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# Design of WTP Based on Government Implemented Scheme for About 69 Villages of the Taluka – Zagadia

Helly Mehta[1], Nikita Patel[2], Urvi Rathod[3]

*[1]Civil Engg Dept, CGPIT, UTU,*
*[2]Civil Engg Dept, CGPIT, UTU ,*
*[3]Civil Engg Dept, CGPIT, UTU,*

***Abstract*— This Project Consist Of the design of the water treatment Plant, Based On The government implemented scheme for the same for about 69 villages of the taluka – zagadia. The design possesses the proper, adequate and authentic information regarding the various data. The project area as far as concerned mainly deals with the water quality test, various water standard, census of villages, means of treatment unit etc. The 69 villages for that the design should carry out are described follows with their census data of years 1981, 1991, 2001, 2011.**

***Keywords*— water treatment plant,**

## I. Introduction

Water is a precious commodity. Most of the earth water is sea water. About 2.5% of the water is fresh water that does not contain significant levels of dissolved minerals or salt and two third of that is frozen in ice caps and glaciers. In total only 0.01% of the total water of the planet is accessible for consumption. Clean drinking water is a basic human need. Unfortunately, more than one in six people still lack reliable access to this precious resource in developing world.

India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. With the present population growth-rate (1.9 per cent per year), the population is expected to cross the 1.5 billion mark by 2050. The Planning Commission, Government of India has estimated the water demand increase from 710 BCM (Billion Cubic Meters) in 2010 to almost 1180 BCM in 2050 with domestic and industrial water consumption expected to increase almost 2.5 times. The trend of urbanization in India is exerting stress on civic authorities to provide basic requirement such as safe drinking water, sanitation and infrastructure. The rapid growth of population has exerted the portable water demand, which requires exploration of raw water sources, developing treatment and distribution systems.

The raw water quality available in India varies significantly, resulting in modifications to the conventional water treatment scheme consisting of aeration, chemical coagulation, flocculation, sedimentation, filtration and disinfection. The backwash water and sludge generation from water treatment plants are of environment concern in terms of disposal. Therefore, optimization of chemical dosing and filter runs carries importance to reduce the rejects from the water treatment plants. Also there is a need to study the water treatment plants for their operational status and to explore the best feasible mechanism to ensure proper drinking water production with least possible rejects and its management. With this backdrop, the Central Pollution Control Board (CPCB), studied water treatment plants located across the country, for prevailing raw water quality, water treatment technologies, operational practices, chemical consumption and rejects management.

## II. DEMAND ASSESSMENT FOR WATER SUPPLY

DESIGN PERIOD: Water supply projects may be designed normally to meet the requirements over a thirty year period after their completion. The time lag between design and completion of the project should also be taken into account; this should not exceed a duration ranging from two years to five years depending upon the size of the project. Table 1 provides details of design periods for different water supply components.

TABLE -1 DESIGN PERIOD OF DIFFERENT HYDRAULIC STRUCTURE

| Sr. No. | Items | Design Period ( In Years) |
|---|---|---|
| 1. | Storage by dams | 50 |
| 2. | Infiltration works | 30 |
| 3. | Pumping: (i) Pump house | 30 |
| | (ii) Electric motors and pumps | 15 |
| 4. | Water treatment units | 15 |
| 5. | Pipe connection to several treatment units and other small appurtenances | 30 |

 

| | | |
|---|---|---|
| 6. | Raw water and water conveying mains | 30 |
| 7. | Clear water reservoirs at the head works, balancing tanks and service reservoirs | 15 |
| 8. | Distribution system | 30 |

PER CAPITA WATER SUPPLY: BASIC NEEDS:- Piped water supplies for communities should provide adequately for the following purposes/ requirements as applicable(i)Domestic needs such as drinking, cooking, bathing, washing, flushing of toilets, gardening and individual air conditioning.(ii)Institutional needs.(iii)Public purposes such as street washing or street watering, flushing of sewers, watering of public parks.(iv)Industrial and commercial uses including central air conditioning.(v)Fire fighting.(vi)Requirement for livestock.(vii)Minimum permissible Unaccounted for Water (UFW).

DOMESTIC AND NON-DOMESTIC NEEDS: The following table 2 represents the per capital water demand for domestic and non-domestic needs as per CPHHEO manual of water Supply and treatment.

