IFERP

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 1, Issue 6, October 2016

Performance Evaluation of 43 MLD Sewage treatment plant at Vadodara

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Abstract: -- **The present study has been undertaken to evaluate the performance of 43 MLD Sewage Treatment Plant (STP) located at Vadodara which is based on UASB process. The Performance Evaluation will also help for the better understanding of design and operating difficulties in Sewage Treatment Plant. Sewage samples were collected from different locations i.e. Raw sewage, UASB outlet and Outlet of the Treatment Plant and analysed for the major waste-water quality parameters, such as pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), MLSS. The performance efficiency of each unit & overall STP in treating the pollutants was calculated. The conclusions of these evaluations may determine required recommendations and focus on modification requirements for the STP and will also determine whether the effluent discharged into the water body are under limits given by GPCB. The conclusions drawn from this study will outline the need for continuous monitoring and performance analysis by removal efficiencies of each and every unit of STP.**

Keywords: **UASB- Upflow Anaerobic Sludge Bed, STP- Sewage Treatment Plant, BOD- Biological Oxygen Demand, COD- Chemical Oxygen Demand, GPCB- Gujarat Pollution Control Board.**

I. INTRODUCTION

The main function of wastewater treatment plants is to protect human health and the environment from excessive overloading of various pollutants. Domestic wastewater usually contains grey water (sullage), which is wastewater generated from washrooms, bathrooms, laundries, kitchens etc. It also contains black water made up of urine, excreta and flush water generated from toilets. Physical, chemical and biological processes are applied to remove physical, chemical and biological contaminants. Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge also suitable for discharge or reuse back into the environment. The efficiency of sewage treatment plants can be illustrated by a study on the evaluation of pollutant levels of the influent and the effluent of the sewage treatment plant. This paper presents performance evaluation of an existing Sewage treatment plant based on **Upflow Anaerobic Sludge Bed** (UASB) technology for performance evaluation.

II. ANAEROBIC TREATMENT

Anaerobic treatment is now becoming a popular treatment method for industrial wastewater, because of its effectiveness in treating high strength wastewater and because of its economic advantages. Developed in the Netherlands in the late seventies (1976-1980) by Prof. Gatze Lettinga from Wageningen University, UASB (Upflow Anaerobic Sludge Bed) reactor was originally used for treating wastewater from sugar refining, breweries and beverage industry, distilleries and fermentation industry, food industry, pulp and paper industry.

In recent times the applications for this technology are expanding to include treatment of chemical and petrochemical industry effluents, textile industry wastewater, landfill leachates, as well as applications directed at conversions in the sulfur cycle and removal of metals. Furthermore, in warm climates the UASB concept is also suitable for treatment of domestic wastewater.

The UASB design is a modular system that allows for a tailor made approach to suit each process design and local circumstances. The prefabricated three phase separator in the top of the reactor is designed of synthetic material and virtually unaffected by anaerobic conventions. This ensures an extended life span compared to conventional steel designs. The compact settler module has excellent abilities to separate gas, water and granular sludge efficiently under various conditions. The STP considered for study is a 43 MLD sewage treatment plant based on UASB technology.

III. UASB TECHNOLOGY

A UASB reactor is shown in figure-1 below. From a hardware perspective, a UASB reactor at first appearance is nothing more than an empty tank. Wastewater is distributed into the tank at appropriately spaced inlets. The wastewater passes upwards through an anaerobic sludge bed where the micro-organisms in the sludge come into contact with wastewater-substrates.

The sludge bed is composed of microorganisms that naturally form granules (pellets) of 0.5 to 2 mm diameter that have a high sedimentation velocity and thus resist wash-out from the system even at high hydraulic loads.

