International Journal of Science, Environment and Technology, Vol. 4, No 5, 2015, 1330 – 1335
ISSN 2278-3687 (O)
2277-663X (P)

# TREATABILITY STUDY METHODOLOGY & APPLICATION

**Ms. Seema A. Nihalani**
Head and Assistant Professor, Department of Civil Engineering
Parul Institute of Engineering and Technology, Waghodia, Vadodara-31760
E-mail: seemanihalani@yahoo.com

**Abstract:** Ever increasing demand of water for domestic, irrigation and industrial use have created water crisis worldwide. Contamination of water resources from wastewater (sewage and industrial effluent) has further aggravated water scarcity. End of Pipe treatment by Sewage Treatment Plant (STP) & Effluent Treatment Plant (ETP) is one of the effective tools to combat water pollution and thereby reduce water scarcity. Treatability studies are crucial to determine specific treatment and recycling technologies as well as capital and operating costs. The present paper describes the basic steps for treatability study involving primary, secondary and tertiary treatments on a lab scale model. Further, a case study of chemical industry has been included.

**Keywords:** ASP- Activiated Sluge Process, UASB- Upflow Anaerobic sludge Blanket, RBC-Rotating Biological Contractor, SBR-Submerged Bio reactor, MBR- Membrane Bio reactor.

## 1. Introduction

A treatability study is a study in which a wastewater /effluent is subject to a physical, chemical, biological, or thermal treatment process to determine:

- Whether the waste is amendable to the treatment process;
- What pretreatment (if any) is required;
- The optimal process conditions needed to achieve the desired treatment;
- The efficiency of a treatment process for a specific waste or wastes; or
- The volumes and characteristics of residuals resulting from various treatment processes

## 2. Phases of treatability study:

The phases of a typical treatability study include:

1. Identifying treatment and recycling goals.
2. Obtaining representative samples for testing.
3. Determining analytical methods to evaluate compliance with requirements.
4. Developing the necessary testing program to determine if the goals can be met.

*Received Aug 23, 2015 * Published Oct 2, 2015 * www.ijset.net*

## 3. Characterisation Of Effluent

The very first step involved in the treatability study is the immediate characterization of effluent after its collection. The treatment to be given to the effluent to achieve the appropriate disposal standards depends upon the characteristics of the sample. The various parameters to be analyzed for the effluent at laboratory are pH, Total Solids, BOD, COD, Chlorides, Sulphates, etc.

## 4. Generic Flow Diagram Showing Treatment Stages

Generally, after characterization first step is to give primary treatment to the effluent for the removal of suspended & colloidal matters from the effluent. The primary treated effluent is subjected to secondary treatment, in which the effluent is treated using microbes for the removal of organic matter from the effluent. If it is intended to reuse the effluent then it is necessary to give tertiary treatment to the effluent, which has been treated up to secondary level.

