To assess the performance of Sewage Treatment Plant: A Case study of Surat city

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Abstract - ***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 study is based on the environmental engineering. The efficiency of the Anjana Sewage Treatment Plant, Surat will be worked out during the entire project. The selected parameters are pH, Turbidity, TSS, TDS, COD and BOD. The treated and non-treated samples will be collected twice a week on every Monday & Thursday per month for winter sessions and summer sessions have been tested in. Results obtained from collected samples are compared with BIS and GPCB standards to evaluate the efficiency of the plant in both season. The removal efficiencies of the activated sludge plant will also be calculated. By regression analysis correlation between BOD and TSS will also be established. Hence the measure against non-treated water can be made to protect the environment. Additionally, the problems associated with the operation and maintenance of wastewater treatment plant is discussed.***

Key Words: *Bio chemical oxygen demand, Chemical oxygen demand, , Total dissolved solids, etc..*

1. INTRODUCTION

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. Surat has more than 45 lacs population. Total eight sewage treatment plants are designed, out of which six are treating wastewater and two are under construction phase. The prime usage of water is for agriculture, domestic and industrial. For all the above mentioned usages, the required water should be of the different and specific quality. These plants are designed and constructed with an aim to manage wastewater so as to minimize and/or remove organic matter, solids, nutrients, disease-causing organisms and other pollutants, before it reenters a water body.

2. HISTORICAL BACKGROUND

The discharge of wastewater to environments caused adverse condition and this led to the development of intensive methods of sewage treatment. Sedimentation and chemical precipitation were one of the first processes used for wastewater treatment. In 1865, early experiments on microbiology of sludge digestion were conducted in England. In 1868, early experiments on intermittent filtration of wastewater were conducted, while in 1870 early experiments on intermittent sand filtration were made in England. In 1876, first septic tank was developed in the United States. In 1882, first experiments on aeration took place in England. United States was the first to use bar racks in 1884. In United States first chemical precipitation treatment plant was installed in 1887. In 1889, filtration in contact beds was tried at the Lawrence Experiment station, Massachusetts. In 1891, the method of sludge digestion in lagoons was developed in Germany. In 1895, methane gas was collected from the septic tanks and used for plant lighting in England. The first rotary sprinklers for rotary filters were developed in 1898. The first grit chambers were developed in the United States in 1904.
The offensive character of the sludge produced by sedimentation led to the use of septic tanks in which the solids were rendered more or less inoffensive, but difficulties of various kinds led to the general adaption of Travis two-storey septic tank in England in 1904 and the

Imhoff tank which was patented in Germany in 1904. The chlorination of wastewater for disinfection was demonstrated by Phelps in the United States, in 1906. The first municipal installation of a trickling filter was made in United States in 1908 and at the same time laws of disinfection were formulated by Chick in United States. In United States, the first Imhoff tanks were constructed in 1911. Simultaneously, in 1911 separate sludge digestion was adopted in United States to distinguish it from the two-storey tank process. In 1912-13 aeration of wastewater in tanks containing slate was carried out at Lawrence Experiment station. In 1914, experiments were conducted by Arden and Lockett that led to the development of the activated sludge process, wherein a high degree of purification is achieved. The process was first applied in a municipal plant for treating sewage at San Marces, Tex in 1916. In 1925, contact aerators were developed by Buswell in United States.

The changing characteristics of wastewater, due to discharge of many contaminants are responsible for the many changes that are taking place today in the wastewater treatment. Wastewater or sewage treatment is one such alternative, wherein many processes are designed and operated in order to mimic the natural treatment processes to reduce pollutant load to a level that nature can handle. In this regard, special attention is necessary to assess the environmental impacts of existing wastewater treatment facilities

3. OBJECTIVE OF THE STUDY

The basic aim of this project is to evaluate the efficiency of each parameter and overall efficiency of sewage treatment plant during the summer and winter season.

Following are the objective of the study:

- To study the importance of each parameter in wastewater engineering.
- To evaluate the removal efficiency of BOD and TSS of sewage treatment plant in summer season.
- To evaluate the removal efficiency of BOD and TSS of sewage treatment plant in winter season.

