International Journal of Emerging Trends in Engineering and Basic Sciences (IJEEBS)
ISSN (Online) 2349-6967
Volume 3, Issue 3 (May-June 2016), PP.033-036

CONSTRUCTION OF ECONOMICAL WATER TREATMENT PLANT BY USING EFFECTIVE PLANNING AND MANAGEMENT TECHNIQUES

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Abstract: - This paper presents the economical way of planning and designing of water treatment plant. Clean drinking water is a basic human need. Unfortunately, more than one in six people still lack reliable access to water in developing world. India has 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. The Planning Commission, Government of India has estimated that water demand increase from 710 BCM (Billion Cubic Meter) in 2010 to almost 1180 BCM in 2050. The conventional water treatment plant requires large space for operational process and maintenance. The construction of conventional water treatment plant for metro cities, township and industries is not economical due to less availability of land. Therefore in present work effective planning of water treatment plant has been carried out to have a compact size treatment plant. Modified form of conventional treatment plant will be having systematic arrangement of different treatment units' i.e. Aerator, Clariflocculator, Rapid sand filter etc. one above other with sufficient working space. By this way of planning and construction around 40% to 50% of land and Cost of construction can be saved.

Keywords:-Raw water, Water treatment plant, Aquifer

I. INTRODUCTION

1.1 Water

Water is a precious commodity on earth. About 2.5% of the total water on earth is fresh water that doesn't 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 planet is in liquid form which is accessible for consumption. Clean drinking water is a basic human need. Trend of urbanization and rapid population growth is exerting stress on civic bodies to provide basic requirement such as safe drinking water, sanitation and infrastructure. The construction of water treatment plant in conventional ways Consumes very high financial resources because of high land, Construction and maintenance cost.

1.2 Working of Water Treatment Plant

Water treatment or the purification and sanitation of water vary as to the source and kind of water. Municipal waters, for example, consist of surface water and ground water, and their treatment is to be distinguished from that of industrial water supplies. Municipal water supplies are treated by public or private water utilities to make the water potable (safe to drink) and palatable (aesthetically pleasant) and to insure the adequate supply of water to meet the needs of community at reasonable cost.

Raw (untreated) water is withdrawn from either a surface water source (such as lakes or streams) or from an underground aquifer (by means of wells). As it is withdrawn from the source, surface water is usually screened through steel bars; finer screens are sometimes employed to remove leaves. If the water is highly turbid (cloudy and Muddy), it may be pre-treated in large basin known as pre-sedimentation basin to allow time for sand and larger silt particles to settle down. This is followed by sequence of treatment process that typically includes aeration, coagulation, flocculation, sedimentation, filtration and disinfection.

1.3 Elevated Water Treatment Plant

This paper presents a modified form of a conventional water treatment plant. Modified or Elevated water treatment plant consists of systematic arrangements of various treatment units (cascade aerator, clarifloculator, rapid sand filter, etc.) in vertical direction one above other with sufficient working space with fully computerized system of operation so that whole plant can be constructed in very less area with minimum construction and maintenance cost and man power.

In situations of scarcity of land and other financial resources, ELEVATED WATER TREATMENT PLANT is the best solution and can be used very effectively in metropolitan cities where cost of land is very high and/or where land is not easily available. It can also be used in big townships like Lavasa city which is away from Pune water treatment plant where it is difficult for the municipal authorities to supply water from Pune.

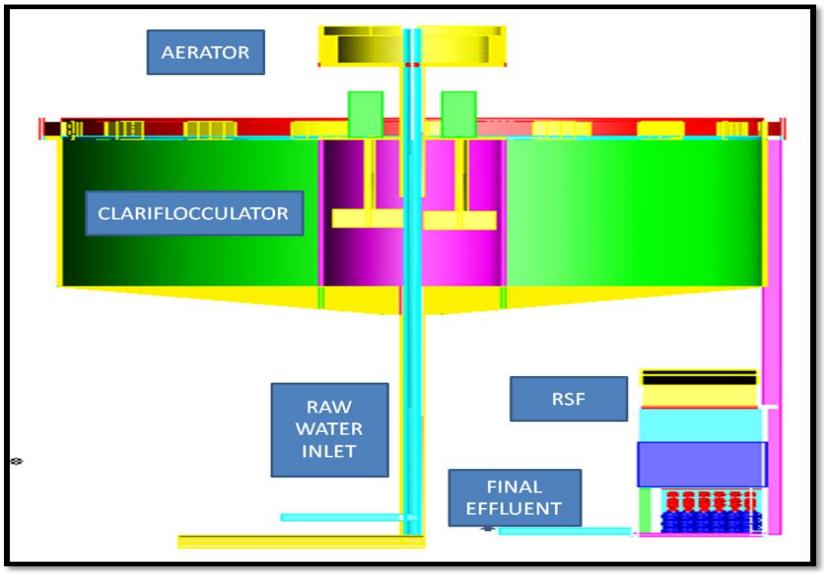

Figure. 1 Typical Sectional Elevation of Elevated water treatment plant

II. DESIGN OF WATER TREATMENT PLANT

2.1 Work Area

Work area for this paper and plant construction is an imaginary township having population of around 15000.