TABLE-2 RECOMMENDED PER CAPITA WATER SUPPLY FOR DESIGNING SCHEMES.

| Sr. No. | Classification of towns/cities | Recommended maximum Water Supply Levels (lpcd) |
|---|---|---|
| **1** | **Towns provided with piped water supply but without sewerage system** | **70** |
| **2** | **Cities provided with piped water supply where sewerage system is existing/contemplated** | **135** |
| **3** | **Metropolitan and Mega cities provided with piped water supply where sewerage system-is existing/contemplated** | **150** |

Silent features of WTP:

1. Population of 69 towns: Year 2011= 81999 souls; Year 2051= 117138 souls
2. Average daily draft (MLD)= 9.470; Maximum daily draft (MLD) = 14.205
3. Design period (years) = 30

## III. METHODS USED FOR FORECASTING THE POPULATION

Arithmetical Increase Method: This method is based upon assumption that the population increases at a constant rate and rate of growth slowly decreases. In our case also population is increasing at a constant rate with slight decrease in growth rate. Also this method is more suitable for very big and older cities whereas in our case it is not desirable.

Using the relation: $P_n = P + n\ i$

Where,

$P_n$ = population in nth year

P = initial population

n = no. of period (10 years)

i = average increase in population

Thus the population of Tarsali in the year of 2041 is given

$P_{2041} = 2691 + 3\ (509) = 4218$

Geometrical Increase Method

In this method the per decade growth rate is assumed to be constant and which is average of earlier growth rate. The forecasting is done on the basis that the percentage increases per decade will remain same.

Incremental Increase Method:This method is an improvement over the above two methods. The average increase in the population is determined by the arithmetical increase method and to this is added the average of the net incremental increase, once for each future decade. By this method population increase by 4507 in the year 2051.

CALCULATION OF DIFFERENT DRAFTS:

Expected population after 30 years = 135299
Average rate of water supply = 70 LPCD
(Including domestic, commercial, public, fire demand, industrial and wastes)
Water required for above purposes for all 69 towns = 3.2725 MLD
Water required for above purposes for all 69 towns = 135299 x 70
= 9.470 MLD

 

1. Average daily draft = 9.470 MLD
2. Maximum daily draft = 1.5 x9.470 = 14.205 MLD

DESIGN CAPACITY FOR VARIOUS COMPONENTS:

1. Intake structure daily draft = 14.205 MLD
2. Pipe main = maximum daily draft = 14.205 MLD
3. Filters and other units at treatment plant = 2 x Average daily demand
= 2 x 9.470
= 18.95 MLD
4. Lift pump = 2 x Average daily demand
= 18.95 MLD

PHYSICAL AND CHEMICAL STANDARDS OF WATER: The various physical and chemical standard guidelines recommended by central public health & environmental engineering organization as recommended by world health organization (WHO).

TABLE-3- PHYSICAL AND CHEMICAL STANDARDS OF WATER

| S.No. | Characteristics | Acceptable | Cause for Rejection |
|---|---|---|---|
| 1 | Turbidity (NTU) | 1 | 10 |
| 2 | Colour (Units on Platinum Cobalt scale) | 5 | 25 |
| 3 | Taste and Odour | Unobjectionable | Objectionable |
| 4 | Ph | 7.0 to 8.5 | <6.5 or >9.2 |
| 5 | Total dissolved solids (mg/l) | 500 | 2000 |
| 6 | Total hardness (as CaCO3) (mg/l) | 200 | 600 |
| 7 | Chlorides (as Cl) (mg/l) | 200 | 1000 |
| 8 | Sulphates (as SO4) (mg/l) | 200 | 400 |
| 9 | Fluorides (as F) (mg/l) | 1.0 | 1.5 |
| 10 | Nitrates (as NO3) (mg/l) | 45 | 45 |
| 11 | Calcium (as Ca) (mg/l) | 75 | 200 |
| 12 | Magnesium (as Mg) (mg/l) | ≤ 30 | 150 |
| 13 | Iron (as Fe) (mg/l) | 0.1 | 1.0 |
| 14 | Manganese (as Mn) (mg/l) | 0.1 | 0.5 |
| 15 | Copper (as Cu) (mg/l) | 0.1 | 1.5 |
| 16 | Aluminium (as Al) (mg/l) | 0.0 | 0.2 |

COMPARISON OF ACTUAL DATA WITH STANDARD DATA:

TABLE-4-COMPARISON OF ACTUAL DATA WITH STANDARD DATA

| Sr. No. | Particulars | Actual | Standard | Difference |
|---|---|---|---|---|
| 1. | Ph | 7.05 | 6.5 to 8.5 | O.K. |
| 2. | Turbidity NTU | Nil | 5 to 10 | - |
| 3. | Colour Hazen Unit | Colourless | 5 to 25 | - |
| 4. | Odour | Odourless | UO | - |
| 5. | Dissolved Solids mg/l | 460 | 500 to 2000 | -40 |
| 6. | Total Hardness (as $CaCO_3$) mg/l | 232 | 300 to 600 | -68 |
| 7. | Calcium (as Ca) mg/l | 19 | 75 to 200 | -56 |
| 8. | Magnesium (as Mg) mg/l | 44 | 30 to 100 | 14 |
| 9. | Chloride (as Cl) mg/l | 56 | 250 to 1000 | -194 |
| 10. | Sulphate (as $SO_4$) mg/l | 36 | 200 to 400 | -164 |
| 11. | Nitrate (as $NO_3$) mg/l | 6.20 | 45 | -38.8 |
| 12. | Fluoride (as F) mg/l | 0.10 | 1.0 to 1.5 | 0.9 |
| 13. | Alkalinity (as $CaCO_3$) mg/l | 208 | 200 to 600 | 8 |
| 14. | Iron (as Fe) mg/l | - | 0.3 to 1 | - |