4. IDENTIFICATION OF PROBLEM

The present study has been undertaken to evaluate performance efficiency of a waste water treatment plant (A sewage treatment plant operating on biological treatment method). Waste water samples will be collected at different stages such as Pre-Monsoon and Post-Monsoon of treatment units and analyzed for the major water quality parameters, such as Biological oxygen demand (BOD), Chemical oxygen demand (COD), Total suspended solid (TSS), Total dissolved solids (TDS), Proportion of hydrogen (pH) and Turbidity. The performance efficiency of each unit in treating the pollutants was calculated. Overall performance of the plant also will be estimated. The obtained results will be very much useful in identification and rectification of operational and maintenance problems as well as the future expansion to be carried out in the plant to meet the increased hydraulic and organic loadings. During monsoon the disposed wastewater is decreased into sea or natural drain without any treatment and considered as higher COD which cannot be treated which affects badly aquatic life and these partially treated or without treated waste water receives a range of chemical substances and microbial flora during its use such that the waste water acquires a polluting potential and becomes a health and environmental hazard. The degree of treatment provided to the waste water will largely be based on the effluent standards prescribed by regulatory agencies when the treated effluent is to be discharged into a watercourse or land. The complete treatment of waste water is brought by a sequential combination of various physical unit operations, and chemical and biological unit processes. The general yardstick of evaluating the performance of sewage treatment plant is the degree of reduction of such harmful parameters which constitute organic pollution. The performance efficiency of treatment plant depends not only on proper design and construction but also on good operation and maintenance.

5. UNIT OPERATIONS OF SEWAGE TREATMENT PLANT

Primary treatment systems are usually physical processes. Primary treatment alone will not produce an effluent with an acceptable residual organic material concentration. Almost invariably biological methods are used in the treatment systems to effect secondary treatment for removal of organic material. In biological treatment systems, the organic material is metabolized by bacteria. Depending upon the requirement for the final effluent quality, tertiary treatment methods and/or pathogen removal may also be included.

Today majority of wastewater treatment plants use aerobic metabolism for the removal of organic matter. The popularly used aerobic processes are the activated sludge process, oxidation ditch, trickling filter, and aerated lagoons. Stabilization ponds use both the aerobic and anaerobic mechanisms. In the recent years due to increase in power cost and subsequent increase in operation cost of aerobic process, more attention is being paid for the use of anaerobic treatment systems for the treatment of wastewater including sewage. Recently at few places the high rate anaerobic process such as Upflow Anaerobic Sludge Blanket (UASB) reactor followed by oxidation pond is used for sewage treatment. The different treatment methods used in wastewater treatment plant are classified in three different categories as:

- Primary Treatment: Refers to physical unit operations.
- Secondary Treatment: Refers to chemical and biological unit processes.
- Tertiary Treatment: Refers to any one or combination of two or all three i.e., physical unit operations and chemical or biological unit processes, used after secondary treatment.

5.1 Important Parameters

- **BIOCHEMICAL OXYGEN DEMAND (BOD) AND CHEMICAL OXYGEN DEMAND (COD)**

In practice two properties of almost all organic compounds can be used: (1) organic compound can be oxidized; and (2) organic compounds contain organic carbon. In environmental engineering there are two standard tests based on the oxidation of organic material: 1) the Biochemical Oxygen Demand (BOD) and 2) the Chemical Oxygen Demand (COD) tests. In both tests, the organic material concentration is measured during the test. The essential differences between the COD and the BOD tests are in the oxidant utilized and the operational conditions imposed during the test such as biochemical oxidation and chemical oxidation.

Biochemical Oxygen Demand (BOD): The BOD of the sewage is the amount of oxygen required for the biochemical decomposition of biodegradable organic matter under aerobic conditions. The oxygen consumed in the process is related to the amount of decomposable organic matter. The general range of BOD observed for raw sewage is 100 to 400 mg/L. Values in the lower range are being common under average Indian cities.

Chemical Oxygen Demand (COD): The COD gives the measure of the oxygen required for chemical oxidation. It does not differentiate between biological oxidisable and nonoxidisable material. However, the ratio of the COD to BOD does not change significantly for particular waste and hence this test could be used conveniently for interpreting performance efficiencies of the treatment units. In general, the COD of raw sewage at various places is reported to be in the range 200 to 700 mg/L. In COD test, the oxidation of organic matter is essentially complete within two hours, whereas, biochemical oxidation of organic matter takes several weeks. In case of wastewaters with a large range of organic compounds, an extra difficulty in using BOD as a quantitative parameter is that the rate of oxidation of organic compounds depends on the nature and size of its molecules. Smaller molecules are readily available for use by bacteria, but large molecules and colloidal and suspended matters can only be metabolized after preparatory steps of hydrolysis. It is therefore not possible to establish a general relationship between the experimental five-day BOD and the ultimate BOD of a sample, i.e., the oxygen consumption after several weeks. For sewage (with k=0.23 d-1 at 20^{o}C) the BOD5 is 0.68 times of ultimate BOD, and ultimate BOD is 87% of the COD. Hence, the COD /BOD ratio for the sewage is around 1.7.

