as pretreatment, aeration, coagulation, flocculation, sedimentation, filtration, fluoridation, conditioning and disinfection. The water treatment plant has been designed based on the water demand and water quality for a design life of 30 years.*

Key Words: **Rapid Sand Filtration, Sedimentation, Water Demand, Population, Water Treatment**

1. INTRODUCTION

Paingottoor panchayath is situated in Kothamangalam taluk at the eastern border of the Ernakulam district, state of Kerala, India. This panchayath is facing acute scarcity of drinking water. A rural water supply scheme to Kadavoor village is now functioning in this area as a part of a comprehensive scheme to Kadavoor, Kallorkadu and Kumaramangalam. But, it is insufficient to meet the present demand of water in its service area.

A majority of this panchayath is hilly area. Due to the peculiarity of the topography of the panchayath, availability of drinking water from the local sources is onlyavailable for a short period of time. In summer season, almost all wells are dried up and scarcity of water is being experienced in this panchayath area. Being the prime need of human being, poor quality of water will adversely affect the health of the people in this area. The inhabitants in this area belong to poor community. Most of them are from Agriculture sector. Majority of the people belong to BPL category. Due to lack of safe drinking water, diseases like jaundice, diarrhoea etc. are very common.

Considering the present grave situations, it is essential replace the existing water supply scheme with a new water supply scheme to provide safe drinking water to the people in the area of this project. Hence, this project is prepared and submitted for approval. Population of scheme area as per 2011 census is 15336 including SC and ST and the projected population calculated at the end of 2048 is 18857.

2. LITERATURE REVIEW

In Water supply engineering, S.K Garg has focused on the various conventional techniques including slow sand filtering and rapid sand filtering methods and their significance, suitability and applications briefly. The essential water quality tests to determine the quality of water at Kaliyar River and the various factors to be considered while designing water treatment plant were studied.

Dr. C Nagamani along with 3 co-workers determined the quality of water samples taken from urban and rural locations at Bangalore and analyzed the physico-chemical status of water samples. In physico-chemical analysis, various quality parameter is measured including pH, Specific conductivity (SP), total dissolved solids (TDS), total hardness compared with WHO standards of water quality.

IS 10500:2012 gives details of the permissible and desirable limits of various parameters in drinking water as per Bureau of Indian Standards (BIS) standard specifications for potable water (BIS-10500-1991).

Ranjeet Sabale and Sahil Mujawar compared the conventional rapid sand filter and capped rapid sand filter. Due to improper backwashing mud ball formation is a major problem shown in filter media.

3. METHODOLOGY

3.1 Data Collection for Population Estimation

The decennial increase in population is 5.69 %.

Table -1: Calculation of forecasted population

Population as per 2011 census	Forecasted population in		
	2018	2033	2048
15336	15948	17341	18857

3.2 Water Demand Calculation

The per capita demand is 70 lpcd.

Table -2: Calculation of design demand

Water Demand in mld			Design Demand including NRW
2018	2033	2048	
1.116	1.214	1.320	1.518

3.3 Sample Collection

It is an absolute necessity that the attempts to collect samples that are representative of the matrix under investigation. When collecting samples, predetermined sampling protocols (procedures and methods) which have been chosen (bearing in mind the sampling (collection) site, the number of samples to be collected, and the timing of the sampling) to meet the purpose of the survey, and which are appropriate to the media is being investigated . The sample is collected from the Kaliyar river at Panamkara.

3.4 Tests for Water Quality Analysis

3.4.1 Determination of Alkalinity

Phenolphthalein alkalinity (P) as mg/L CaCO3 = 0 mg/l.

Therefore, Hydroxide alkalinity = 0 mg/l.

Carbonate alkalinity = 0 mg/l.

Bicarbonate alkalinity = 30 mg/l.

As per IS 10500-1991, desirable limit of alkalinity is 200 mg/l and the permissible limit is 600mg/l. Since, the alkalinity obtained is 30 mg/l which is less than 200 mg/l. So the sample can be used for the drinking purpose with respect to its alkalinity criteria.

3.4.2 Determination of Acidity

Mineral acidity in mg/L as $CaCO_3$=300 mg/L.

Since, the sample contains mineral acidity it should be treated before using for drinking purpose.

3.4.3 Determination of Dissolved Oxygen

The Dissolved oxygen of given sample was obtained as 7.5mg/l.

3.4.4 MPN of Faecal Coliform

Water containing faecal coliforms will produce gas in 24 +/- 2 hrs when inoculated in A broth and incubated at specified temperature. The reagent used is culture medium- A1 broth.

3.4.5 Determination of Residual Chlorine

Residual chlorine content in the sample is 0 mg/l.

As per IS 10500-1991, the minimum desirable limit of residual chlorine is 0.2 mg/L. Residual chlorine present in the given water sample is much lesser than the minimum limit.

3.4.1 Determination of Chloride

The chloride content in mg/L =3.5 mg/L. As per IS 10500:1991 the desirable limit for chloride content in portable drinking water is 250 mg/L. Since the chloride obtained is 3.5 mg/L which is less than 250 mg/L, so sample can be used for drinking purpose.

3.4.1 Determination of Hardness

Carbonate hardness = 148mg/l.

Non-Carbonate hardness = 118mg/l.

As per IS 10500:1991, desirable limit for hardness as $CaCO_3$ is 300 mg/l. The sample has a total hardness 148 mg/l which is less than 300mg/l.

3.4.1 Determination of Turbidity

The turbidity of given sample of water was found to be 18.7 NTU. As per IS 10500:2012, the permissible turbidity of drinking water is 5 NTU. So, water is not suitable for drinking purpose.

