# Performance Evaluation And Efficiency Assessment Of A Waste Water Treatment Plant – A Case Study

M. Rajasekhar*, N. Venkat Rao**, Dr. T. Muralidhara Rao***
*Dept.of Civil Engineering, Vardhaman College of Engineering, Shamshabad, Hyderabad – 501218. AP, India.*

## Abstract

*The treatment of waste water in industries is inevitable since water is precious and scarce hence the proper consumption and disposal of water is a mandatory task. The water should be made fit for reuse, irrigation and safe disposal. Waste water containing toxic pollutants, fibres, lignin and other suspended solids which are decomposed by consuming dissolved oxygen (DO) present in water. The safe disposal of water is also very much important to avoid the water pollution by preventing the contamination of surface and ground water. The present study has focussed on the process of treatment of industrial waste water at Deevyashakti Paper Mills Pvt. Ltd. The samples at various points have been collected and tested in laboratory. The concentration of Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) are found and compared with permissible limits. The overall efficiency of the plant in terms of its ability to remove all the impurities is determined.*

**Keywords:**
***Performance Evaluation, Efficiency, COD, BOD, TSS.***

## “1. Introduction”

The United Nations estimates about half the world’s population i.e. potentially more than three billion people may suffer from water shortage by the year 2025. It is estimated that more than two billion people do not have access to safe drinking water (or) sanitation. Worldwide fresh water resources are becoming increasingly scarce, yet pollution in open waters continues to advance. In many industrial sectors waste water produce is creating a critical problem for our environment. The vision of world community is to be free from waste water by 2025. Thus we need to work on the most sustainable, effective and reliable water treatment system possible. With the help of our state of the art technology we should strive to contribute to a zero liquid discharge industrial production to see our future generations to live in a clean and healthy environment. At this junction it is very much essential to go for the treatment of waste water generated from industries. In this connection we have conducted a practical study on waste water treatment at Deevyashakti Paper Mills pvt. Ltd., Shadnagar, Mahaboob Nagar Dt, Andhra Pradesh, India, as a case study. Our study has focussed on the operational efficiency, performance and maintenance of the treatment plant. We have organised a detailed study how the industrial waste water is treated at various stages to remove all the organic and inorganic impurities, how the water can be made fit for reuse in industry and irrigation purpose.

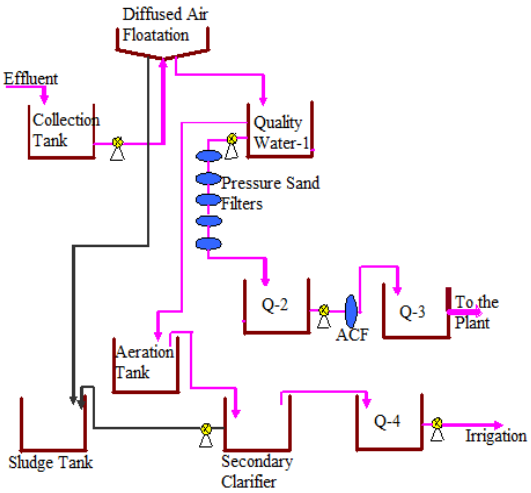


## “2. Process of treatment”

The process of waste water treatment generally depends on the quality of water expected. The entire process of treatment is accomplished in four levels such are Preliminary treatment, Primary treatment, Secondary treatment and advanced or tertiary treatment. At the preliminary and primary levels suspended and floating matter of various sizes can be removed. The secondary treatment is a biological treatment meant for removing soluble and colloidal impurities. The tertiary treatment which is also called an advanced treatment involves physical, chemical and biological processes or their various combinations depending up on the impurities to be removed.

### “2.1. Preliminary Treatment”

It is the basic operation in the waste water treatment process which is aimed to remove the large floating and suspended solids. The fundamental functions in this process are screening and grit removal. Normally following sizes of screens are used for screening purpose: Fine screens (< 20 mm), medium screens (20 – 50 mm) and Coarse screens (50 – 100 mm).




