Verification of Waste Water Treatment Process by Assessing the Physico Chemical Parameters

Rahul Sukharia[1], Dr. V. K. Srivastava[2]

Department of Science, Pandit Deendayal Petroleum University, Gandhinagar, Gujarat

Abstract- **Many industries are located in South Gujarat and producing variety of products and subsequently producing huge amount of liquid, solid, and gaseous discharge in the environment. The primary consideration of our study is based on evaluation of existing wastewater plant along with its operation and control. A major tool for proper process control is frequent and accurate sampling and laboratory analysis, hence it is significant to study the efficiency of the treatment technologies that are currently equipped to treat the waste water. This study provides an insight about the percentage efficiency of the waste water treatment plant and the step wise degradation of the selected parameters which were analysed at each stage of treatment. The study also gave a brief idea of the type of wastewater that was discharged in the estuarine zone near Valsad (Gujarat). Concentrations of each parameter were analyzed using protocols laid by BIS (Bureau of Indian Standards). The overall performance of the existing WWTP was satisfactory as per the standards laid by GPCB. The removal efficiencies of Chemical Oxygen Demand and Bio-chemical Oxygen Demand were found to be 94.87% and 93.43% respectively. Moreover, the efficiency of the tertiary treatment of the WWTP was adequate.**

Keywords- waste water, treatment, parameters, analysis.

I. INTRODUCTION

- In India, South Gujarat is known as economic capital as well as economic backbone of Gujarat.
- Many industries are established here and conduct their production activities and discharge solid, liquid, and gaseous waste in the environment.
- A study conducted by *Malik G. M. et al, 2010* indicates that there are diverse contaminations and pollution in rivers at Valsad; out of which river Par is least polluted with compared to rest of the rivers. The effluent treatment plant of the chemical industry was selected as the study area to evaluate its efficiency to treat the effluent.
- The selected chemical industry is one of the major established Industries in this location and contributes 90% of the total industrial discharge in the river Par. One of the primary considerations in evaluating an existing wastewater plant is in the area of plant operation and control. A major tool required for proper process control is frequent and accurate sampling and laboratory analysis.
- Verifying the effectiveness of WWTP has the advantage of assessing the performance of the WWTP after commissioning the plant based on the treatment efficiency of parameters such as BOD, COD, TSS and Sulphides. Suitable remedial measures can be adopted to improve the performance of treatment plant.
- Carried out the study on evaluating efficiency of the treatment plant by studying water samples, which were collected at different stages of treatment units.
- Performance effectiveness of each unit was calculated, which is the proof that WWTP has been working with the norms of GPCB and meeting the standard discharge limits.
- The stepwise reduction in concentration of various parameters from the waste generated through successive unit operations was covered under this study.
- The main objectives are to study the sequential combination of various physical unit operations, and chemical and biological unit processes, to assess the effluent quality and meet higher treatment requirements, to evaluate the performance of the WWTP of the chemical industry.

II. METHODS AND MATERIALS

Parameters analysed:

1. Chemical Oxygen Demand (Dichromate reflux)
2. Biochemical Oxygen Demand (Winkler's)
3. Acidity (Titrimetric)
4. Phenolic compounds (4 Aminoantipyrine method without chloroform extraction)
5. Total Suspended Solids (Gravimetric)
6. Phosphorus (Spectrophotometer)
7. Oil & Grease (Solvent Extraction)
8. Sulphide (Titrimetric)

1. Chemical Oxygen Demand:

Chemical oxygen demand (COD) does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water.

Principle: The organic matter of the sample is oxidized to water, carbon dioxide and ammonia by reflux ion with a known excess of potassium dichromate in a 30 ml sulphuric acid solution. The excess dichromate is titrated with a standard solution of ferrous ammonium sulphate solution. Silver sulphate is added as a catalyst to promote oxidation of straight chain aliphatic compound. Mercuric sulphate is added to eliminate the interference due to chlorides.

2. Biochemical Oxygen Demand:

Natural organic detritus and organic waste from waste water treatment plants, failing septic systems, and agricultural and urban runoff, acts as a food source for water-borne bacteria.
Bacteria decompose these organic materials using dissolved oxygen, thus reducing the DO (Dissolved Oxygen) available for other aerobic organisms in water. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter

under aerobic conditions. Biochemical oxygen demand is determined by incubating a sealed sample of water for five days and measuring the loss of oxygen from the beginning to the end of the test. Samples often must be diluted prior to incubation or the bacteria will deplete all of the oxygen in the bottle before the test is complete. The main focus of wastewater treatment plants is to reduce the BOD in the effluent discharged to natural waters. Wastewater treatment plants are designed to function as bacteria farms, where bacteria are fed oxygen and organic waste. The excess bacteria grown in the system are removed as sludge, and this "solid" waste is then disposed of on land.