- **TURBIDITY**

Water that is not clear but is "dirty," in the sense that light transmission is inhibited, is known as turbid water. Many materials can cause turbidity, including clays and other tiny inorganic particles, algae, and organic matter. Turbidity is measured using a turbid meter. Turbid meters are photometers that measure the intensity of scattered light. Opaque particles scatter light, so scattered light measured at right angles to a beam of incident light is proportional to the turbidity. Formazin polymer is currently used as the primary standard for calibrating turbid meters, and the results are reported as nephelometric turbidity units (NTU).

- **pH**

The pH of a solution is a measure of hydrogen (H+) ion. The hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage is slightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

- **SOLIDS**

Wastewater treatment is complicated by the dissolved and suspended inorganic material it contains. In discussion of water treatment, both dissolved and suspended materials are called solids. The separation of these solids from the water is one of the primary objectives of treatment.

The sewage solids may be classified into dissolved solids, suspended solids and volatile suspended solids. Knowledge of the volatile or organic fraction of solid, which decomposes, becomes necessary, as this constitutes the load on biological treatment units or oxygen resources of a stream when sewage is disposed off by dilution. The estimation of suspended solids, both organic and inorganic, gives a general picture of the load on sedimentation and grit removal system during sewage treatment. Dissolved inorganic fraction is to be considered when sewage is used for land irrigation or any other reuse is planned.

6. METHODOLOGY

The methodology is based on the collection of samples from the Anjana Sewage treatment plant located at Surat. The treated and non-treated samples have been collected six times per month from August 20th 2012 to March 31st 2013 and have been checked in the laboratory every two days in weekends. The important parameters to be analyzed are biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solid (TSS), total dissolved solids (TDS), proportion of hydrogen (pH) and turbidity. The efficiency have been found out from the above parameters and the expected outcome will be the treatment plant's efficiency. Hence the measure against un-treated water can be made to protect the environment.

7. RESULT AND ANALYSIS

The variation of inflow in MLD for the plant is shown in figure no 1 for the months winter season.

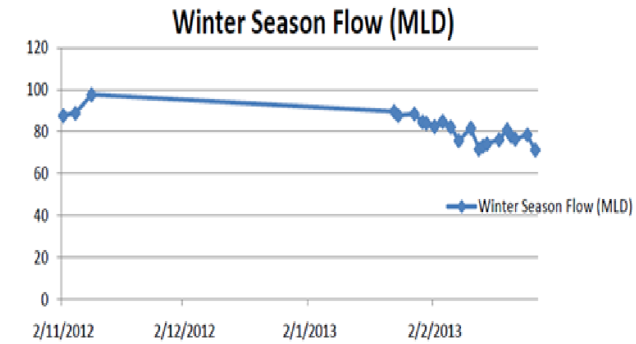

Chart -1: inflow variation for the winter season.

The variation in TSS for treated and raw sewage of the plant is shown in figure no 2 for the months of winter season.

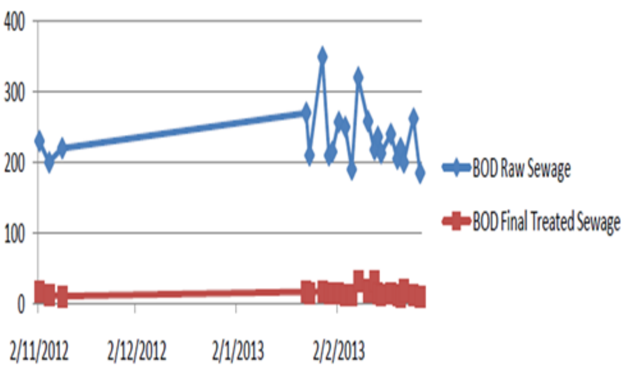

Chart -2: variation in TSS for treated and raw sewage for the winter season.

The variation in BOD for treated and raw sewage of the plant is shown in figure no 3 for the months of winter season.

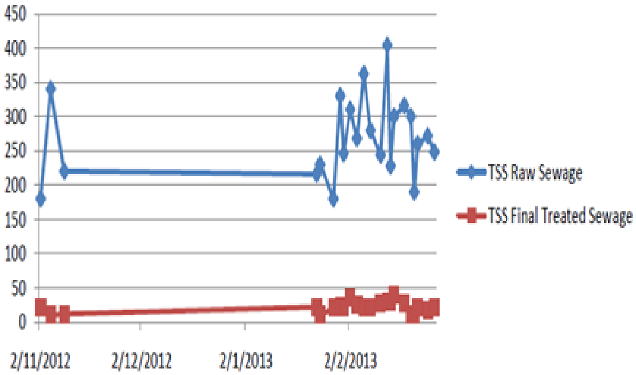

Chart -3: variation in BOD for treated and raw sewage for the winter season.

