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Design of Components of Water Distribution System for Ayavana Panchayat

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Abstract - *Like air, water is* also *an essential requirement of all the creatures on earth. Population is growing rapidly, so sufficient quality and quantity of water is required to meet the growing demand. To achieve this Kerala Water Authority rules and regulations have been followed. Water is required for industrial, commercial, institutional, public needs as well as for firefighting. This paper deals with the augmented design of components of water distribution network for Ayavana Panchayat. One of the major direct benefit of this project is to supply potable water to a large group of people. According to government of Kerala, depending on the land features, the per capita consumption of water by an individual person in an area is 100 liters/day and the design is made based on this assumption.*

***Key Words*: Distribution network, water demand, population forecast, gravity system, frictional loss**

1. INTRODUCTION

Water supply systems are basic necessity of every city or town having dense population. If good water supply systems are not provided, general health in a city cannot b maintained. Therefore, providing clean water is more important than any other services. People depend on water for different daily needs and it is an inevitable factor in daily life. Since population growth is exponential, water has to be supplied to meet their need and should be of good quality. A quick and easy access to potable water will bring vast improvements in the quality of life, such as improved life expectancy, reduction in water borne illness etc. This paper deals with the augmented design of components of water distribution network for Ayavana Panchayat. Ayavana panchayat is situated 8km away from Muvattupuzha on the banks of river Kaliyar. Ayavana panchayat includes Anchalpetty, Kakkattoor, Kalampoor, Enanelloor, Kavakkad, Karimattom etc. Kerala water authority rules and regulations have been followed for the design. For sufficient design, the components for collection, treatment, storage, transportation at desired pressure and velocity are needed to be designed. Reservoir, aerator, overhead tank, pipe lines, pumps, valves etc should be designed to meet the water requirement.

2. DESIGN

2.1 Population Forecast

One of the most important factors that determines the amount of water to be supplied to a region is the population of that region. Population is forecasted based on design period. Various methods can be used for population forecast such as Arithmetical Increase, Geometrical Increase, Incremental Increase etc., Here the method adopted is Incremental Increase method.

According to incremental increase method,

$P_n = P + nI + nr\,(n + 1)/2$

Where, P = present population = 20539

I = average increase per decade =1038

r = incremental increase = 5.6%

n = number of decades

The population of Ayavana Panchayat is 20539 according to 2011 census. The values of I and r is also obtained from census data. The population for the years 2020, 2021, 2036 and 2051 is forecasted using the above method. The population forecasted for the years 2020, 2021, 2036 and 2051 is 21478, 21719, 23617 and 25680 respectively.

2.2 Water Demand

Water demand is the total amount of water used by people or customers in an area. Hence it is a function of population. The water required for a person is taken as 100 liters per capita per day.

Water demand = population * 100 liter per capita per day.

The water demand estimated for the years 2021, 2036 and 2051 is 2.172, 2.362 and 2.568 Million liter per day respectively.

2.3 Water system losses

Water system losses can occur due to many reasons such as leakage from service reservoirs, leakage from pipe connections, frictional losses in pipes etc., frictional loss in pipes can be estimated with the help of Hazen-Williams equation.

According to Hazen Williams equation,

hf = 6.843 (D*1.167) *VC*1.852

Where D is the diameter, V is the velocity of flow, C is the Hazen William coefficient

2.4 Method of distribution

There are 3 different methods by which water is distributes to the consumers. They are

i) Gravity system
ii) Pumping system
iii) Combined gravity and pumping system

The system used here is gravity system which means water is flowing under gravitational force. Pumping system is used where water does not reach by gravity.

Gravity system is more reliable and economical distribution system since source of supply is at sufficient height.

2.5 Layout of distribution network

Laying of distribution systems can be done in four ways:

- Dead end system
- Gridiron system
- Ring system
- Radial system

The distribution system adopted for Ayavana Panchayat is dead end system. Pipes in dead end system can be laid easily, also the discharge and pressure can be determined easily and accurately in each pipe which makes design calculations simple.

2.6 Conducting topographic surveys and preparation of maps

To obtain the levels for fixing up the alignment of the rising main the area is surveyed between the source of water supply and the distribution area. The treated water is carried to the distribution reservoir with the help of this main. The detailed survey map of distribution area is also prepared showing the positions of residential area, industrial area, roads, lames etc., To locate the elevations of each region and differentiate the low and high elevated region topographical maps are also prepared.

2.7 Tentative layout

A tentative layout is prepared marking the positions of water treatment plant, distribution mains, valves, pumps, fire hydrants etc., The whole area is divided into zones. In the case of Ayavana panchayat the whole area is divided into three zones. The zones are selected by considering the easiness of distribution. The population density of these three zones are also marked.

2.8 Discharge in pipelines

Discharge in pipelines are determined based on the population density of the area and the zone to which water is transmitted. The discharge in pipes should be kept 2.25 to 3 times that of average rate of supply.

Discharge = demand / (working hours*60*60)
= 3.58 / (16*60*60)
= 62.07 liter per second

2.9 Calculation of pipe diameters

After finding the discharge in pipes, the pipe diameters can be found by assuming a velocity between 0.6 to 3 m/s. Here velocity is assumed as 1m/s for calculating pipe diameter.
We know that, Q = A V
$= (\pi/4) * d^2 * 1$
From the above equation pipe diameter d can be determined. During the late 19^{th} century cast iron pipes were installed in water distribution systems. They were replaced by ductile iron pipes and finally to plastic pipes introduced in 1970s and beyond.

2.10 Appurtenances

Given below are some accessories that can be fitted to the distribution system
(i)sluice valves or gate valves
(ii)Air valves
(iii)Reflux valves
(iv)Relief valves
(v)Altitude valves, and scour valves.

2.11 Laying of distribution networks

For normal and heavy traffic, the minimum trench depth should be 15+ D+30+ ≥145 cm and for other cases it should be 15+D+30+≥115 cm.

Where, D = external diameter of the pipe in cm
15cm = bedding thickness
30cm = compacted overburden thickness.
Filling on the pipes should be more than 0.8 cm in depth, and referable one meter to protect it from heavy traffic loads and also for the long life of the pipes.

3. CONCLUSION

The present research work is to develop sustainable water network system for Ayavana Panchayat, Ernakulam. Initially work is carried out to understand present situation of water management system in the study area. Based on the results obtained and present water system losses, new pipe diameters and sizes of other components are computed. The design mainly focuses to verify social satisfaction level, economic viability, environmental sustainability and system robustness.

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