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RESEARCH ARTICLE OPEN ACCESS

Design and Analysis of STP Using Dynamic Modelling and Simulation Software (GPS-X)

Puja C Kadam[1], Smit S Patil[2], Soham S Warde[3], Atmaja V Patil[4], Shubham S Khatokar[5]
[1]*Department of Civil Engineering, Mumbai University, Maharashtra, India*
[2]*Department of Civil Engineering, Mumbai University, Maharashtra, India*
[3]*Department of Civil Engineering, Mumbai University, Maharashtra, India*
[4]*Department of Civil Engineering, Mumbai University, Maharashtra, India*
[5]*Department of Civil Engineering, Mumbai University, Maharashtra, India*

ABSTRACT
Wastewater treatment is a process used to remove contaminants from wastewater or sewage and convert it into effluent that can be returned to the water cycle with acceptable impact on the environment or reused for various purposes. The design of a Sewage Treatment Plant (STP) is a theoretical process and thus lacks methods to test the design and identify its flaws that might show up in the practical design. Dynamic modelling and simulation softwares can help bridge this gap by performing computer-aided simulations of the sewage treatment process. The project aims to demonstrate the use of the software (GPS-X) that can help make this process economical and convenient. The paper then further focuses on upgrading the STP by modifying its components and analyzing it using the GPS-X software.

Keywords **-** GPS-X, Moving Bed Biofilm Reactor (MBBR), Sewage Treatment Plant (STP), Wastewater Treatment

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I. INTRODUCTION

Water being a universal solvent has been and is being utilized by mankind time and again. Of the total amount of global water, only 2.4% is distributed on the main land, of which only a small portion can be utilized as fresh water. The available fresh water to man is hardly 0.3-0.5% of the total water available on the earth and hence needs to be wisely used and preserved.

Water treatment systems clean waste water that can then be reused for numerous purposes. But, because water must meet certain standards based on its planned reuse, waste water treatment methods must be tailored accordingly to ensure safety. However, India treats only 20% of its sewage and rest fall directly into rivers causing severe problems. The Problem faced by government and scientists in India is the effective planning and creation of new Wastewater Treatment Plants (WWTPs).

A Sewage Treatment Plant (STP) can be expressed as the factory, which prevents harm to the environment from waste produced by human beings. When the waste produced is beyond the limit of environment to decompose, STP is one of the viable solutions. The present STP reduces the waste produces manure & energy and helps us to keep our rivers, ponds clean. Various types of STPs are being introduced each day, according to the requirement and economic view. STP in Virar is a Moving Bed Biofilm Reactor (MBBR) based STP and treats sewage water for the complete area of Gokul Township in Virar West. This type of STPs can also be termed as an energy saver as it recharges the water sources and can be re-used for domestic purpose.

II. METHODOLOGY

The design dimensions of an STP (Virar STP) were obtained and a modified design was modelled in the GPS-X software. This modified design was created for the purpose of getting a higher working efficiency for the current STP. The comparison between the existing STP and the newly designed STP was carried out and the results were noted down.

2.1 Virar STP

The Virar STP (30 MLD) was initiated by the local government of Virar to meet the treatment demands of the sewage produced in the Gokul

Township region of Virar. It mainly consists of primary, secondary and tertiary treatment. The primary treatment consists of a Grit Chamber used to get rid of grit particles from the influent wastewater which then flows into an Equalization Tank that allows the incoming flow to be held and pumped at a uniform rate. The secondary treatment consists of a Moving Bed Biofilm Reactor and a Clarification Tank. This treatment usually leads to a significant reduction in the parameters like, Total Suspended Solids (TSS) and Biochemical Oxygen Demand (BOD). The tertiary treatment of sewage is carried out using disinfection tanks and a Thickening & Dewatering Unit.

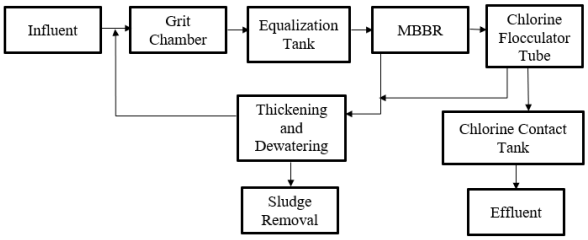

Fig. 1. Flow chart of Virar STP

2.2 Modified STP

For obtaining better efficiency some of the existing components were substituted by similar but more efficient components. Also, new components were introduced. The processes for the STP are planned as per the following categories;

- Primary Treatment - In Primary treatment, wastewater is fed to a screen to remove all large objects that are suspended in the water. This done through addition of components i.e., Grit Chamber and Equalization Tank. 50-60% of the suspended solids get removed and a 30-40% reduction of the five-day biological oxygen demand can be expected.
- Secondary Treatment - Secondary treatment is a treatment process for wastewater to achieve a certain degree of effluent quality by using a sewage treatment plant with physical phase separation to remove settleable solids and a biological process to remove dissolved and suspended organic compounds. It makes use of aerobic biological processes to further purify the wastewater. Trickling Filter, MBBR and Secondary Clarifier are the components used in this process.
- Tertiary Treatment - Tertiary treatment is the third stage of the wastewater treatment and is also known as an advanced treatment. Tertiary treatment removes the load of nitrogen and phosphorus present in the water. It includes processes like filtration, ion exchange, activated carbon adsorption, electrodialysis, nitrification, and denitrification. Components like Chlorination Tank, Sludge Thickener and Dewatering unit aid in these processes.

