Analysis and Performance of Common Effluent Treatment Plant

*S.HemanthSai*, **C. Mounika**

*Assistant Professor, Department of Civil Engineering, NallaNarasimha Reddy Group of Institutions, Telangana, India*

*Assistant Professor, Department of Civil Engineering, VignanaBharathi Institute of Technology, Telangana, India*

**ABSTRACT**

The discharge from industries after the manufacturing of products is called as an Effluent. This effluent contains solids, liquids, and other pollutants. Hence these effluents have to be treated before letting out into municipal drainage pipes or streams or underground. Every industry cannot have its own treatment plant as it is costly. With a view to economize their expenditure on treatment, Government of India encouraged for common construction of effluent treatment plants by giving subsidy to them. Even state government provides subsidy to them. The extra expenditure will have to be borne by the industries in the proportion of quantity of effluent to the common effluent treatment plant. The industrial wastes contain pH, Temperature, Oil & Grease, suspended solids, Dissolved solids, Organic matter, etc. Based on the generation of the wastes, treatment schemes should be tailor made and not standard flow sheets to be followed. Waste generation is a common phenomenon now a days due to population explosion, modernization in terms of luxury living, research and development in the field of chemical fertilizers, pesticides high yield seeds, increase in number of crops per year, use of cosmetics, manufacture of advanced electrical & electronic goods, processing of leather goods, concentration of household, hospitals, hotels, galvanizing units, paints & varnishes, vehicle washing stations, vehicular density contributing to air pollution. Industrialization to meet the demand of the population also contributes to the population with required treatment facilities at source industry to a maximum extent.

**Key words:** pH, Suspended solids, Organic matter, Industries, Chemical fertilizers.

1. **Introduction:**

In many parts of the world, financial, social and political issues have emerged taking after quick mechanical advancement and urbanization, bringing about unfriendly consequences for the personal satisfaction. Urbanization is placing a vital role on the pressure of public amenities. Be that as it may, long haul and more extensive issues would in the end likewise be experienced as industrialization and urbanization apply weight on the bigger asset base that backings the group. This bigger asset base incorporates ranger service, freshwater and marine assets, and also space reasonable for further advancement. The challenges related with natural debasement regularly start from modern advancement. They are intensified by fast urbanization that is in charge of the development of many significant urban communities. Fast industrialization and its fixation in or close urban focuses have put high weights on the conveying limit of nature at particular areas. At these areas waterbodies, for example, waterways, lakes, and beach front waters normally been extremely have influenced. Freshwater is a vital natural resource which will continue to be renewable as long as it is managed well. Preventing pollution from domestic and industrial activities is important to ensure the sustainability of the locale’s development. Undoubtedly the water pollution control efforts which have been underway in many countries have already achieved some success. Nevertheless the problems that are confronted grow in complexity and intensity. The pollution of freshwater bodies with the constant deterioration in water quality can only worsen the situation. Such pollution is due to the inadequate treatment of the effluents, sewage and discharging them into the water
1.2 Industrial Waste Water:
It may be useful to compare industrial wastewater with domestic sewage since designers of wastewater treatment facilities often begin their careers and almost certainly their education in environmental engineering by looking at sewage and sewage treatment plants. The latter can then provide a familiar framework which the reader can use to compare industrial wastewater and its treatment.

The biodegradability of sewage can be found by considering its Chemical Oxygen Demand (COD) and the corresponding BOD (5 day’s BOD), the nitrogen (N) would typically be in the form of organic nitrogen and Ammonia Nitrogen (Nitrates (NOB-N) would not be expected to be present as conditions in the sewers would be such that nitrate formation is unlikely while nitrate degradation because of anoxic reactions is likely. The Phosphorous (P) would be a combination of organic and Phosphate (P$_{oa}$) forms. The pH of effluent would be within the range of 6-9 and this is generally considered suitable for biological processes. Industrial wastewaters have very varied compositions depending on the type of industry and materials processed. Some of these wastewaters can be organically very strong, easily biodegradable, largely inorganic, or potentially inhibitory. This means TSS, BOD’s and COD unlike sewage, pH values well beyond the range of 6-9 are also frequently encountered. Such wastewaters may also be associated with high concentrations of dissolved metal salts.

This is then expected to enable the combined wastewater to be treated easily compared to the treatment of the industrial wastewater on its own. However, even where the option of discharging into a sewerage system is available, some parameters is frequently required at the factory before such discharge is permitted. Such pretreatment may include pH adjustment to 6-9 and BOD reduction to 400 mg.