The variation of inflow in MLD for the plant is shown in figure no 4 for the months summer season.

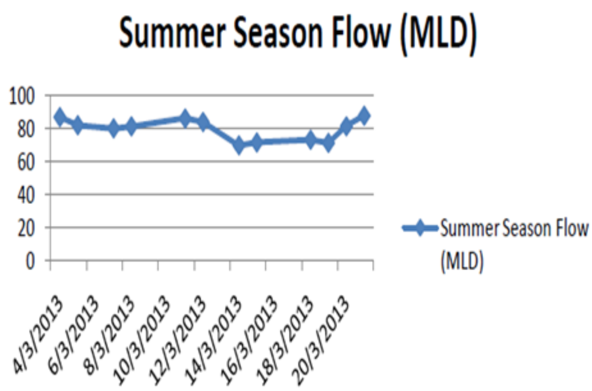

Chart -4: inflow variation for the summer season.

The variation in TSS for treated and raw sewage of the plant is shown in figure no 5 for the months of summer season.

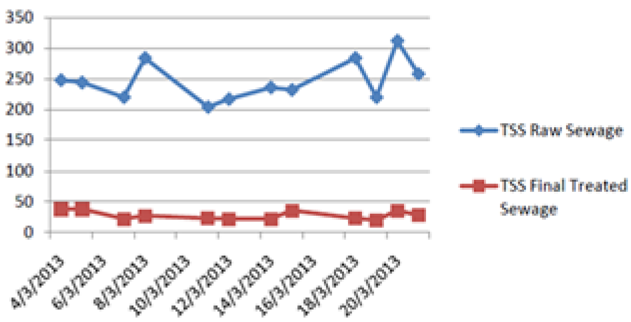

Chart -5: variation in TSS for treated and raw sewage for the winter season.

The variation in BOD for treated and raw sewage of the plant is shown in figure no 3 for the months of summer season.

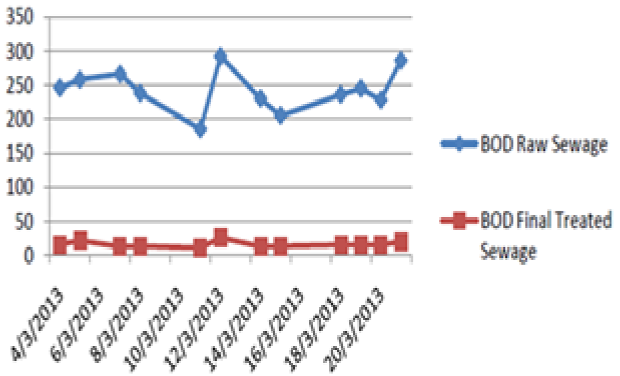

Chart -6: variation in BOD for treated and raw sewage for the summer season.

Establishment of constant relationships among the various measures of organic content depends primarily on the nature of the wastewater and its source. By using regression analysis, variation of influent BOD with the influent TSS and variation of removal efficiency of BOD with removal efficiency of TSS was determined. Because of the rapidity with which TSS test can be conducted, these correlations can be very useful as BOD measurement will take 5 days. Once the correlation has been established, TSS measurement can be used to good advantage for treatment plant control and operation.

Correlation between	Expression	Correlation coefficient
Variation of influent BOD with TSS	y =(280.23) + (25.56)x	r =0.2624
Variation of BOD removal efficiency with TSS removal efficiency	y =(12.807) + (2.569)x	r =0.174

Note: y: BOD removal, x: TSS removal

Table 1 Correlations developed between BOD and TSS

CONCLUSION

A waste water treatment plant with Activated Sludge Process as biological treatment method has been considered for performance evaluation. The overall performance of the existing was satisfactory. The removal efficiency as per SMC Data of BOD was found to be 94.84% and that of TSS was 90.75%. The removal efficiency as per samples tested in laboratory of BOD was found to be 94.04% and that of TSS was 92.68% for the winter season. Also for the summer season it was worked as 93.08% and 88.68% for BOD and TSS respectively. The individual units are also performing well and their removal efficiencies are satisfactory. BOD and TSS removal efficiencies of the primary clarifier are 57.38% and 53.42% respectively. BOD and TSS removal efficiencies of the activated sludge plant (Aeration tank + Secondary clarifier) are 87.90% and 86.50% respectively. The removal efficiency as per the sample tested in laboratory of BOD was found to be 93.42% and that of TSS was 90.61%. Thus with comparing the data with SMC and the sample tested in laboratory the plant is working satisfactory and the individual units is also working well.

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