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Analysis and Design of Advanced Sewage Treatment Plant

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ABSTRACT: Intermittently Decanted Extended Aeration (IDEA) is an advanced technology of sequential batch reactor (SBR) and conventional activated sludge process (ASP). This technology combines sedimentation and aeration in the same tank therefore we can say that it is a hybrid of conventional SBR technique and Extended Aeration system. It is designed in such a way that advantages of both the technologies can be used in one technique. The extended aeration provides more than sufficient oxygen, hence because of this sludge production is reduced and BOD removal increases. So, in this paper with the help of easily available STOAT software we have designed SBR based STP and IDEA based STP. For this we have selected SBR based STP located at Airoli and collected data by visiting it. In this research we compare both the results obtained after successful run of SBR and IDEA based different STP in STOAT software.

KEYWORDS: STOAT software, SBR, Intermittently Decanted Extended Aeration (IDEA) technology, 3D Graphs, Comparison of SBR and IDEA technology

I. INTRODUCTION

Sewage is wastewater generated by residential, institutional, commercial and industrial establishments. It commonly consists of wastewater from sinks, tubs, showers, dishwashers, and clothes washers and black water i.e. the water used to flush toilets, combined with the human waste that it flushes away, soaps and detergents, etc. A typical 4-person household produces around 400 to 500 litres of sewage every day. Sewage generally contains 99% water, but the remaining material contains solid material, ions and harmful bacteria. This matter must be extracted from the water with a filtration process before the sewage can be released back into a natural water source i.e. dumped or converted to a non-toxic form.

62,000 million litres per day (MLD) is the estimated value of sewage generated in urban areas, while the treatment capacity across India is only 23,277 MLD, or 37% of sewage generated, this information was released by the government in December 2015.

The project work starts with the referring of various papers and scholar's article already published on our topic 'Analysis and design of Advanced Sewage Treatment Plant'. We have studied many different papers in this field. These papers were consisting of different software and techniques used in sewage treatment process everywhere in Indian cities as well as in the other countries. On the basis of different papers studied, a review of methodology is adopted. It will include the selection of advanced sewage treatment process i.e. IDEA process and best suited software i.e. STOAT for designing of STP to meet the objectives of our project.

The main aim of our project is to design new IDEA based sewage treatment plant and compare it with existing process. For this we are going to do modelling and simulation of sewage treatment plants with help of STOAT software. Afterwards we will check the suitability of one technique over other technique.

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II. PROPOSED METHODOLOGY AND DISCUSSION

Methodology for this project is presented in chart format as follows:

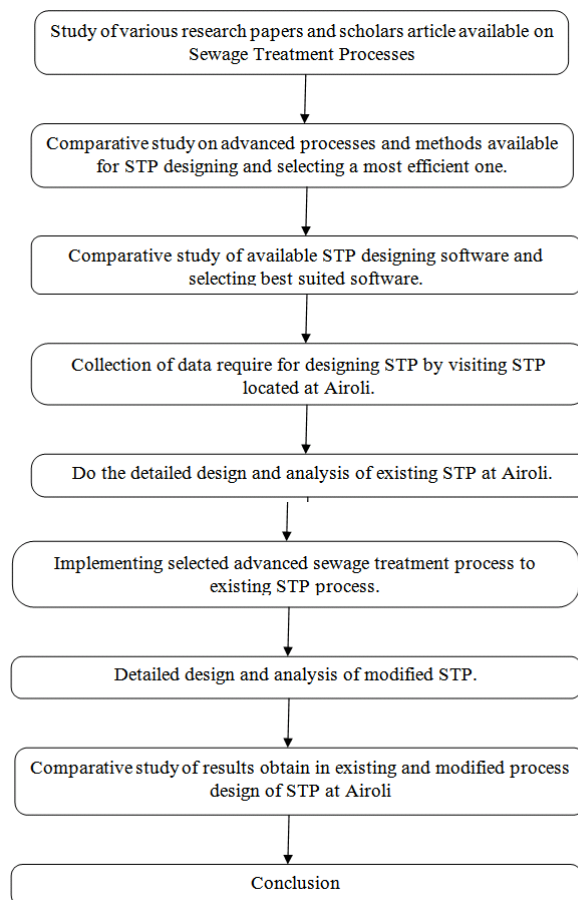


Fig.1 Flow chart of methodology used

On the basis of different papers studied we have selected advanced sewage treatment process and best suited software for designing of STP to meet the objectives of our project.