1.3 Industrial Waste Water Treatment:
Modern wastewaters are effluents that outcome from human exercises which are related with crude material preparing and assembling. These wastewater streams emerge from washing, cooking, cooling, warming, extraction, response by-items, detachment, movement, and quality control bringing about item dismissal. Water contamination happens when potential poisons in these streams achieve certain sums making undesired modifications a getting waterbody. While modern wastewaters from such preparing or assembling destinations may incorporate some household sewage, the last is not the real segment. Residential sewage might be available as a result of washrooms and inns given to laborers at the preparing or assembling office. Cases of mechanical wastewaters incorporate those emerging from substance, pharmaceutical, electrochemical, gadgets, petrochemical, and sustenance preparing businesses.

1.4 Necessity to treat Industrial Waste Water:
All major things on earth, ecosystems, and humans depend on freshwater i.e., the water with less than 100mg L$^{-1}$ salts for their survival. The earth’s water is primarily saline in nature (about 97%) In the remaining 3% of water, 87% of it is locked in the polar caps and glaciers. This means that only 0.4% of all water on earth is accessible freshwater. The latter is, however, a continually renewable resource although natural supplies are limited by the amounts that move through the natural water cycle. Unfortunately precipitation patterns, and hence distribution of freshwater resources, around the globe is far from even.

2. Nature and Characteristics of Industrial Wastewater
It is only natural for industry to presume that its wastewater can best be disposed of in the domestic sewer system. However, the authorities should not accept any wastewater discharges into the domestic sewer system without prior knowledge about the characteristics of the wastewater, the sewage system’s ability to handle them and the effects of the wastewater upon all the areas of the city disposal system. Institution of a sewer ordinance, restricting the types or concentrations of wastewater admitted in the sewer leading to a treatment plant, is one means of protecting the system. The most important physical characteristic of wastewater is its total solids content, which is composed of floating matter, settleable matter, colloidal matter, and matter in solution. Other important physical characteristics include odor, temperature, color, and turbidity.
2.1 Chemical Characteristics

Organic matter:
Organic compounds are composed of a combination of carbon, hydrogen, and oxygen, with nitrogen in some cases. Other important elements, such as sulfur, phosphorus, and iron, may also be present. Also, industrial wastewater may contain small quantities of a large number of different synthetic organic molecules ranging from simple to extremely complex in structure.

Surfactants:
Surfactants are large organic molecules that are slightly soluble in water and cause foaming in wastewater treatment plants and in surface waters into which the wastewater effluent is discharged. Surfactants tend to collect at the air-water interface. During aeration of wastewater, these compounds collect on the surface of the air bubbles and thus create very stable foam.

Phenols:
Phenols and other organic compounds are also important constituents of water. Phenols cause taste problems in drinking water, particularly when the water is chlorinated. They are produced primarily by industrial operations and find their way to surface waters via industrial wastewater discharges. Phenols can be biologically oxidized at concentrations up to 500 mg/liter.

Volatile organic compounds (VOCs):
Organic compounds that have a boiling point less than \(< 100 \, ^\circ\text{C}\) and/or a vapor pressure > 1 mm Hg at 25 °C are generally considered to be volatile organic compounds (VOCs). The release of these compounds in sewers and at treatment plants is of particular concern with respect to the health of collection system and treatment plant workers.

Fats, oils and grease:
Fats are among the more stable of organic compounds and are not easily decomposed by bacteria. Kerosene, lubricating oils reach the sewer from workshops and garages, for the most part they float on the wastewater, although a portion is carried into the sludge on settling solids. To an even greater extent than fats, oils, and soaps, the mineral oils tend to coat surfaces causing maintenance problems.

The oil and grease (O & G) is a very important test used to determine the hydrocarbon content of industrial wastewaters. O&G tests include free O&G and emulsified O&G measures. These tests will determine the type of treatment required. Free O &G can be removed by flotation & skimming using gravity oil separator.

2.2 Characteristics of Treated Waste Water

The effluent treatment Plant of this company is designed to obtain the in land surface water discharge standards.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNIT</th>
<th>TOLERANCE UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>40</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>mg/l</td>
<td>100</td>
</tr>
<tr>
<td>BOD 5 days @ 20°C</td>
<td>mg/l</td>
<td>30 (Max)</td>
</tr>
<tr>
<td>COD</td>
<td>mg/l</td>
<td>500 (Max)</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>mg/l</td>
<td>10 (Max)</td>
</tr>
<tr>
<td>Ammonical Nitrogen</td>
<td>mg/l</td>
<td>50 (Max)</td>
</tr>
<tr>
<td>Chlorides (cl)</td>
<td>mg/l</td>
<td>1,000 (Max)</td>
</tr>
<tr>
<td>Teristics of Dissolved solids</td>
<td>mg/l</td>
<td>1,000 (Max)</td>
</tr>
<tr>
<td>Phosphate (P)</td>
<td>mg/l</td>
<td>5 (Max)</td>
</tr>
</tbody>
</table>
3. Sources of Waste Water Generated in Pharmaceutical Industrial Process

**Water of reaction:**
Water formed during the chemical reaction.

**Process solvent Water:** Water used to transport or support the chemicals involved in the reaction process, this water is usually removed from the process through a separation sludge, such as centrifugation, decantation, drying or stripping.