**“Figure 1. Process – Flow diagram”**

## “2.2. Primary Treatment”

Diffused Air Floatation technique is the most preferable rather than sedimentation in paper industry since it helps to recover fine fibres from the screened effluent. Some particles of density close to that of waste are difficult to get settled in normal sedimentation tank and it takes long time for separation. In such cases settlement can be speeded by aerating the effluent by attaching bubbles to suspended matter, with this the buoyancy of particles increases and makes them to float on the surface and they can be easily removed. Dispersed Air Floatation and Diffused Air Floatation are the two methods presently available. This floatation process will be furnished with the help of two chemical reactions called Coagulation and Flocculation. The purpose of coagulation is to make particles adhere to each other. In the coagulation process a positive ion is added to the water to reduce the surface charge to the point where the particles are not repelled form each other. The charges of the particles can be neutralized first then the particles attain the ability to stick together. The most commonly used coagulants are Aluminium and Ferric ion. In fact coagulation is the process of making the particles less stable by neutralizing its charge, thus encouraging initial aggregation of colloidal and finely divided suspended matter. The particles no longer repel each other can be brought together. All precipitation processes operate under the same fundamental chemical principles. Precipitation is a physico – chemical process in which soluble inorganic matter are connected to relatively insoluble metal and inorganic salts, precipitates.

Flocculation is the process of mixing or rapid mixing by which chemicals are quickly and uniformly dispersed in the water. Ideally the chemicals would instantaneously disperse throughout the water. Particles must be contacted each other and form a larger flocks. This contacting process is called flocculation. This is a very best and proven process for the removal of suspended solids.

## “2.3 Secondary Treatment”

Three principal activities are accomplished at this stage. The process is based on suspended growth process in which an adequate biological mass (aerobic bacteria) in suspension with in the tank is maintained by mechanical mixing. The sludge of the effluent which is previously agitated under aerobic condition containing full of bacteria called activated sludge. The primary effluent is mixed with activated sludge then aerated so as to oxidise the organic matter and convert in to settelable flocks. These flocks can be removed in the secondary clarifier. The blowers are working continuously so that each and every molecule of the mixed liquor comes in to contact with the open air. So that the bacteria aeration tank takes regenerated oxygen. Nutrients are added to the bacteria. Generally the necessary needed nutrients are DAP, Urea. The ratio of BOD, Nitrogen, Phosphorous maintained in the aeration tank is BOD:N:P = 100:5:1. But sometimes Mixed Liquor Suspended Solids (MLSS) will go on decreasing due to continuous flow of the effluent. If the MLSS is less than 1000 mg/l, cow dung is added in to the aeration tank to maintain the required MLSS. The ratio of MLVSS and MLSS should be maintained as 0.6. The effluent water after mixing up with the mixed liquor in the aeration tank is entering in to secondary clarifier. The clean water is subjected to overflow. The overflow is tested in the laboratory. This water is used for irrigation if the BOD and COD are within the limits. The settled matter in the secondary clarifier is removed by a pump and the sludge is sent in to aeration tank, so that there is no loss in MLSS and bacteria. The sludge from primary clarifier (Diffused Air Floatation) and excess sludge from secondary clarifier are sent to filter press.

## “2.4. Advanced Treatment”

The most common method used for the removal of soluble organics from waste water is adsorption on activated carbon. Adsorption is a surface phenomenon where in the dissolved substances in waste water is attached to and adheres to the surface of the adsorbent. Activated carbon with its extensive internal micro porous structure is the most commonly used adsorbent either in powdered or granular form. Adsorption on activated carbon is probably the most economical and technically attractive method available for removing soluble organics such as Phenols, Chlorinated carbons, surfactants and colour and odour producing substances from waste water. Adsorption system is based on granular activated carbon. This may be of fixed bed type (flow down) or expanded bed type (flow up). The adsorption can be arranged in several different process configurations. In case of series operations the waste water enters the first column and leaves the second column where as in case of parallel operations each column receives the same feed and the effluent from each column are combined to form a composite product. When the carbon bed is saturated with chemicals, it is regenerated. In the series operations, the first column is removed from series when the bed is exhausted and a fresh column is placed at the end of the series. Then the second column becomes the lead column. In parallel operation the beds become saturated simultaneously and are replaced by a fresh batch.

