Vol-08 Issue 08, August -2024 ISSN: 2456-9348
Impact Factor: 7.936

IJETRM
International Journal of Engineering Technology Research & Management
Published By:
https://www.ijetrm.com/

TO STUDY THE DESIGN PARAMETER OF DRINKING WATER TREATMENT PLANT

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ABSTRACT
The design of a drinking water treatment plant is crucial to ensure the provision of safe and clean water for public consumption. This project outlines the comprehensive approach taken in the design and implementation of a modern drinking water treatment facility. The plant is designed to process raw water from natural sources, such as rivers or reservoirs, through a series of treatment stages to remove contaminants and pathogens. The primary treatment stages include coagulation, flocculation, sedimentation, filtration, and disinfection. Advanced technologies and materials are integrated to enhance the efficiency and reliability of the treatment process. For instance, high-efficiency pumps and energy-saving systems are employed to reduce operational costs and environmental impact. With the continuous increase in population, there is a corresponding rise in the demand for water to meet the needs of the community. This necessitates the redesign and expansion of existing water treatment plants. The redesign includes both the hydraulic design and the treatment process of the plant. For the hydraulic design, it is essential to forecast the population. In this case, the population forecast has been performed using the incremental increase method. To design the treatment process, it is crucial to understand the properties of the raw water. The physical, chemical, and biological properties of the water have been determined, and these properties influence the chosen method of treatment. We are designing the water treatment plant for the towns of Borgaon and Sangoba, with the Sina River as the source of raw water. The properties of the water vary depending on its surface source. The average total water demand for the area has been estimated to be 270 Liters per capita per day (LPCD). The plant is being designed to serve a population of 10,000. The layout of the water treatment plant will be designed using AutoCAD software, taking into account all necessary hydraulic and treatment process considerations.

Keywords:
Design, Demand, Water treatment plant, Population.

1. INTRODUCTION

1.1 General
Designing drinking water treatment plants for rural areas is a multifaceted challenge that requires a comprehensive understanding of local conditions and the integration of appropriate technologies. The primary objective is to ensure the provision of safe, clean, and reliable drinking water, thereby enhancing public health and improving the quality of life for rural communities. This endeavor is particularly critical as rural areas often face unique challenges such as limited financial resources, sparse and dispersed populations, and varied water sources that demand tailored and innovative solutions.

1.2 Scope of Project
Drinking water treatment plants are used to remove particles and organisms that lead to diseases and protect the public's welfare and supply pure drinkable water to the environment, people and living organisms. In addition, they also provide drinking water that is pleasant to the senses: taste, sight and smell and provide safe, reliable drinking water to the communities they serve.
Drinking water is sourced from surface water (lakes, rivers, and reservoirs), groundwater (wells and boreholes), and rain. The treatment of water varies based on its source. Surface water is exposed to environmental elements such as wildlife droppings, urban and agricultural runoff, and trash. Groundwater, stored in underground reservoirs known as

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aquifers, has historically been considered safe without treatment due to its natural filtration process as it seeps through the ground. It is more protected from environmental elements compared to surface water and is free from air pollution One of the major challenges facing many Nigerian local communities today is the non-availability of potable water for domestic use. Potable water, suitable for drinking, is scarce in numerous communities, from cities to villages. Although many communities have abundant surface and groundwater resources, turning this raw water into a suitable form for public consumption is challenging due to various factors. These challenges include economic constraints, technical difficulties, and management inadequacies.
Addressing these issues requires a multifaceted approach involving appropriate water treatment technologies, adequate funding, and efficient management practices to ensure the provision of safe and potable water to all communities.