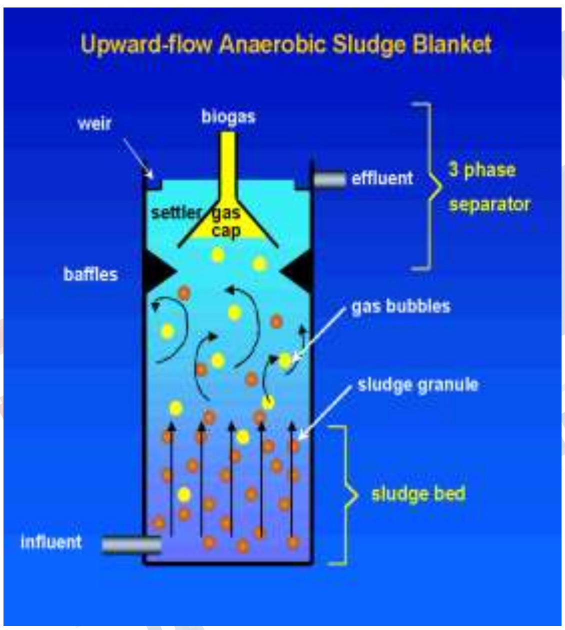

Figure 1 UASB REACTOR

The resulting anaerobic degradation process typically is responsible for the production of gas (e.g. biogas containing CH_4 and CO_2). The upward motion of released gas bubbles causes hydraulic turbulence that provides reactor mixing without any mechanical parts. At the top of the reactor, the water phase is separated from sludge solids and gas in a three-phase separator (also known the gas-liquid-solids separator). The three-phase-separator is commonly a gas cap with a settler situated above it. Below the opening of the gas cap, baffles are used to deflect gas to the gas-cap opening.

Two to three months time is needed to build up a satisfactory sludge blanket without the addition of "seed" from a working UASB. A shorter time is needed if seeding is not required.

During the start-up period, COD removal in the UASB gradually improves as sludge accumulation occurs. This may be called ***sludge accumulation phase.*** The end of the sludge accumulation phase is indicated by sludge wash-out. At this time, the reactor is shut down to improve the quality of the sludge. This may be called the ***sludge improvement phase.*** After sludge improvement, the blanket formation starts. Once the blanket is formed, again some surplus sludge wash–out could occur and now to get the stable operation, one has to thereafter keep removing the excess sludge periodically. The excess sludge so removed, can be sent directly to the sludge drying bed. Daily operation of the UASB requires minimum attention.

The two main conditions for any well performing biological wastewater treatment system are:
(1) To ensure good contact between the incoming substrate and the sludge mass in the system.
(2) To maintain a large sludge mass in the system

In the UASB reactor the influent is distributed uniformly over the bottom of the reactor and then, following an up-flow pathway, rises through a thick layer of anaerobic sludge, where after it is withdrawn at the top of the reactor. Thus the contact between the influent organic material and the sludge mass, in the reactor, is automatically guaranteed.

In order to maintain a large sludge mass, the UASB reactor has a built-in phase separator, where the dispersed solids are retained by settling, so that an effluent virtually free from settleable solids can be discharged. The retained sludge particles Sludge Granules will end up sliding back from the settler compartment into the digester compartment and accumulate there, thus contributing to the maintenance of a large sludge mass in the reactor.

IV .SEWAGE CHARACTERISTICS

Normally sewage consists of organic substances, pathogenic bacteria and suspended solids as major impurities. The principle groups of organic substances found in sewage are proteins, carbohydrates, fats etc. out of which a substantial portion of biodegradable matter that serves as food for bacteria and other micro-organisms. The bacterial decomposition of this organic matter requires oxygen which leads to depletion of oxygen from the waste as well as the natural stream where the sewage is discharged. In order to control this oxygen depletion, removal of the organic matter which is biodegradable is utmost important and achieved by reducing it in terms of BOD and COD. One such innovative and cost effective technology for BOD and COD reduction is UASB (Upflow Anaerobic Sludge Blanket).