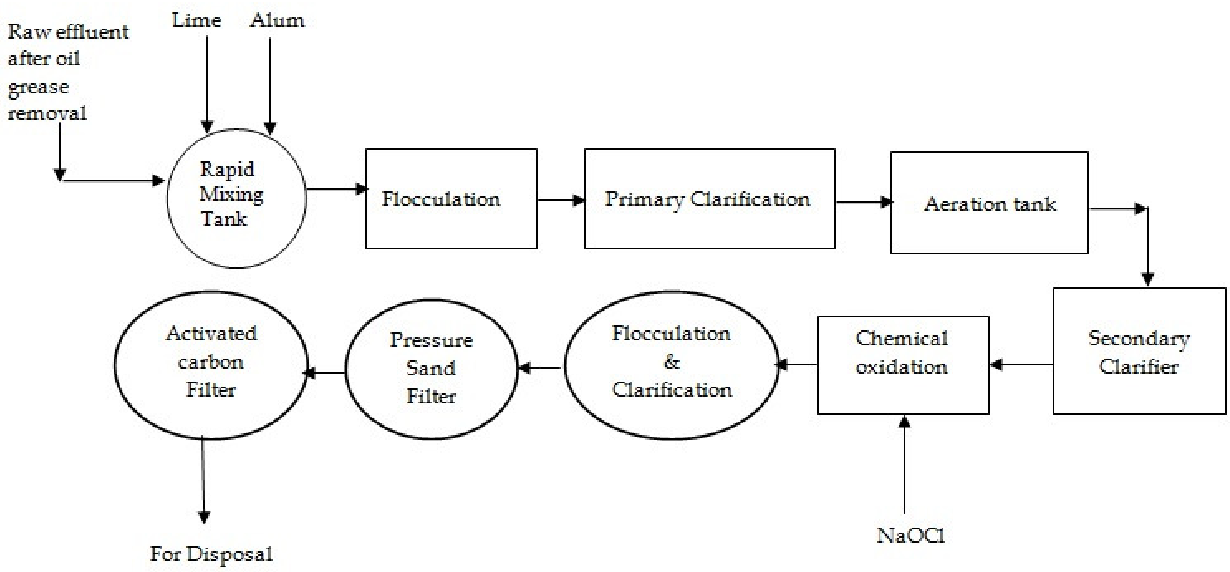


**Figure 1:** Generic treatment scheme

The primary, secondary and tertiary treatments are run separately to determine optimum parameters and operating conditions for each stage of treatment separately. A composite or representative effluent sample is then subject to primary, secondary and tertiary stage of treatment sequentially and reduction in BOD, COD, TSS and parameters determined intermittently at each stage. The final treated effluent after tertiary treatment is analysed for all parameters recommended as per PCB norms.

**4. A Primary Treatment**

There are various technologies available for primary treatment of effluent. The main aim of the primary treatment is to reduce solids (suspended & colloids) which are imparting COD to the effluent. There are various coagulants & polyelectrolyte available in the market for the treatment. In the laboratory for the determination of coagulant dose jar test Apparatus is used. The jar test is a common laboratory procedure used to determine the optimum operating conditions for water or wastewater treatment. This method allows adjustments in pH, variations in coagulant or polymer dose, alternating mixing speeds, or testing of different coagulant or polymer types, on a small scale in order to predict the functioning of a large scale treatment operation. A jar test simulates the coagulation and flocculation processes that encourage the removal of suspended colloids and organic matter from the effluent.

The jar test is the most common method of determining proper coagulant dosages. When there is a question as to which chemical should be used as a coagulant, it is often necessary to run more than one series of jar tests. Different coagulant chemicals and pH ranges should be used to determine which one produces the most satisfactory results at the lowest cost. The step- by-step procedures for a jar test are as follows:

- Reduce the stirring speed to 25 to 35 rpm and continue mixing for 15 to 20 minutes. This slower mixing speed helps promote floc formation by enhancing particle collisions, which lead to larger flocs. These speeds are slow enough to prevent sheering of the flock due to turbulence caused by stirring to fast.
- Turn off the mixers and allow the containers to settle for 30 to 45 minutes.
- Then measure the final turbidity in each container.

**4. B. Secondary Treatment**

Primary treated effluent shall be given the treatment using microorganisms for the removal of organic biodegradable matter from the effluent. Before proceeding for this treatability it is necessary to check that the effluent is biodegradable or not. For this purpose, one must check BOD to COD ratio. If effluent is having BOD: COD $\geq$ 0.5, then it is biodegradable & if the ratio is less than 0.5 then it is not easily biodegradable. In case of the second possibility, seeding is to be done. Various biological treatments used in field are ASP, UASB, RBC, Trickling filter, SBR, MBR etc.

**Effluent Treatment By Activated Sludge Process:**

The development of biomass by any biological treatments requires generation of specific kind of microorganisms, which can degrade the biodegradable organic pollutants in an efficient manner. Activated Sludge is strictly aerobic process & acclimatization is required by gradual exposure of biomass with respect to specific characteristics of wastewater, which will enhance the capacity of the microorganisms & able to carry out the oxidation process.

Step –Wise Procedure at Lab Scale

1. Take a jar of 5 lit capacity. Put the 3 lit of effluent with an animal deifications slurry (cow dung) or soil suspension or sewage sludge suspension or garden soil suspension or soil from discharge point of wastewater & add glucose at the rate of 500 mg/lit.
2. Aerate continuously at a rate of 3 to 4 liters per minute.
3. After aeration period of 24 hours, allow it to settle for about 30 minutes.
4. Remove the supernatant retaining the biomass.
5. Add again 3 lit of effluent & glucose at the rate of 500 mg/lit in the biomass & aerate continuously.
6. Continue the aeration process for 5 to 7 days until good amount of sludge formation taking place with a clear supernatant indicating good adsorptive capacity of sludge.
7. If acclimatization is necessary with specific industrial wastewater, then take 10% i.e. 300 ml of industrial wastewater & 2700 ml of domestic wastewater or tap water & add it to aeration systems.
8. Withdraw the sample at every 2 hr, after starting aeration & measure the pH, Dissolved Oxygen, BOD, COD, temperature, MLSS & SVI & find out percentage reduction in BOD & COD.

