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Augmentation of Water Supply Scheme to Muvattupuzha

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***Abstract*: Muvattupuzha possess first in many hills. The city is nearing to upgrading from municipality to district. Hence it's a fast industrial growth and urbanization has been noticed in all sectors. Many housing complexes and flats commercial and business centers, industrial and educational complexes are sprouted. The highly civilized life style and high living standards of the people have increased the demand of water. Due to the non-availability of alternate sources like open wells, ponds etc., the people invariably depend upon on piped water for all their requirements. The water supply scheme to Muvattupuzha was designed for 2021 AD. This scheme was commissioned in the year 1975 and augmented in 2002 up to10.5 mld capacity with design period upto 2021AD. This project aims to access the water parameters of Muvattupuzha water and to provide augmentation to the Muvattupuzha water treatment plant with design period upto 2051 AD.**

***Keywords*: Augmentation, functional design, population forecast, treatment plant, water parameters, water demand.**

1. Introduction

The municipal town of Muvattupuzha is a fast developing urban township situated in the foot hills of Eastern Ghats in Ernakulum district. A supply scheme was commissioned in the year 1975 and then augmented on 2002 up to 10.5 MLD with a design period up to 2021 AD. But a number of extensions were given from this scheme to neighboring villages named as Marady, Vellorkunnam and Muvattupuzha village. Due to this extension and consequent increase in standard and style of living of people the Augmentation of this scheme is necessitated. It is an important trade center for hill products such as ginger, pepper, cardamom, rubber etc. The main route passing through this municipal area is to Sabarimala pilgrim center from northern side of Kerala and other southern states.

The Muvattupuzha municipality was formed in 1958. Muncipality has an area of 13.18 km2 and a population of 30397 as per 2011 census. The total number of household is 6513. The three rivers kaliyar, Kothamangalam and Thodupuzha rivers are joining in this town. Hence this town is known as Muvattupuzha. The town is blessed with Perennial River, good roads, business houses. Trade centers education institutions and cultural establishments. The town is good example for Indian's rich culture unity in diversity – people of different castes pursue their life in peace. Temple churches and mosques jostle in perfect coexistence.

The water supply scheme to Muvattupuzha was designed for 2021AD. This scheme is commissioned in the year 1975 and augmented in 2002 up to 10.5 MLD capacity. The intake well is situated at Kavumpady Karamu and Treatment plant at Sivankunnu 200m from intake point. The proposal is for enhancing the drinking water supply rate to 150 lpcd to the inhabitants in newly enhanced Muvattupuzha municipality. 35% of domestic demand is added to meet institutional, industrial, firefighting and plotting population demands. Thus the ultimate water demand of the new water supply project for the year 2051 AD is estimated.

2. Methodology

A. Quality of water

Th The quality of water is the criterion for the assessment of suitability of water for drinking and irrigation purposes. It is determined by testing the water sample for different water parameters.

1) Water parameters

The river water sample is tested for different water parameters like colour, odour, turbidity, alkinity, acidity, sulphate, iron, magnesium, calcium and total hardness to evaluate the extend of pollution Muvattupuzha river water. subsection heading and modify the heading.

Table 1
Test results

Characteristics	Desirable limit	Obtained value	Inference
Alkalinity(mg/l)	200-600	18	Not agreeable
Colour(mg/l)	5	10	Not agreeable
Turbidity(ntu)	1	13.2	Not agreeable
Ph	6.50-8.50	6.57	Not agreeable
Acidity(mg/l)	5	8	Not agreeable
Sulphate(mg/l)	200-600	190	Not agreeable
Total hardness	300-600	36	Not agreeable
Calcium(mg/l)	75	7.21	Not agreeable
Iron(mg/l)	0.3-1	1.16	Not agreeable
Nitrate(mg/l)	45	2.04	Not agreeable
Magnesium(mg/l)	30	4.37	Not agreeable

2) Population forecast

Population forecast is the calculation of how many people will be living in country or in a town at some point of time in the future.

Using geometrical increase method, Population, P_n
$= P \times (1+r)^n$
As per the 2011 census population municipality
= 30,397
Design period
= 30 yrs.
Base year
= 2019
Assuming the plant will commence to function from 2021 population estimated
I.e. 2021+30
= 2051
Assuming that the rate of increase in population per decade
= 12.45%.
Population in 2019
= 33401
Population in 2051
= 43690.87
≈ 48691
Hence the treatment plant is designed to serve a population of around 48691.

3) Water demand

The total water consumption depends on several factors like: climatic conditions, cost of water, living standards of the inhabitants, pressure in the pipelines, type of supply, etc. The total quality of water required divided by the total population gives the per capital water demand.

Table 2
Water demand

Year	Population	Water demand in mld
2021	34198	5.12
2036	40807	6.12
2051	48691	7.30

Taking Institutional, industrial, firefighting and plotting population demands as 35%.

Table 3
Total water demand

Year	Taking 35% of domestic demand	Total water demand in mld
2021	1.76	6.91
2036	2.14	8.62
2051	2.55	9.85

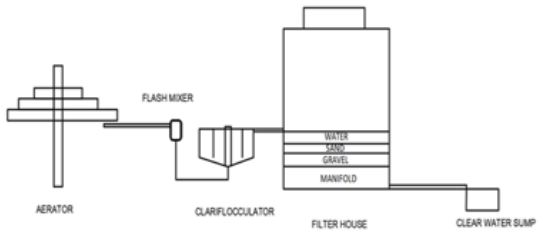

Fig. 1. Hydraulic flow chart

Design of raw water pumping main

Length of pumping main = 225m
Ultimate demand in 2051 = 9.85mld
Demand including 10% wastage = 10.83mld
Hours' of pumping = 23hrs
Rate of pumping in lps $= 10.83 \times 10^3 (23 \times 60 \times 60)$
i.e =131lps
Assuming the velocity of flow = 1m/s
Discharge, Q = AV
0.131m/s $= \pi/4d^2$
Diameter, D = 0.408m
≈450mm
therefore, provide 450mm dia DI K – 9 pipe.