3.4.1 Determination of Sulphates

Sulphate content in the sample is 13.56 mg/l which is less than the desirable limit (200mg/l) and permissible limit (400mg/l) as per IS 10500:2012. So, this water can be used for drinking purpose with respective of sulphate content alone.

3.4.1 Determination of pH

pH value of water indicates the hydrogen ion concentration in water. At neutrality the pH of pure water at 25˚C is 7.
pH= -log [H +]

Reagent used is pH paper. The result obtained was 7(neutral).

3.4.1 Determination of Solids

The term solids mean solid matters suspended or dissolved in water or waste water. Water with high residue is generally unacceptable. A limit of 500 mg/l (dissolved solids) is fixed for drinking water.

3.5 Design of Water Treatment Plant

A new water treatment plant of capacity 3 mld is proposed to be constructed as a part of this scheme to meet an ultimate demand for a population of 18857 in the year 2048.

The main components of the water treatment plant are: Sedimentation cum coagulation tank, Rapid sand filter and Disinfection.

3.5.1 Input Conditions

The output capacity is 3MLD. The wastage and loss are assumed to be 2% of the filtered water and the time lost

during backwashing is assumed to be 25min. The time available for filtration is taken as 23.58h. Thus, the design capacity (Dc) is 130m^3/h.

3.5.2 Cascade Aerator

The criteria and the number of units adopted are 0.03m^2/ m^3/hr and 1 unit respectively.

The diameter of bottom most tray (Da) is obtained as 2.3m.

The number of steps is assumed to be 3. The size of tread and rise of each step are 0.4m and 0.25m respectively. Thus, the total height of aerator is obtained as 0.75m.

The diameter of trays was obtained as 2.30 m (bottom most), 1.80 m (2nd tray), 1.30 m (3rd tray) and 0.80 m (4^{th} tray).

Collecting peripheral launder is designed for 50% overload with depth of launder as 45 cm and free fall as 0.2 m.

3.5.3 Measuring weir

Triangular weir or V notch with a channel of 5 m length give a steady and uniform flow over the weir.

3.5.4 Flash mixer and Raw Water Channel

One unit of flash mixer is provided with detention time of 45 sec. The diameter and the total depth are obtained as 1.25 m and 1.80 m respectively.

The size of raw water channel obtained is 30 m x 0.4 m x 0.3 m.

3.5.5 Design of Clariflocculator

The velocity and diameter of the inlet pipe are obtained as 0.80 m/s and 500 mm respectively.

Only one flocculator unit is taken with a detention time of 30 min. The outer diameter of flocculatoris 5.3 m and 4 number of blades are taken.

For Clarifier, detention time is assumed as 2.5 hr. 1 unit is proposed. The diameter of flocculator is obtained as 12 m. Outer wall depth was provided as 3.50 m.

3.5.6 Alum Solution Tank

Dosage of Alum provided= 20 mg/l

Hence size of alum solution tank obtained is 2.9 m x 2.65 m x 1.05 m.

3.5.7 Lime Solution Tank

Dosage of Lime provided= 20 mg/l

Therefore, provide 2 lime solution tank of size 2.9 m x 2.65 m x 1.05 m

3.5.8 Rapid Sand Filter

Filter rate is assumed to be 80 lpm/m^2

8 Beds of size 6.25 m x 5 m is provided.

3.5.9 Under drain system

In Manifold, a central cannel of size 0.55 m x 0.65 m is provided. 75 mm PVC 10 kg pipes is provided as laterals with a lateral spacing of 23 cm.

3.5.10 Back Wash

Rate of back wash water	-	0.50m^3/m^2/min
Duration of water wash	-	10 min
Quantity of back wash water	-	156.25 m^3

3.5.11 Filter House

A filter house of size 33 m x 24 m is provided.

3.5.12 Wash Water Tank

A Wash Water Tank of size 10.5 m x 10.5 x 3.3 m is provided.

3.5.13 Clear Water Sump

A Clear Water Sump of size 17 mx 17 m x 5 m is provided.

3.5.14 Clear water pump house

Length and width is provided as 17 m x 10 m.

3.5.15 Backwash water reusing system

For settling tank , water depth is assumed as 3.20 m. The size obtained is 10.00 m x 5.00 m x 3.50 m.

For holding tank, same size of 10.00 m x 5.00 m x 3.50 m is provided.

3.5.16 Drain for disposing waste water from the plant

A Channel size of 0.65 m x 0.90 m

Length of channel required -100.00 m.

3. CONCLUSIONS

The design of water treatment plant has been done successfully. From our project, it is expected to obtain a water treatment plant with a capacity of 3 MLD. On completion of this project into practice, a population of 18857 living in Paingotoor Panchayath will be benefitted

with safe drinking water, thereby fulfilling the dreams and necessary requirements of the people.

ACKNOWLEDGEMENT

I would like to take this opportunity to thank a lot of eminent personalities, without whose constant encouragement, this endeavor of mine would not have become reality.

I would like to express my gratitude to SOORYA R., Assistant Professor, Department of Civil Engineering, VJCET, Kerala for her support and valuable guidance.

I am extremely thankful to Prof. SHINE GEORGE, HOD of Civil Engineering Department, VJCET, Kerala for her encouragement and support.

I would like to thank all the Assistant Professors, Department of Civil Engineering for providing me their valuable guidance.

Last but not the least, I express my deepest sense of gratitude for the inspiration, enthusiasm and help given by my parents and friends.

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