**4. C. Tertiary Treatment**

The biologically treated effluent is subjected to tertiary treatment for the polishing of the effluent either for the disposal or for reuse purpose. There are various advance technologies available for this purpose, which can be used for achieving the desired quality effluent. The different technologies are enlisted below which are most commonly used in the field are: pressure filters, activated carbon, Chlorine, Ozone, H2O2, UV rays, membranes etc.

Many times chemical oxidation using sodium hypochlorite prior to tertiary treatment, in order to bring down the COD within design load range of filters. The tertiary treatment by activated carbon helps in polishing the treated effluent, by the removal volatile organic matter & residual suspended solids from the effluent. It can be done in the same way as that of sand filter; the only difference is that the media is different. Usually granular activated carbon is used as a filtering media. The organic matters present in the effluent are adsorbed on the surface of the media.

## 5. Case Study

Composite samples were drawn from equalization tank and analysed as per the standard methods to determine their composition. The quantitative analysis of influent is reported in Table 1.

**Table 1: Effluent Characterisation**

| **S.No** | **Parameter** | ***Unit*** | **Raw Effluent** |
|---|---|---|---|
| 1 | pH | | 10.3 |
| 2 | Colour | *mg/l* | Dark Brown |
| 3 | TSS | *mg/l* | 70 |
| 4 | TDS | *mg/l* | 621 |
| 5 | COD | *mg/l* | 1228.8 |
| 6 | BOD | *mg/l* | 824.6 |
| 7 | O&G | *mg/l* | 190 |
| 8 | Amm. $N_2$ | *mg/l* | 29.4 |
| 9 | $PO_4$ | *mg/l* | 2.0625 |
| 10 | Phenol | *mg/l* | 6.97 |
| 11 | $SO_4$ | *mg/l* | 1577.7 |

Based on the quality of influent it is clear that biological oxidation will not be effective since the concentration of Sulphate is very high. Thus, chemical treatment including chemical coagulation followed by chemical oxidation is suggested to ascertain the treatability.

Chemical coagulation using Sodium Hypochlorite & Hydrogen peroxide is done and then the effluent is allowed to settle. The results of COD reduction are shown below:

**Table 2: COD reduction using Sodium Hypochlorite**

| S. No. | **Dose of NaOCl (ppm)** | ***1 hr oxidation time*** | | ***3 hrs oxidation time*** | |
|---|---|---|---|---|---|
| | | **pH** | **COD** | **pH** | **COD** |
| | **Initial** | **10.3** | **1228** | | |
| 1 | 200 | 10.55 | 666 | 10.58 | 792 |
| 2 | 400 | 10.7 | 355.2 | 10.72 | 532.8 |
| 3 | 600 | 10.87 | 444 | 10.93 | 488.4 |

**Table 3: COD reduction using Hydrogen Peroxide**

| S. No. | Dose of $H_2O_2$ (ppm) | *1 hr oxidation time* | | *3 hrs oxidation time* | |
|---|---|---|---|---|---|
| | | **pH** | **COD** | **pH** | **COD** |
| | **Initial** | **10.3** | **1228** | | |
| 1 | 300 | 10.3 | 835.2 | 10.3 | 912.64 |
| 2 | 600 | 10.3 | 835.2 | 10.3 | 1071.36 |
| 3 | 900 | 10.3 | 278.4 | 10.3 | 1111.04 |
| 4 | 1200 | 10.3 | 371.2 | 10.3 | 1150.75 |

**Conclusion**

- Thus a percentage reduction of 71% is obtained in COD using Sodium Hypochlorite as coagulant
- Thus a percentage reduction of 77% is obtained in COD using Hydrogen Peroxide as coagulant
- Based on above observations it is clear that Hydrogen peroxide treatment is more effective.
- Thus, Treatability studies are crucial to determine specific treatment and recycling technologies as well as capital and operating costs.

**References**

[1] CPHEEO, "Manual on Sewerage and Sewage Treatment." Second Edition, The Central Public Health and Environmental Engineering Organization Ministry of Urban Development, New Delhi., May 2012.

[2] Metcalf and Eddy, 'Waste Water Engineering Treatment and Reuse', 4$^{th}$ edition, Tata McGraw Hill Publishers, 2003

[3] Gikas, P., Tchobanoglous, G., The role of satellite and decentralized strategies in water resources management, Journal of Environmental Management, 2009, VOL. 90, PP 144-152

[4] Tchobanoglous, G; Burton, F, L; Stensel, H.D. (2003) Wastewater Engineering Treatment and reuse: Metcalf and eddy 4$^{th}$ Ed., McGraw-Hill, New York, NY, USA.