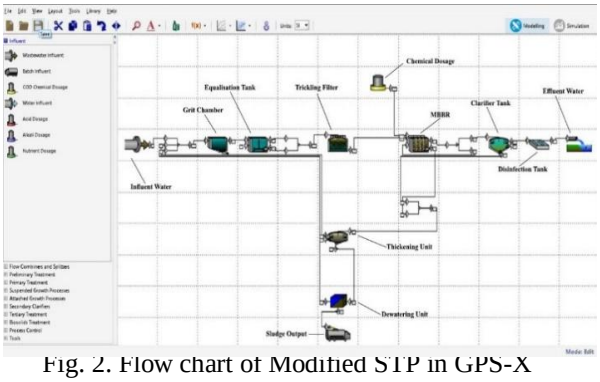

Fig. 2. Flow chart of Modified STP in GPS-X

Table 1: Comparison between components of Virar STP and Modified STP

Components	**Virar STP**	**Modified STP**
Primary Treatment	Grit Chamber, Equalization Tank	Grit Chamber, Equalization Tank
Secondary Treatment	MBBR, Clarifier Flocculator Tube	Trickling Filter, Chemical Dosage, MBBR, Circular Clarifier
Tertiary Treatment	Chlorine Contact Tank, Thickening & Dewatering Unit	Disinfection Tank, Thickening & Dewatering Unit

Table 2: Dimensions of Modified STP

Components	**Dimensions**
Grit Chamber	15m x 0.76m x 1.75m
Equalization Tank	28.4m x 14.2m x 12.5m
Trickling Filter	10m x 10m x 5m
MBBR	10m x 10m x 5m
Circular Clarifier	Diameter = 25m, Depth = 11.5m
Disinfection Tank	10m x 7m x 6m
Thickening & Dewatering Unit	10m x 5m x 10m

III. RESULTS

After the design and simulation of the modified STP, the obtained output results of various important parameters like Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO) and pH were compared with the actual result data of the Virar STP. The following are the values which were obtained at a influent load of 12 MLD.

Table 3: Comparison of result data

Para-meter	Unit	Wastewater Characteristics		
		Influent	Effluent Virar STP	Effluent Modified STP
TSS	mg/l	54.88	10	5.97
BOD	mg/l	38.28	<5	1.14
COD	mg/l	66.0	21	8.11
DO	mg/l	0.0	4.4	5.0
pH	-	9.0	7.28	7.0

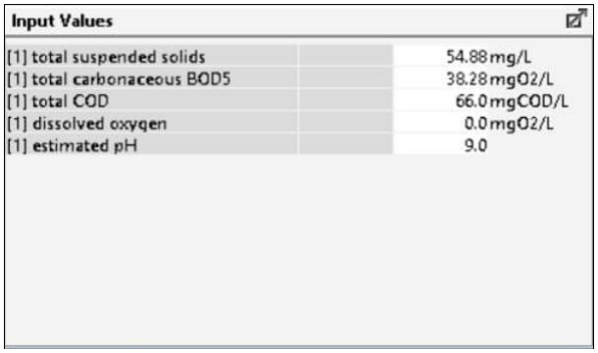

Fig. 3. Input influent values

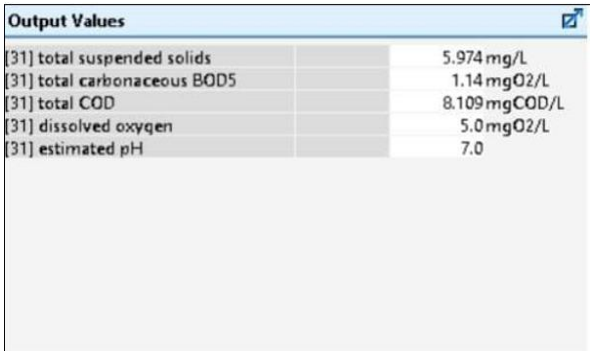

Fig. 4. Output effluent values

On simulation of the modified STP design in the GPS-X software, it was observed that the modified design offered greater reduction in TSS, BOD & pH and increase in the DO of the effluent water.

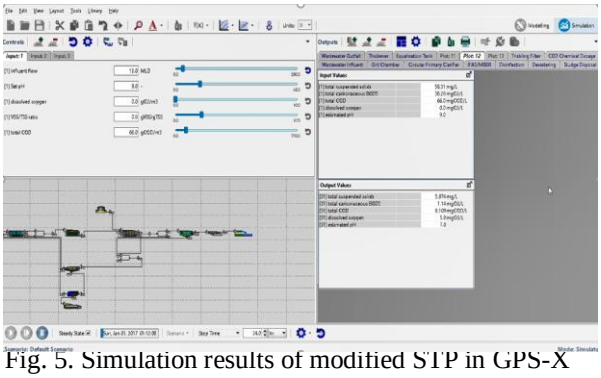

Fig. 5. Simulation results of modified STP in GPS-X

IV. CONCLUSION

The GPS-X software has been used for the simulation of the STP design and from the obtained results it can be concluded that the modified design gives better effluent water quality as compared to the existing STP. From the above results it can be concluded that the effluent water quality of the modified design is safe for disposal into the environment. This improvement can be attributed to the addition of components, namely trickling filter, circular clarifier and disinfection tank. Wastewater resource is very worth of control and management since its treatment has two major objectives. The first is to protect the environment by reducing the pollution of fresh water resources and hence reducing the health hazards. The second is to activate this available water resource for mitigating water scarcity. Softwares like GPS-X can be instrumental in designing better water treatment systems for the disposal of water, thus reducing the impact of human activities on the environment.

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1. Rajendra Lad, Executive Civil Engineer, VVCMC, Virar [rajendralad38@gmail.com]
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