2.2 Design of Water treatment units

2.2.1 Water Demand

Total demand = 335 liter/head/day (IS 1172-1993)

Total demand of township/ locality having 15000 population = 15000 x 335

= 5025000 liters/head/day = 5.025 MLD,

Let's design the treatment plant for 6MLD.

2.2.2 Design of Screen:

Provide coarse screen made up of iron roads 5cm center to center with inclination of 45 Degree with horizontal.

2.2.3 Design of Aerator:

Design of Inlet pipe (for free fall aerator)

$Q = 6$ MLD $= 6 \times 10^3 / 24 \times 60 \times 60 = 0.069$ m^3/Sec (Velocity = 1 m/s)

$Q = A \times V$

$0.069 = 3.14/4 \times D^2$

Diameter of inlet pipe D = 0.3m

Provide three steps for cascade aerator with radial width of 0.4m, 0.8m and 1.2m in descending order.
Max. Diameter (Lower most step) = 1.2 + 0.3 + 1.2 = 2.7m
Area of Cascade Aerator = 5.725 m^2

2.2.4 Design of Flocculator:
Detention period = 30 min (permissible range 20 to 60 min)
Volume = Q X D (Detention Period)
= 0.069 X 30 X 60
= 124.2 m^3
Area = 124.2/ 3 (keeping depth of 3m)
= 41.4 m^2
Provide 1 unit of 6.2m X 6.7m

2.2.5 Design of Sedimentation Tank

Detention period = 3 hours (permissible range 2 to 4 hours)
Volume = 0.069 X 3 x 60 x 60
= 745.2 m^3
Area = 745.2/3 (keeping depth of 3m)
= 248.4 m^2
Provide 1 unit of 15.5m X 16m

2.2.6 Design of Rapid Sand Filter

Assuming 3% of filtered water is used for back washing and duration for the same is 30 min.
Actual Quantity of water filtered/hour = (1.03 X 0.069)/ 23.5
= 262.97 m^3/hr
Rate of filtration = 3500 lit/ hr/ m^2 (permissible range 3000 to 6000 Lit/hr/m^2)
Filtration area required = 262.97 X 10^3 / 3500
= 75.13 m^2
Provide 2 units of size 3.52m X 11.1m.

Table 1. Comparison between Conventional and Proposed WTP

Water Treatment Unit	Area required for	
	Conventional Water treatment Plant (in Sq. meters)	Proposed water treatment plant (in Sq. meters)
Cascade Aerator	5.725	5.725
Flocculator		
Sedimentation Tank	41.4	41.4
Rapid sand filter	248.4	248.4
Approach channel	75.13	75.13
Chlorination room	25 (assumed)	5 (assumed)
Office and lab	25 (assumed)	25 (assumed)
Total land required	100 (assumed)	100 (assumed)
	520.655 ~ 525	289.8 ~ 290*

*in case of proposed WTP area requirement calculations, only bigger area should be considered (Clariflocculator i.e. Sum of Floculator area and Sedimentation tank area) as plant is Elevated.

III. RESULTS

Results shows that the planning method suggested in this paper saves around 45% of land as compared to plant constructed by conventional methods of planning and designing.
Percentage land saving = 100 – (290/ 525) X 100 = 44.76 % ~ 45 %

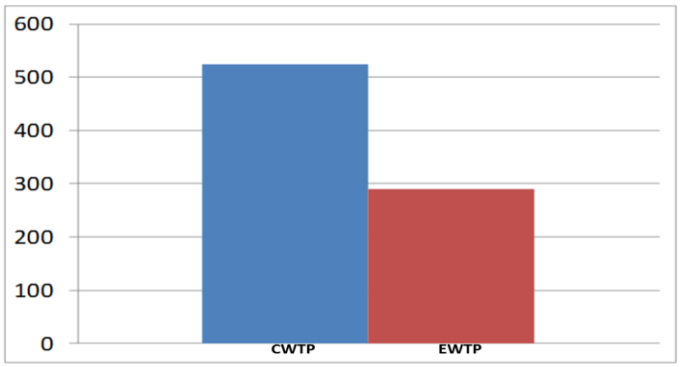

Figure. 2 Area requirement comparisons between CWTP & EWTP

IV. CONCLUSION

There are thousands of water treatment plants in the world but almost all of them are conventional in terms of planning. A lot of work has been done in the water treatment process to save the cost of treatment and to achieve the desired standards which saves the running cost of treatment process, but it do not save the capital cost of installation of treatment units. Therefore it is necessary to modify the existing planning approach to save the cost of construction and also to save the valuable land. By adopting the planning method suggested in this paper, huge cost of land, construction and maintenance can be saved.

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