OBJECTIVES

The study has following objectives
1.Study the requirement of water demand with respect to future population
2.Design the parameter of water treatment plant
3.prepare AutoCAD layout of plant

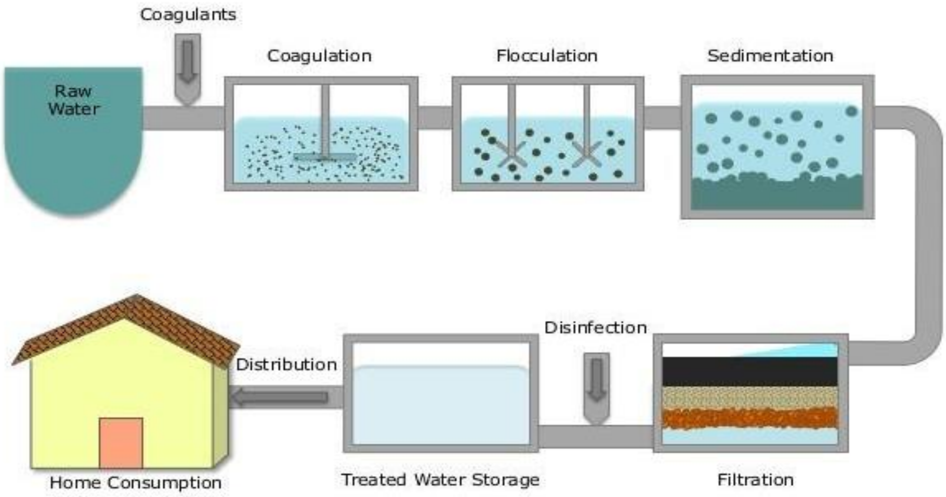
METHODOLOGY

3.1 Drinking Water Treatment Process

In rural areas, ensuring access to clean and safe drinking water is a critical health priority. The process of treating drinking water in these regions involves several key methodologies tailored to address specific challenges such as limited infrastructure and variable water quality sources. Initial steps often include community-based assessments to identify local water sources and contamination risks. Treatment techniques can range from simple, low-cost methods like boiling and solar disinfection to more advanced approaches such as bio-sand filtration, chlorination, and the use of ceramic filters. Implementing these treatments requires a comprehensive approach that encompasses not only the technical aspects of water purification but also community education and participation to ensure sustainability and effectiveness. By integrating these methodologies, rural communities can achieve significant improvements in water quality, thereby enhancing public health and overall quality of life.

3.2 Benefits of project

Fig.1 Water treatment process



Improved Health: Reduces waterborne diseases by removing pathogens and contaminants.
Increased Access: Provides reliable access to safe drinking water for the entire community.
Economic Benefits: Reduces medical expenses and increases productivity by preventing illness.
Enhanced Quality of Life: Improves overall well-being and supports daily activities by ensuring clean water availability.
Sustainability: Promotes long-term water resource management and conservation.

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Community Empowerment: Educates and involves local populations in water management, fostering self-reliance.
Environmental Protection: Minimizes environmental degradation by treating wastewater and promoting cleaner ecosystems.
Design period is defined as the future period for which a provision is made while planning and designing the water supply program

3.3 Selection Basis of Design Period

Design period must be nominated in such a way that it is neither too long nor too short. Shorter design period may lead to an uneconomic project whereas a longer design retro may result in the fiscal load on the present-day population as the gears need to be of high capacities.
Following is the selection basis of design period
Fluid Available
The fluid available at the water source must be able to fulfil the needs and demands at the design year. Advanced the Fluid accessible longer can be the enterprise period and the plan period would be shorter if the fluid existing is low.
Development of community
For the evolving publics, higher will be the people growing amount due to passage from the community with poor infrastructures. So, the estimation of the population may not be accurate so a short design period is selected whereas the case is just reverse for the developed community where population growth rate is low.
Population Growth rate
Due to passage and extra natural spectacle as genetic and passing the population cannot be correctly strongminded so the design dated is booked shorter for high people growing rate.
Availability of funds and rate of interest
If the account accessible for the water source system is acceptable (not limited), the system with higher volume can be built for which a extended design period can be taken. Shorter project dated is taken when the fund is partial. If the interest on the money borrowed for the construction of water supply project, a longer design period can be take and vice-versa.
Design period of working period
This drinking water treatment plant we are going to design is for 5 decades i.e. 50 years from 2021 to 2061.

3.4 Population forecasting

Population prediction is clear as the method of causal the expected populace for a particular design period of water supply system with the help of the study and analysis of future events and available records.
Methods of population forecasting
Arithmetical increase method
Geometrical increase method
Incremental increase method
Decreasing rate of growth method

3.4.1 Arithmetical increase method

In this method the normal rise in people per era is calculated from the past survey reports. This rise is added to the existing people to find out the population of next era. We have use Arithmetical increase method to calculate the future population of villages. For this we have taken the population of last six decades and from this data we have calculated the population for next five decades.