The Municipal sewage treatment plant considered for this study has a design flow of 43 MLD and peak flow of about 85 MLD. The incoming sewage characteristics are as follows:

1. pH – 6.5 to 8.0
2. Suspended solids < 360 mg / lit
3. BOD < 350 mg / lit
4. COD < 650 mg / lit
5. Oil and Grease < 10 – 20 mg / lit

V. TREATMENT PROCESS

A typical arrangement of a UASB type treatment plant for municipal sewage would be as follows:

1. Initial pumping to wet well.
2. Screening, Degritting and division of flow
3. Main UASB reactor
4. Gas collection and Conveyance
5. Post treatment facility
6. Sludge treatment

As shown in figure-2 the sewage enters the treatment plant through a main sewer and is collected in the wet well and pumped to inlet screen chamber. The sewage flows through the mechanical bar screens whereby the floating solids, plastic bags, rags etc shall be removed through a belt conveyor into a trolley stationed beneath. After screening the sewage is passed through detritus tank where grit particles are separated by gravity and removed.

The sewage then flows through parshall flume to division box -1 and from this to 4 sub-division boxes. From each sub-division box sewage is distributed to 3 distribution boxes. From each distribution box the sewage flows to 6 FPR feed boxes. Thus each UASB reactor shall be fed by 2 distribution boxes and 12 feed boxes. From each feed box 10 nos of HDPE pipes feed the sewage to the bottom of the reactor. The sludge from this sewage settles at the bottom of the reactor and forms a sludge blanket which carries out the BOD and COD reduction of sewage.

The sewage passes upward through this sludge blanket and the organic matter and solids present in this sewage are decomposed and reduced anaerobically by the bacteria present in this sludge blanked and bio-gas is formed. Due to long retention time, solids are degraded and also a large fraction of organic matter is digested by the anaerobic bacteria resulting in formation of bio-gas which contains mainly (70 – 80 %) Methane CH_4 and some minimal percentage of CO_2, N_2, H_2O and H_2S.

VI. POST TREATMENT:

About 70 to 80% reduction in the BOD may be adequate to meet the effluent discharge standards however some form of post treatment is generally required after UASB treatment to destroy the anaerobicity and aerate the effluent, to drive off the odorous gases and catch any solids carry over that may occur occasionally. This consists of an extended type aeration activated sludge process. In this phase the treated effluent from UASB is brought into contact with a mixed microbial population in the form of a flocculent suspension in an aerated and agitated suspension. The microbes are thoroughly mixed with the organic matter so that they grow and stabilize the remaining organic matter.

As the microbial organisms grow they coalesce together to from an active mass of microbial floc called activated sludge. The mixture of this activated sludge along with the wastewater known as mixed liquor flows to secondary clarifier where the removal of microbes as well as organic matter takes place in the form of sludge by sedimentation. A portion of this settled sludge is however returned to the aeration tank to maintain the food to micros ratio in the aeration tank. The final treated effluent from the secondary clarifier is discharged to natural course of stream after verification that it meets the IS standards of disposal for wastewater.

The sludge produced in the UASB and Activated Sludge process system is taken to sludge thickener for thickening and reduction in volume and further transferred to sludge drying beds. After drying the solid cake is used as manure for agriculture.

The characteristics of final effluent sent for disposal to river are as follows:

1. pH – 6.5 to 8.0
2. Suspended solids < 20 mg / lit
3. BOD < 20 mg / lit
4. COD < 100 mg / lit
5. Oil and Grease < 2 mg / lit

VII.PERFORMANCE EVALUATION

Samples were taken from the sewage treatment plant from the following three sampling points and analysis was done for basic parameters including pH, TSS, BOD and COD.