The DSPM manufactures the duplex paper board having four layers as top layer, under top layer, filler layer and back layer. The first two layers require good quality of water for the next two layers quality may be negligible. But while making white back paper almost all requires quality water not more than suspended solids 20 mg/l. The plant has got full fledged effluent treatment plant of activated sludge processing consisting of one number of 30 KW blower and 20 feet of secondary clarifier. In fact effluent has been a regular process at the plant. Effluent water form paper machine, form pulp mill and other departments are combined and allowed to pass in to collection tank. From this tank the combined effluent is pumped in to the DAF. The colour of the effluent at this stage is thick brown its pH value is around 8.5 and the total suspended solids are in the range of 2500 mg/l. Most of the suspended solids are removed in the DAF and they will be allowed to pass in to the quality water – 1 (Q-1). Then the water Q-1 passes through 5 Pressure Sand Filters (PSF) and purify water enters tank Q-2. Maximum amount of suspended solids will be removed at DAF only whatever the solids remained are ultimately removed through the maximum extent after passing through 5 PSFs. After carbon filtering the Q-2 water is allowed to enter in to Q-3. After biological treatment final treated water used for irrigation purpose.

## "3. Results and Discussion"

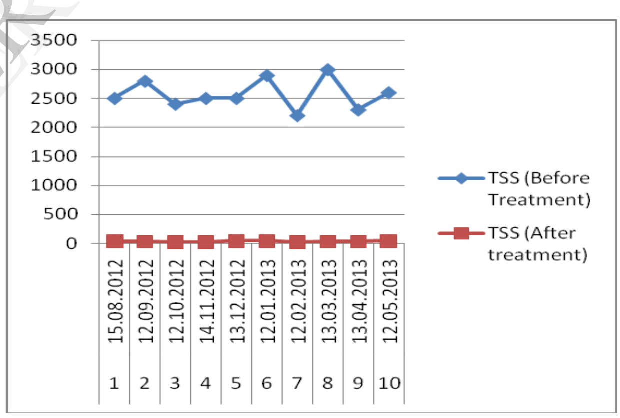
In fact there are three methods available for the collection of samples to conduct the test. Out of these three methods we have chosen Grab sampling method for the collection of samples. During the process of the treatment we have collected the test samples at various points viz. DAF inlet, PSF inlet, ACF inlet and secondary clarifier outlet and we have identified the amount of impurities (Suspended solids, BOD, COD) at every stage.

All parameters are in mg/l.

**"Table. 1. Total Suspended Solids before and after treatment"**

| S. No | Date | TSS (Before Treatment) | TSS (After treatment) |
|---|---|---|---|
| 1 | 15.08.2012 | 2500 | 40 |
| 2 | 12.09.2012 | 2800 | 35 |
| 3 | 12.10.2012 | 2400 | 28 |
| 4 | 14.11.2012 | 2500 | 26 |
| 5 | 13.12.2012 | 2500 | 46 |
| 6 | 12.01.2013 | 2900 | 42 |
| 7 | 12.02.2013 | 2200 | 30 |
| 8 | 13.03.2013 | 3000 | 34 |
| 9 | 13.04.2013 | 2300 | 39 |
| 10 | 12.05.2013 | 2600 | 47 |
| | | | |