3.5 Water Demand

Water demand is definite as the capacity of river requested by operators to mollify their requirements.
There are two types of water demand
1) Domestic demand
2) Commercial demand
We have considered total water demand 270LPCD as per standard
Definition of Potable Water
Potable or drinking water can be defined as the water delivered to the consumers that can be safely used for drinking, cooking, and washing. A certification by licensed professional applied scientist focused in the field is no longer satisfactory. The public health aspects are of such importance and complexity that the health authority having jurisdiction in the community now reviews inspect, samples, monitors, and evaluates on continuing basis the water supplied to the communal using continually updated intake water standards.

3.6Unit of water treatment plant

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Impact Factor: 7.936

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Intake structure
Screening unit
Aeration unit
Coagulation
Flocculation
Sedimentation
Filtration
Disinfection
Flow chart of drinking water treatment process

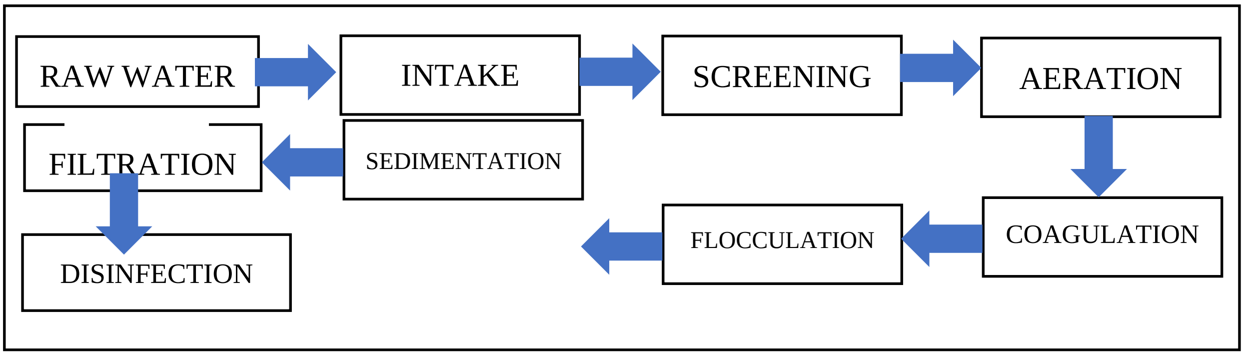

Fig No. 2 Flow Chart of Water Treatment Plan

Calculations

For Borgaon Village

Table No: 1 Population Forecasting for Borgaon Village

Sr. No	Year	Population	Increase in Population
1	1961	4995	-
2	1971	5247	252
3	19812	5908	661
4	1991	6442	334
5	2001	7707	1265
6	2011	7424	717
Total	-	-	3702

For Sangoba Village

Table : 2 Population Forecasting for Sangoba Village

Sr. No	Year	Population	Increase in Population
1	1961	1471	-
2	1971	1641	170
3	19812	1678	37

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4	1991	1719	41
5	2001	1841	122
6	2011	1941	100
Total	-	-	470

No of decades (n) = 1/10(2061-2011) n =5
Present population (p) =1941
Average increase in decades =470/5 = 94
Population at the year P2021 = 2011+1*94 P2021 = 2105
Table:3 Population Forecasted

P 2021	2105
P 2031	2199
P 2041	2293
P 2051	2387
P 2061	2481

Table : 4 Total Population

Year	Population of Borgaon	Population of Sangoba	Total
2021	4442	2105	6547
2031	5183	2199	7382
2041	5923	2293	8216
2051	6664	2387	9091
2061	7404	2481	9885

Design population: 10000

water demand
Average water consumption: 270LPCD
Average Discharge (Qavg) = 9885*270 LPCD
= 2668950L/Day
= 2668.95 m3/s
= 0.030 m3/s
Minimum discharge = 40% = 2668.95*0.4
= 1067.58 m3/day
= 0.012 m3/s
Maximum discharge = 180% = 2668.95*1.8
= 4804.11 m3/day
= 0.055 m3/s