**Process stream water:** Water is added to the carrier, spent acid or spent base which has been separated from the reaction mixture, in order to petrifying the steam by washing away the impurities.

**Product washes:** Water is added to the reaction medium to purifying an intermediate or final product by washing away the impurities, or water to wash the crude product after it has been removed from the reaction medium.

**Spent acid/caustic:**
Spent acid and caustic stream which may be primarily water discharge from the process during separation steps which follow the reaction step in which the acidic / the basic reagent are used to facilities, catalyze or to participate.

**Condensed steam:**
Steam used as a sterilizing medium.

**Air pollution control scrubbers blow down:** Water or acidic or basic compounds used in air emission control scrubbers to control fumes the reaction vessels, storage tanks, incinerators and others.

**Equipment and floor washes:**
Water used to clean process equipment between product campaigns during unit downs and floor during general housekeeping or spill clean.

3.2 Selected Process Flow Diagram

We have selected the Patancheru Environ-Tech process. This plant is economically in cheap operation compared to other operations. The following below operations are done in this plant.

---

**Fig 1: Flow diagram of CETP**
4. Primary Treatment
The primary treatment is employed to remove suspended solids, floating materials, oil and grease etc and also to condition the waste water for either discharge to a receiving body of water or to secondary treatment. The treatment includes the physical treatment and Chemical treatment.

- Physical treatment
- Chemical treatment
- TPS (Terminal pumping station)
- ET’s (Equalization Tanks)
- Clarifluculator
- Decantor
- BT’s (Buffer Tanks)

Physical methods:
Include processes where no gross chemical or biological changes are carried out and strictly physical phenomena are used to improve or treat the wastewater. Examples would be coarse screening to remove larger entrained objects and sedimentation (or clarification). In the process of sedimentation, physical phenomena relating to the settling of solids by gravity are allowed to operate. Usually this consists of simply holding a wastewater for a short period of time in a tank under quiescent conditions, allowing the heavier solids to settle, and removing the "clarified" effluent. Sedimentation for solids separation is a very common process operation and is routinely employed at the beginning and end of wastewater treatment operations. While sedimentation is one of the most common physical treatment processes that is used to achieve treatment, another physical treatment process consists of aeration -that is, physically adding air, usually to provide oxygen to the wastewater. Still other physical phenomena used in treatment consist of filtration. Here wastewater is passed through a filter medium to separate solids

Chemical treatment:
Consists of using some chemical reaction or reactions to improve the water quality. Probably the most commonly used chemical process is chlorination. Chlorine, a strong oxidizing chemical, is used to kill bacteria and to slow down the rate of decomposition of the wastewater. Bacterial kill is achieved when vital biological processes are affected by the chlorine. Another strong oxidizing agent that has also been used as an oxidizing disinfectant is ozone.

A chemical process commonly used in many industrial wastewater treatment operations is neutralization. Neutralization consists of the addition of a Coagulation consists of the addition of a chemical that, through a chemical reaction, forms an insoluble end product that serves to remove substances from the wastewater. Polyvalent metals are commonly used as coagulating chemicals in wastewater treatment and typical coagulants would include lime (that can also be used in neutralization), certain iron containing compounds (such as ferric chloride or ferric sulfate) and alum (aluminum sulfate).

Parameters:
- Ph 5.5 to 9.00
- COD 15000 mg/lit

Equilization tanks:
Generally all waste water treatment plants receive unsteady flows, in terms of quantity and quality. However improved efficiency reliability and control are possible only when physical, chemist biological processes are operated at (or) near uniform conditions. The primary object of Equilization is to reduce the magnitude of variations in flow and quality for the later process.