SUGGESTED UNITS OF TREATMENT PLANT: The water test is conducted during the summer. As the treated water is required during the whole year therefore the worst (monsoon) condition is to be considered. Thus the following units are suggested for design of treatment plant.

 

INTAKE STRUCTURE:

Intake well : Intakes consist of the opening, strainer or grating through which the water enters, and the water is pumped to the mains or treatment plant. Types of Types of intake : 1) River intake 2) Wet intake 3) Dry intake 4) Submerged intake 5) Movable and floating intake.

*Figure-1-Intake well*

TREATMENT UNIT:

Aeration unit: Purposes of aeration in water treatment are: To reduce the concentration of taste and odor causing substances, such as hydrogen sulfide and various organic compounds, by volatilization / stripping or oxidation. To oxidize iron and manganese, rendering them insoluble.To dissolve a gas in the water. To remove those compounds that may in some way interfere with or add to the cost of subsequent water treatment.


*Figure-2- Aeration unit*

Coagulant dose: Coagulation describes the effect produced by the addition of a chemical to a colloidal dispersion, resulting in particle destabilization. Operationally, this is achieved by the addition of appropriate chemical and rapid intense mixing for obtaining uniform dispersion of the chemical.The coagulant dose in the field should be controlled in the light of the jar test values. Alum is used as coagulant. Alum required in particular season is given below:

For Monsoon = 50 mg/L, for Winter = 20 mg/L, for Summer = 5 mg/L.

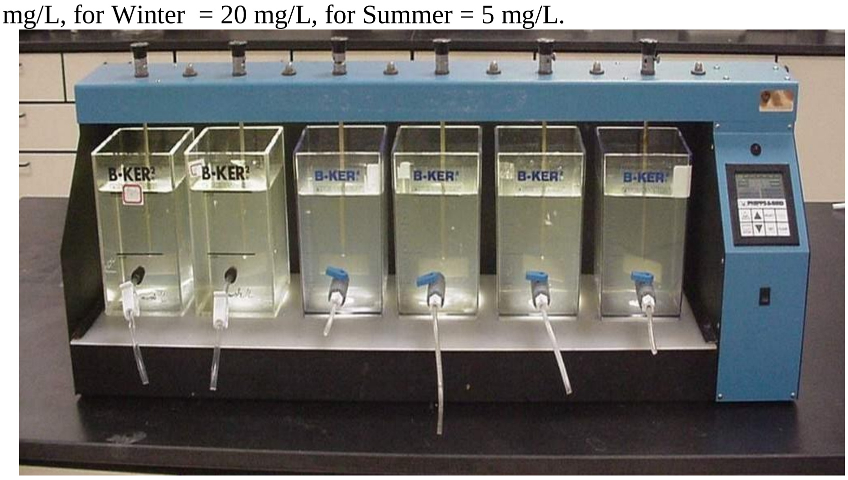

*Figure-3-Coagulant dose*

Flash mixer: Rapid mixing is and operation by which the coagulant is rapidly and uniformly dispersed throughout the volume of water to create a more or less homogeneous single or multiphase system.

This helps in the formation of micro flocks and results in proper utilization of chemical coagulant preventing localization of connection and premature formation of hydroxides which lead to less effective utilization of the coagulant. The chemical coagulant is normally introduced at some point of high turbulence in the water. The source of power for rapid mixing to create the desired intense turbulence is gravitational and pneumatic


*Figure-4- Flash mixer*

Clariflocculator: Clariflocculator is widely used for water and waste water treatment. The coagulation and sedimentation processes are effectively incorporated in a single unit. A simple clariflocculator is designed having vertical paddles. Te water enters through a central influent pipe and is fed into the flocculation zones through parts. The effluent from flocculation zone passes below the partition wall dividing the flocculator portion and the clarifier portion. The clarified effluent is collected by a peripheral effluent launder. The components of clariflocculator to be designed include the effluent pipe, the flocculator, the clarifier and the effluent launder.