STOAT is a dynamic sewage treatment works modelling package used all over the world. STOAT is a program for comprehensive modelling and simulation of wastewater treatment plant. It is given by the British company WRc Plc.

Advantages of STOAT:

1. Main advantage of STOAT is it is free of cost.
2. It is only freely available software to include fundamental BOD-based models, which enable users to directly use data, which is routinely collected at treatment plants, negating the need for additional costly data collection exercises.
3. STOAT is used for modelling different types of WWTPs like activated sludge systems, biofilm-based processes, sequencing batch reactors, IDEA process, sewer models, etc.
4. It gives effective dynamic modelling results while designing new plant and updating old existing plant.

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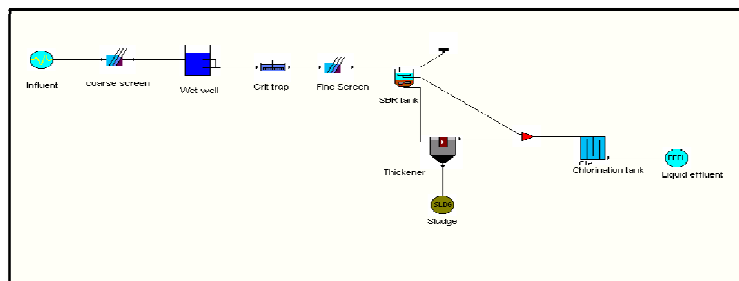
IDEA is an advanced technology of sequence batch reactor and activated sludge process. Extended aeration provides sufficient oxygen to reach endogenous phase, thus small sludge production and high BOD removal. The IDEA treatment process consists of following 3 phases: Aeration, Settling, and Decanting.

Advantages of IDEA:

1. Lower civil cost as construction is less complicated
2. High and consistent quality of effluent and low volume of sludge.
3. Flexible for various types of effluents.
4. Minimizes fluctuations in effluent quality.
5. Automatic operation made possible with PLC.
6. Electricity consumption of the plant is optimized.

III. DESIGN AND ANALYSIS OF SBR BASED STP

In order to design STP, it was necessary for us to visit an existing sewage treatment plant to get a proper idea about an actual treatment plant and its components and design. Hence, we choose the sewage treatment plant located in Airoli. The sewage treatment plant located at Airoli is an 80 MLD plant. Its daily inflow is about 21-22 MLD. In this sewage treatment plant SBR technique is used. Fig 2 (a) shows dynamic modelling of SBR based STP.



(a)

Here we have design flow chart of SBR based STP. Following are the dimensions details used in STOAT run.

Sr. No.	Components	Data Provided
1.	Coarse Screen	Spacing = 0.02 metre
2.	Grit Chamber	Volume=200 cubic metre
3.	Fine Screen	Spacing = 0.006 metre
4.	SBR tank	Volume = 10125
5.	Chlorination tank	Volume= 845 cubic metre

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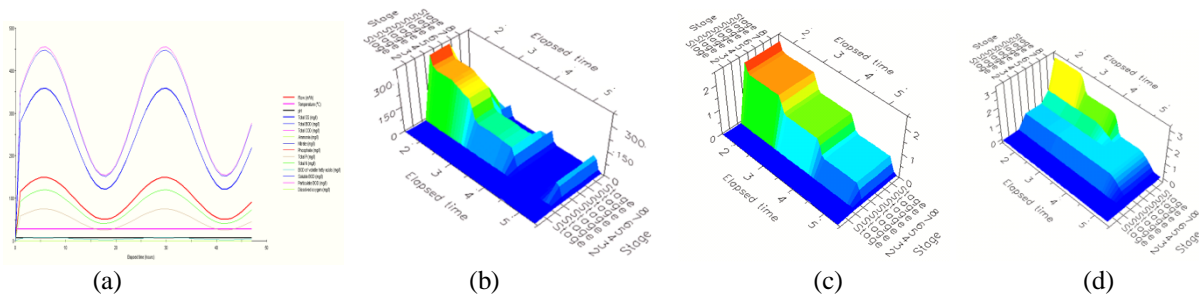
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Results and Discussion of SBR based STP:

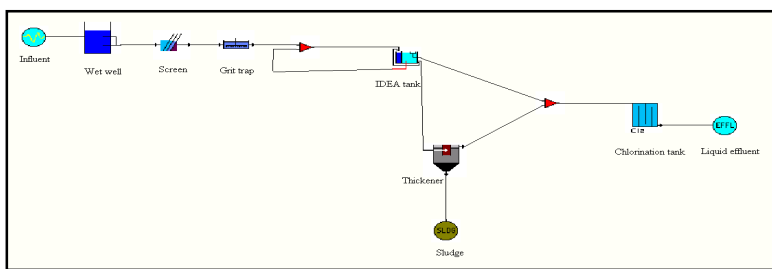
Fig 3 Results of SBR based STP shows variation in different values of parameters such as (a) Influent profile, (b) BOD, (c) Ammonium nitrogen and (d) Nitrate with help of 3D graph.

1. BOD varies from 300mg/l to 7.35mg/l.
2. Ammonium N level varies from 20mg/l to 2.01mg/l and
3. Nitrate level varies from 10mg/l to 3.01mg/l.

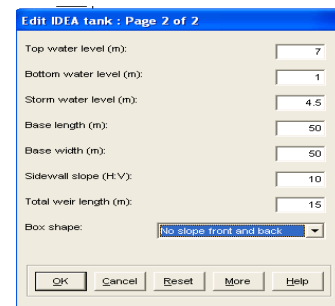


IV. DESIGN AND ANALYSIS OF IDEA BASED STP

In this we are going to design Airoli sewage treatment plant by replacing SBR with IDEA technique. With help of STOAT Software, we will give detailed working and result analysis of IDEA based STP. Fig 4(a) shows dynamic modelling of IDEA based STP.



(a)



(b)

Dimension details of all components except IDEA tank are same as that of used in SBR run. Dimensions for IDEA tank are as per given in fig.3 (b)

Results and Discussion of IDEA based STP:

Fig 5 Results of SBR based STP shows variation in different values of parameters such as (a) Influent profile, (b) BOD, (c) Ammonium nitrogen and (d) Nitrate with help of 3D graph.

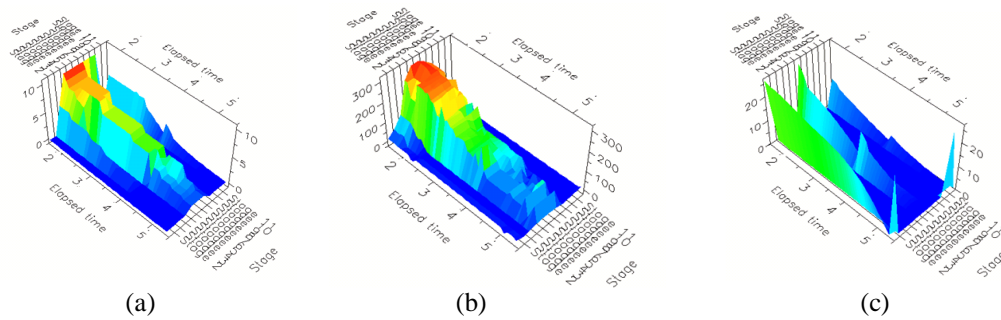
1. BOD varies from 300mg/l to 17.25mg/l.
2. Ammonium N level varies from 20mg/l to 1.87mg/l and
3. Nitrate level varies from 10mg/l to 0.95mg/l.

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V. CONCLUSION

In case-1, dynamic modelling of SBR based STP and in case-2, dynamic modelling of IDEA based STP is done with help of STOAT. We got the different effluent results from respective simulations as mention below. From this analysis and comparisons, we conclude that IDEA based STP is more economical and suitable for treatment of nitrogen and ammonium content than conventional processes. In future we can check suitability of IDEA over other conventional methods by doing more different runs and analysis based on different criteria with help of STOAT software.

Sr. No.	Parameters	SBR results(mg/l)	IDEA results(mg/l)
1.	Total BOD (mg/l)	7.35	17.25
2.	Ammonia (mg/l)	2.01	1.87
3.	Nitrate (mg/l)	3.01	0.95
4.	Total Phosphorous (mg/l)	1.89	1.82
5.	Total Suspended Solids (mg/l)	50.23	10.45

Fig 6 shows comparison of effluent results obtain in both cases

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