Sampling point 1 : From inlet chamber (Raw sewage)

Sampling point 2 : From UASB outlet (Sewage after UASB treatment)

Sampling point 3 : From outlet of secondary clarifier. (Final treated effluent for disposal)

The variations in pH, TSS, BOD and COD along the three sampling points are shown in the graphs below:

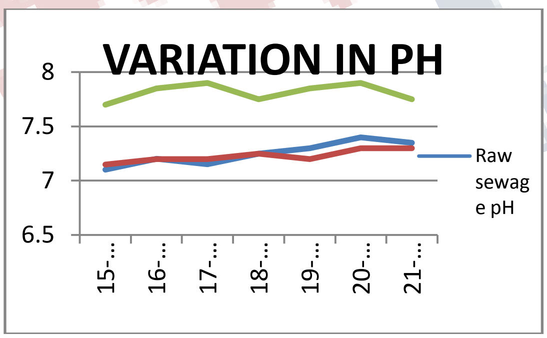

Figure:3 Variation in pH

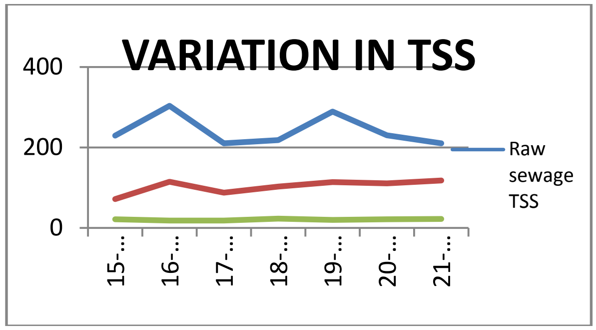

Figure:4 Variation in TSS

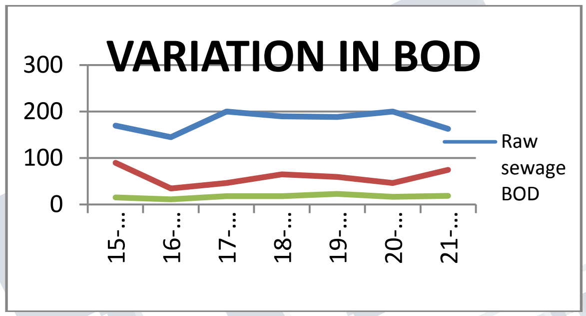

Figure: 5 Variation in BOD

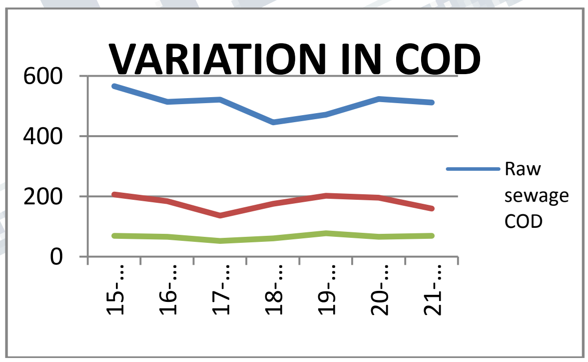

Figure: 6 Variation in BOD

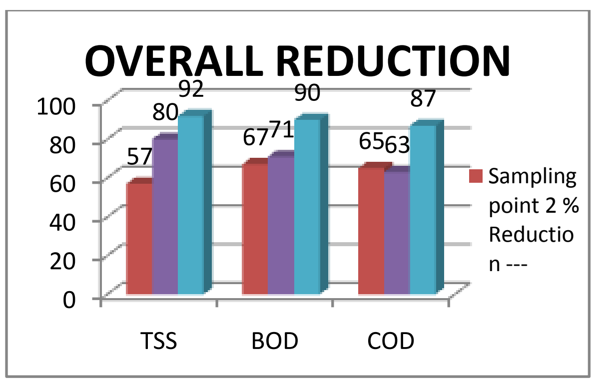

Figure:7 Overall reductionin TSS, BOD & COD

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 1, Issue 6, October 2016

VIII. CONCLUSIONS

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 plant was satisfactory. The percentage reduction in TSS, BOD and COD after UASB treatment alone is 57, 67 and 65 respectively. The percentage reduction in TSS, BOD and COD after post treatment is 80, 71 and 63 respectively. The overall percentage reduction in TSS, BOD and COD after entire treatment cycle is 92, 90 and 87 respectively. Therefore it can be concluded that the plant is working satisfactory and the individual units are also working well.

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