*Figure-5- Clariflocculator*

Rapid sand filter: The rapid sand filter comprises of a bed of sand serving as a single medium granular matrix supported on gravel overlying an under drainage system, the distinctive features of rapid sand filtration as compared to slow sand filtration include careful pre-treatment of raw water to effective flocculate the colloidal particles, use of higher filtration rates and coarser but more uniform filter media to utilize greater depths of filter media to trap influent solids without excessive head loss and back washing of filter bed by reversing the flow direction to clear the entire depth of river.

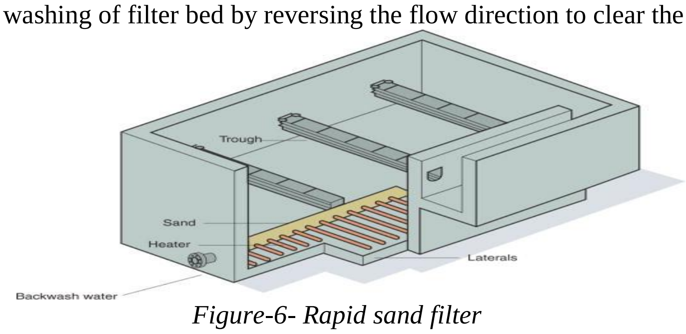


*Figure-6- Rapid sand filter*

Chlorination unit: Disinfection should not only remove the existing bacteria from water but also ensures their immediate killing even afterwards, in the distribution system. The chemical which is used as a disinfectant must therefore be able to give “residual sterilizing effect” for a long period, thus affording some protection against recontamination. In addition to this, it should be harmless, unobjectionable to taste, economical and measurable by simple tests. ‘Chlorine’ satisfies the above said more than any other disinfectant and hence is widely used.


*Figure-7- Chlorination unit*

STORAGE UNIT: Underground storage tank- The reservoir is used for storing the filtered water which is now fit for drinking. From this, the water is pumped to ESR normally the capacity of this type of reservoir depends upon the capacity of the pumps and hours of pumping during a day. If the pumps work for 24 minutes then the capacity of this reservoir may be between 30 minutes to 1 hour.

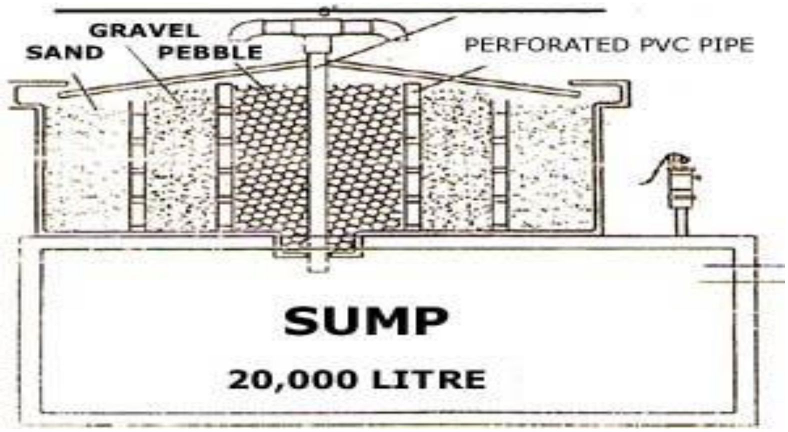


*Figure-8- Underground storage tank*

Elevated storage reservoir: Where the areas to be supplied with treated water are at higher elevations than the treatment plant site, the pressure requirements of the distribution system necessitated the construction of ESR. The treated water from the underground reservoir is pumped to the ESR and than supplied to the consumers.

Provide 1 ESR of overall Height = 4.30m , Diameter= 5.89m

*Figure-9- Elevated storage reservoir*

## IV. CONCLUSIONS

From above proposed design of various water treatment plant units, it can be said that if previous data`s are available then expansion of WTP or designing for WTP with same population but with different zone of locality, climate and lifestyle of the population can be forecasted and designed for various purpose of any other town or a city.

## REFERENCES

[1] A.G. Bhole. “Low cost package water treatment plant for rural areas” I.E. (1) Journal – EN 1995.
[2] Birdie J.S.“Water supply and sanitary engineering”, Pub.: Dhanpat Rai & sons, New Delhi, 1994.
[3] Fair G.M.“Water and waste water engineering”, (vol.1&2) John Wiley & sons, Inc. New York.
[4] Garg S.K. “Water supply engineering” Khanna pub. New Delhi,1994.
[5] Government of India “Central pollution control board ( Ministry of environment and forests.)
[6] Government of India “Manual on water supply & treatment”, Ministry of works & housing, New Delhi, 1984.
[7] Hudson H.F. Jr.“Water clarification process: Practical design & evaluation” Van Norstrand Reinhold Co., New York, 1981.
[8] Steel E.W. & “Water supply & sewerage”, McGraw Hill Ltd., New Mcggee T.J. York, 1981.
[9] Twart A.C. “Water supply” Arnold International Student Edition (AISE) Great Britain, 1985.