4.1 Design of structural unit
4.1.1 Intake structure

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Qavg = 0.030m3/s
Velocity inside the gravity pipe 1 m/s Area = Discharge/velocity
= 0.030/1
= 0.030 m2
Diameter of gravity pipe 0.47 to 0.5 m
No of well = 1 (circular wells were preferred) Detention time t = 20min
Discharge = volume /time
Q = 0.030 m3/s
= 1.8 m3/min
V = Q*t
= 1.8*20
= 36m3
Effective depth of intake well = 10m
Area of the well = 3.6/10
= 3.6m2
To find diameter of circular section
A = π/4*d2
d = (4*3.6/ π) 0.5= 2.14
d= 2.14m
Area of intake well = 3.6m2
Diameter of intake well = 2.14m
Depth of intake well = 10m
Design of suction pipe:
Q = 0.030m3/s
V = 1.5m/s
Cross –sectional area of suction pipe
A = Q/V
= 0.030/1.5
= 0.02m2
Diameter Of suction pipe
D = (4*0.02/ π)0.5 = 0.15m
Area of suction pipe = 0.02m2
Diameter of suction pipe = 0.015

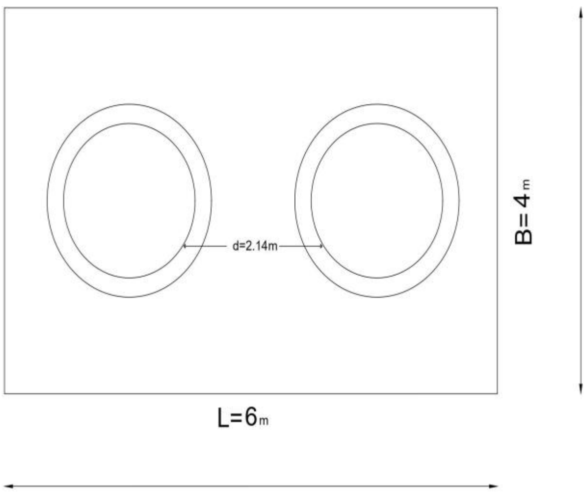

Fig No. 3Intake Structure

Conclusion

From the results of chemical analysis performed with the samples of drinking water follows that produced water can be characterized as a very soft. Hence it could be summarized that potable water should meet physical, chemical,

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bacteriological, and radionuclide parameters when supplied by an approved source, delivered to a treatment and disinfection facility of proper design, construction and operation and in turn delivered to the consumers through a protected distribution system in sufficient quantity and pressure. Water purification is the removal of contaminants from untreated water to produce drinking water that is pure enough for the most critical of its intended uses, usually for human consumption. Substances that are removed during the process of drinking water treatment include solids, bacteria, algae, viruses, fungi, minerals such as iron, manganese and Sulphur, and other chemical pollutants such as fertilizers. Measures taken to ensure water quality not only relate to the treatment of the water, but to its conveyance and distribution after treatment as well. It is therefore common practice to have residual disinfectants in the treated water in order to kill any bacteriological contamination during distribution.
World Health Organization (WHO) guidelines are generally followed throughout the world for drinking water quality requirements. In addition to the WHO guidelines, each country or territory or water supply body can have their own guidelines in order for consumers to have access to safe drinking water. Water purification involves a series of processes aimed at removing contaminants from untreated water to make it safe for human consumption and other uses. These processes typically include coagulation, flocculation, sedimentation, filtration, and disinfection. Coagulation and flocculation involve adding chemicals to water to bind particles together, which settle out during sedimentation. Filtration then removes remaining particles and microorganisms through layers of sand, gravel, or membranes. Disinfection, often using chlorine or UV light, kills remaining bacteria and viruses to ensure water safety. Throughout these processes, it's crucial to monitor and maintain water quality, including pH levels, turbidity, and residual disinfectants, to meet stringent health standards. A well-maintained distribution system is also vital, ensuring water reaches consumers without contamination. Water purification not only enhances water clarity and taste but also protects public health by preventing waterborne diseases and ensuring access to clean drinking water worldwide.

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