Principle: The dissolved oxygen content of the sample is determined before and after three days incubation at 27˚C. The amount of oxygen depleted is calculated as BOD. Sample devoid of oxygen or containing less amount of oxygen are diluted several times with special type of dilution water saturated with oxygen, in order to provide sufficient amount of oxygen for oxidation.

3. Acidity:

pH is a measure of the amount of free hydrogen ions in water. Specifically, pH is the negative logarithm of the molar concentration of hydrogen ions: pH = -log $[H^+]$

Because pH is measured on a logarithmic scale, an increase of one unit indicates an increase of ten times the amount of hydrogen ions. A pH of 7 is considered to be neutral. Acidity increases as pH values decrease, and alkalinity increases as pH values increase. Most natural waters are buffered by a carbon-dioxide-bicarbonate system, since the carbon dioxide in the atmosphere serves as a source of carbonic acid.

This reaction tends to keep pH of most waters around 7 - 7.5, unless large amounts of acid or base are added to the water. The pH of water affects the solubility of many toxic and nutritive chemicals; therefore, the availability of these substances to aquatic organisms is affected. As acidity increases, most metals become more water soluble and more toxic. Toxicity of cyanides and sulphides also increases with a decrease in pH (increase in acidity). Ammonia, however, becomes more toxic with only a slight increase in pH.

Principle : The concentration of mineral acids present and contributing the mineral acidity can be calculated by titrating or neutralizing samples to pH 4.3. The CO2 and Bicarbonates (carbonic acid) present in the sample can be neutralized completely by continuing the titration to pH 8.3 .

Interference: A fading and temporary end point characterizes the phenolphthalein acidity titration performed at room temperature on a sample containing iron and aluminium sulphate. Better results are obtained by titrating the sample at boiling temperature. Acid samples from mine drainage are subjected to interferences. Coloured or turbid samples may interfere in end point. Analyze such samples by potentiometric titration.

4. Phenolic Compounds:

Principle: This is a photometric test method , based on the reaction of steam-distillate Phenolic compounds which react with 4-aminoantipyrine at pH ± 2 in the presence of potassium ferricyanide [$K_3Fe(CN)_6$] to from a coloured antipyrine dye.

The antipyrine colour formed in an aqueous solution is measured at 500 nm.

The amount of Phenolic compounds in the sample is expressed as mg/L of Phenol (C_6H_5OH).

Interference: To eliminate or minimize the interference, use steam distilled sample. Phenols are distilled from non-volatile impurities. Because the volatilization of phenols is gradual, distillate volume shall ultimately equal that of the original sample.

5. Total Suspended Solids:

Water with higher solids content often has a laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them. High concentration of dissolved solids about 3000 mg/L may also produce distress in livestock. In industries, the use of water with high amount of dissolved solids may lead to scaling in boilers, corrosion and degraded quality of the product. Estimation of total dissolved solids is useful to determine whether the water is suitable for drinking purpose, agriculture and industrial purpose. Suspended material is aesthetically displeasing and provides adsorption sites for chemical and biological agents. Suspended organic solids which are degraded anaerobically may release obnoxious odours. Biologically active suspended solids may include disease causing organisms as well as organisms such as toxic producing strains of algae. The suspended solids parameter is used to measure the quality of wastewater influent and effluent. Suspended solids determination is extremely valuable in the analysis of polluted waters. Suspended solids prohibit light, thus dropping the growth of oxygen generating plants.

Principle: A well mixed sample is filtered through a standard glass fiber filter, and the filtrate is evaporated to dryness in a weighed dish and dried to constant weight at 179-181°C. The increase in dish weight represents the total dissolved solids. A well mixed sample is filtered through a weighed standard glass fiber filter and the residue retained on the filter is dried to a constant weight at 103-105°C. The increase n weight of the filter represents the total suspended solids. In case the suspended material clogs the filter and decrease the filtration rate, the difference between the total solids and total dissolved solids may provide an estimate of the total suspended solids.

6. Phosphorus:

Principle: The molybdo-phosphoric acid formed is reduced to an intensely coloured complex molybdenum blue by stannous chloride. This method is significantly sensitive and the reliability of the method increases at concentrations below 0.1mg/l of phosphorous with minimum interference.

Interference: Silica and arsenic interfere surely, if the sample is heated. Arsenate, sulphide, fluoride, thiocyanate, thiosulphate or excess molybdate cause negative interference. Ferrous iron which causes bluish colour does not affect the result, if the concentration is below 100mg/L. if nitric acid is used in the test, chloride interferes at 75mg/L.

7. Oil & Grease:

Any material recovered as a substance soluble in trichlorotrifluoroethane. [IS 3025 (Part 39) : 1991]

Principle: Oil & grease is extracted from water by trichlorotrifluoroethane and estimation is done gravimetrically

Interference: The solvent extracts not only oil & grease but other organic substances also.

8. Sulphide:

Principle: Zinc acetate reacts with sulphides to fix sulphides and form Zinc Sulphide precipitates which are insoluble in water. Hydrochloric acid addition dissolves these ppts and form Zinc chloride + Hydrogen Sulphide. When I2 solution is added it replaces the sulphides attached to hydrogen atom by iodine atoms. Unreacted I2 is titrated using starch as indicator.