Parameters:
- COD 3040 mg/l
- pH 7.26
- TDS 2410 mg/l
- BOD 1250 mg/l
- SS 370 mg/l
- Cl⁻ 1150 mg/l
- NH₄⁺ 32.93 mg/l
- SO₄²⁻ 139 mg/l

Clarifier (Primary settling tank):
The function of the clarifier is to separate the solids from the mixed liquor. The mixed liquor enters the drum of the clarifier, which is the center of the
clarifier. It equally distributes the mixed liquor at the center of the clarifier and overflows through the outlet pipe into the final sump. In process, the sludge has specific gravity slightly more than the water, which settles towards the bottom of the clarifier. The setting of the sludge is recycled to aerators through recycling pump. It M.L.S.S is more than 4000mg/l in the aeration tank, then sludge is sent to drying beds.

Buffer Tanks:

The aim of the buffer is to realize a consistent volume and possibly a consistent quality. In the buffer tanks to add the sewage for dilution, and to maintain the culture (bacteria) and air blowers also used to mix the effluents. By buffering one is able to avoid or limit peaks in wastewater volume and concentration. The chemical and microbiological stability of the wastewater must certainly be taken into consideration.

5. Secondary Treatment:

Secondary treatment is provided to remove the dissolved and colloidal, biodegradable organic matter in the wastewater. As the starch plant waste water is highly biodegradable in Nature, the secondary treatment is carried biologically in this E.T.P. Biologically degradable organics may exist in waste water in soluble, colloidal or suspended form. Biological removal of degradable organics involves a sequence of steps including mass transfer, adsorption, absorption and biochemical enzymic reactions. In this E.T.P biological treatment is carried anaerobic lagoons and Extended Aeration system and Activated sludge process. The different process units in secondary treatment are

- Aerobic lagoons.
- Activated sludge process

Aeration Tank:

The effluent from the contact filter enters in to the aeration tank, where it under aerobic conditions. The necessary Oxygen required for decomposition is provided through surface aerators. In this extended aeration system one 20 hp Floating aeration and four to hp surface aeration is provided. According to design consideration the mixed liquor suspended solids (M.L.S.S) 4000mg/l maintained in the aeration tanks. The mixed liquor over news continuously from the aeration tank into the clarifier through the outlet pipe.

Floating Aerators:
- Rotation of fans 1475RPM
- Motor capacity 30HP
- Oxygen requirement 20kg/hr

Fixed Aerators:
- Rotation of fans 1470RPM
- Motor capacity 50 HP
- Oxygen requirement 35kg/hr

Final Clarifier:

Clarifiers are settling tanks built with mechanical means for continuous removal of solids being deposited by sedimentation. A clarifier is generally used to remove solid particulates or suspended solids from liquid for clarification and (or) thickening. Concentrated impurities, discharged from the bottom of the tank are known as sludge, while the particles that float to the surface of the liquid are called scum.

Parameters:
- COD 200 mg/l
- TDS 1720 mg/l
- BOD 22 mg/l
- SS 50 mg/l
- P 7.56
- Cl 600 mg/l
- SO 2 95 mg/l
- NH 2.25 mg/l
- Outlet capacity 2.5 MLD

6. Conclusions

1. The present investigation is directed towards the study of waste treatment in the angle of continuous improvement and conforming to the norm of the national standard.
2. We should take up cost effective treatment leading to further reduction of COD, BOD, TDS, SS and make use of the treated water for hygienic application such as agriculture, washing, and gardening.
3. The process requires up gradation of secondary treatment with increase of growth of micro organism and create environment for reduction of both BOD and COD and increase of clarifier efficiency.
4. Finely a cost effective tertiary treatment may be added to the present system such as introduction of MBR (Membrane Bioreactor) to bring down COD level drastically (reduction up to 80-90%).

5. We further suggest to reduce volatile organic compound (VOC) which causes obnoxious smell to the enter plant area. This can be done by keeping the effluent in an enclosed space and the vapors are burnt to reduce VOC.

6. After treatment, the samples show permissible levels of pollutant parameters like COD, BOD, TDS, pH etc. Hence CETP is treating effluent to desired level.

7. However, effluents with 5000 TDS and less are only treated in CETP. The effluent with more than 5000 TDS are not treated.

### References

[2] Biological treatment process by Hammer
[4] Industrial waste water treatment by A.D.Patwardhan (Ph.D.)
[8] Integrated Efficiency of Common Effluent Treatment Plant by K. A. Chitnis , Dr.A.K.Khambete Research Scholar, SVNIT Surat; Associate Professor, SVNIT, Surat.

### About the Authors

S. HemanthSai has done his M. Tech and is currently working as Assistant Professor in NallaNarasimhaReddy Group of Institutions, Hyderabad, Telangana, India.

C. Mounika has done her M. Tech and is currently working as Assistant Professor in VignanaBharathi Institute of Technology, Hyderabad, Telangana, India.