Design of cascade aerator

Design flow = $9086 m^3$/day
No of units = 1
Flow per unit = $9086 m^3$/ day
Velocity should be always less than 1.0 m/s and the preferred velocity range is 0.2 to 0.8m/s

Design of Aerator Shaft

Internal diameter of aerator shaft $= \sqrt{(O.109 \div (\pi \div 4) \times 0.8)}$
i.e = 0.5
Outer diameter of shaft (assume 20 cm thick concrete lining)
i.e = 0.5+0.4 = 0.9 m
Let us provide cascade aerator with four trays
Rate of flow = $9086 m^3$/ day
$= 0.109 m^3$/day
$= 0.109 \times 60 \times 60$
$= 393 m^3$/hr.
Loading rate ranges from 0.015 to 0.045 m^2/m^3/ hr.
Loading rate = 0.04 m^2/m^3/hr.
Area required for bottom tray $= 393 \times 0.04$
= 15.72
≈ 16 m^2
Diameter of bottom tray, D_4 = 4.5 m
D_3 =4.5-1 = 3.5m
D_2 = 2.5m
D_1 = 1.5m

Design of flash mixer

Design flow = $0.109 m^3$/s
No of units = 1
Flow = 0.109
= 0.109 m^3 /s

Detention time 20 to 60 sec
Assume detention time t = 30 sec
Volume V = Q×T
$= 0.109 \times 30$
= 3.27 m^2
≈ $3.3 m^2$

Provide a rectangular flash mixer
V = L×B×H
L = B
Assume H/B = 1.5B
V = B×B×1.5B
$= 1.5 B^3$
3.3 $= 1.5 B^3$
B^3 = 3.3/1.5
= 2.2
B = 1.3

V = 1.3×1.3×2
V = 3.3 m^3
Hence provide 1.3×1.3×2 m flash mixer.

Design of clariflocculator

No of units = 1
Flow per units = 0.109 m^3 /sec
Velocity ranges from 2m/sec to .8m/sec
Assume 2m/sec
Internal diameter of shaft = √ (0.109 x 4) ÷ (π x 0.7)
= 450mm
External diameter of shaft = 0.45 + (0.2×2)
= 0.9m
=900mm
Area of central shaft A1 = π/4×0.92
= 0.63m^2
Hence provide a central shaft with 450 mm internal diameter and 20 cm wall thickness, so that external diameter is 900 mm.

Design of filter house

Rapid sand gravity filter is provided.
Rate of filtration ranges from 80 to 100 1pm/m^2
Generally, 80 1pm/m^2
Therefore, area = 0.109÷(80x10^{-3}÷60)
= 81.75m^2
Minimum number of filter beds, n = 12√Q
= 12√0.109
= 3.96
≈ 4nos
Area of single bed is not greater than 15m^3
Therefore, number of beds = 81.75/15
= 5.45
≈ 6 nos
Provide 3 twin beds
Size = 81.75/6
= 13.625 m^2
L/B ratio ranges from 1.25 to 1.33
Assume L/B ratio = 1.31
L = 1.31B
1.31B^2 = 13.625
B = 3.23 m
≈ 3.2m
L = 3.22x1.31
= 4.22m
≈4.2m
Hence size is 4.2mx3.2m
Area =13.625m^2
Total area = 2x3x3.2x4.2m
= 80.64m^2
Width of gullet varies from 0.8 to 1m.

Design of clear water reservoir (CWR)

Output capacity = 10.83x(10^3÷24)
= 451.25m^3/hr
Duration for temporary storage = 0.50hr
Capacity of CWR = 902.5m^3
≈ 903m^3
Assume a water depth of 3m
Therefore, area of tank = 903/3
= 301m^2
Assume L/B = 1.5
L = 1.5B
1.5B^2 = 301m^2
B^2 = 201m^2
B = 14.17
≈ 15m
L = 1.5×15
= 22.5m
≈ 23m
Provide 0.5m free board
Height, h = 3.5m
Hence provide a tank of size 23×15×3.5m.

3. Result and discussions

1. The river water is highly polluted and is subjected to treatment. The results of tests on water parameters such as colour, odour, turbidity, alkalinity, acidity, sulphate, Calcium, iron, magnesium and total hardness are negative.
2. The water treatment system to Muvattupuzha is augmented with respect to population forecast and water demand for the design period up to 2051 AD.
3. The following components are designed:
   - Raw water channel with 450 mm dia DI K– 9 pipe.
   - Cascade Aerator with four trays and a design flow of 9086 m^3/day.
   - Rectangular flash mixer of 1.3 x 1.3 x 2m size with design flow of 0.109m^3/s.
   - Clariflocculator with central shaft of 450 mm internal dia and 20cm thickness.
   - Filter House Containing 3 twin beds of size and Filter inlet pipe of 400mm dia.
   - Clear water reservoir of size 23×15×3.5m.

4. Conclusion

The study assessed the evaluation of water quality in Muvattupuzha River. Results of the study show that river is highly polluted. This may be due to the municipal and industrial waste discharge to the river. Results of present investigation shows that all the water samples tested were biologically poor and hence unfit for consumption. Conventional treatment and disinfection is recommended before using it for drinking and other human activities. The project is aimed to providing completely safe and economical water to Muvattupuzha. The project includes the details of population projection, water demand, and the design for the augmentation of treatment plant at Muvattupuzha and it was completed. The project mainly deals with the water quality, functional design and the overall augmentation of water supply system for the design period upto 2051.

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