Interference: Sulphites are the major interference which may react with Iodine. Hence ppts formed are washed several times so as to remove the sulphite interference.

III. RESULTS AND DISCUSSION

This section demonstrates the results of the data from WWTP. The performance of system -as a total – is presented by comprising the level of different physical, chemical and biological parameters in influent and the effluent. In addition, results showed the performance of different system components. Analysis of the performance aspects of WWTP and factors leading to inadequate performance of the system is discussed. One of the research aims is to evaluate the behavior of wastewater treatment and the performance of the plant through analyzing the biological, chemical, solids, nutrients removal efficiency of the plant. The BOD, COD, TSS, Phenol, Sulphide, Ammonical Nitrogen, Oil and Grease, phosphorus and pH were chosen as parameters to reflect the removal efficiency of the plant. The data collected from the WWTP lab were recorded daily and the tests were performed on the basis of protocols given by Bureau of Indian Standards for industries. The data collected were averaged as monthly readings for 30 days to indicate the values of the selected parameters for 30 days and then to indicate the removal efficiency of the plant as a performance indicator.

Sr. No	Table No. 1				
	Parameter	**Inlet**	**Outlet**	**STD**	**Removal Efficiency (%)**
1	COD	2850	188.42	250	94.87
2	BOD	1370	90	100	93.43
3	Acidity	3200	70	NA	97.81
4	Phenol	28	10	10	64.28
5	TSS	284	100	100	64.78
6	Phosphorus	10	5	5	50
7	Oil & Grease	25	5	10	80
8	Sulphide	13.21	1	2	92.43

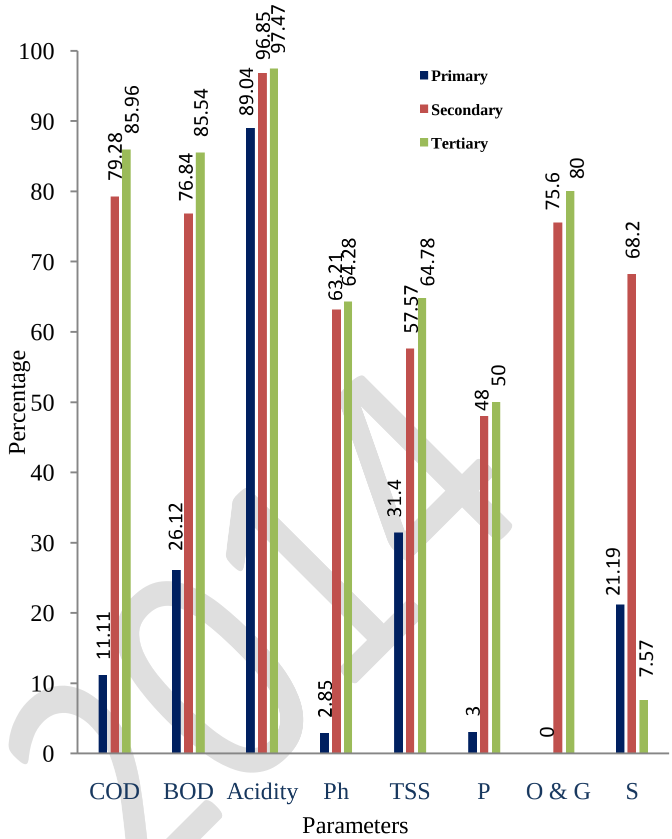

Fig. 1 Percentage reduction in the concentration

IV. CONCLUSION

The overall performance of the existing was satisfactory as per the standards laid by GPCB is concerned. The removal efficiencies of the parameters are found to be as following:

1. Chemical Oxygen Demand : 94.87%
2. Biochemical Oxygen Demand : 93.43%
3. Acidity : 97.81%
4. Phenol : 64.28%
5. Total Suspended Solids : 64.78%
6. Phosphorus : 50%
7. Oil & Grease : 80%
8. Sulphide : 92.43%

The individual units are also performing well and their removal efficiencies are satisfactory in terms of reduction in concentration of wastewater components. This performance evaluation of the WWTP shows a good overall result and hence it is clear that river Par is least polluted among all other south Gujarat rivers because of the presence of a huge chemical industry, with an adequately performing WWTP. The efficiency of the tertiary treatment of the WWTP of the industry was adequate when the WWTP was constructed. But as the Industry is growing and the volume of wastewater along with higher concentrations are entering in the WWTP the tertiary treatment which was meant to remove TDS and TSS after overall treatment of other parameters should be updated with latest technologies of reverse osmosis, ultraviolet disinfection, filtration etc, so as to maintain the good performance as it is observed to have at present.

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ACKNOWLEDGMENT

Authors are thankful to Pandit Deendayal Petroleum University (PDPU), Gandhinagar for providing encouragement and other facilities to carry out this study.