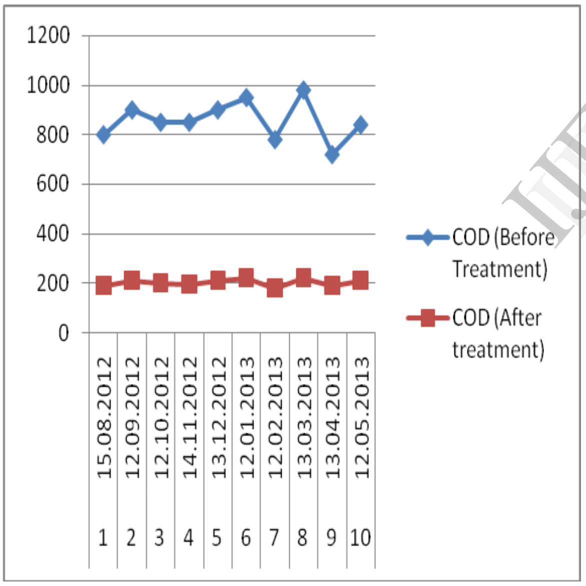

**"Figure 2. Comparision of TSS before and after treatment"**

**"Table. 2. Chemical Oxygen Demand (COD) before and after treatment"**

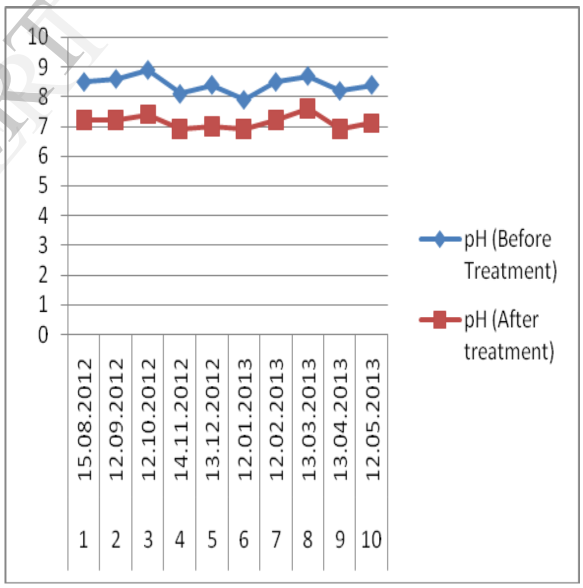
| S. No | Date | COD (Before Treatment) | COD (After treatment) |
|---|---|---|---|
| 1 | 15.08.2012 | 800 | 190 |
| 2 | 12.09.2012 | 900 | 210 |
| 3 | 12.10.2012 | 850 | 200 |
| 4 | 14.11.2012 | 850 | 195 |
| 5 | 13.12.2012 | 900 | 210 |
| 6 | 12.01.2013 | 950 | 220 |
| 7 | 12.02.2013 | 780 | 180 |
| 8 | 13.03.2013 | 980 | 220 |
| 9 | 13.04.2013 | 720 | 190 |
| 10 | 12.05.2013 | 840 | 210 |

**"Table. 3. pH before and after treatment"**

| S. No | Date | pH (Before Treatment) | pH (After treatment) |
|---|---|---|---|
| 1 | 15.08.2012 | 8.5 | 7.2 |
| 2 | 12.09.2012 | 8.6 | 7.2 |
| 3 | 12.10.2012 | 8.9 | 7.4 |
| 4 | 14.11.2012 | 8.1 | 6.9 |
| 5 | 13.12.2012 | 8.4 | 7.0 |
| 6 | 12.01.2013 | 7.9 | 6.9 |
| 7 | 12.02.2013 | 8.5 | 7.2 |
| 8 | 13.03.2013 | 8.7 | 7.6 |
| 9 | 13.04.2013 | 8.2 | 6.9 |
| 10 | 12.05.2013 | 8.4 | 7.1 |



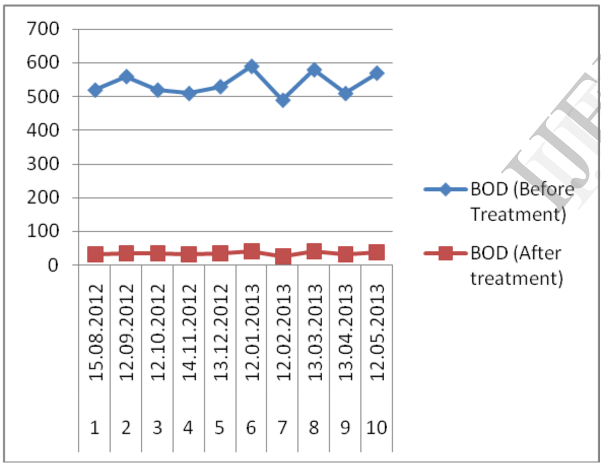

**"Figure 3. Comparision of COD before and after treatment"**




**"Figure 4. Comparision of pH before and after treatment"**

**"Table. 4. Biological Oxygen Demand (BOD) before and after treatment"**

| S. No | Date | BOD (Before Treatment) | BOD (After treatment) |
|---|---|---|---|
| 1 | 15.08.2012 | 520 | 30 |
| 2 | 12.09.2012 | 560 | 35 |
| 3 | 12.10.2012 | 520 | 33 |
| 4 | 14.11.2012 | 510 | 30 |
| 5 | 13.12.2012 | 530 | 35 |
| 6 | 12.01.2013 | 590 | 40 |
| 7 | 12.02.2013 | 490 | 25 |
| 8 | 13.03.2013 | 580 | 40 |
| 9 | 13.04.2013 | 510 | 32 |
| 10 | 12.05.2013 | 570 | 37 |




**"Figure 5. Comparision of BOD before and after treatment"**

The efficiency of the plant has been determined by considering the parameters like Total Suspended Solids, COD and BOD by using the formula

$$\text{Efficiency of the Plant (\%)} = \frac{Ci - Co}{Ci} \times 100$$

Where
Ci is influent concentration of any parameter in mg/l, and
Co is effluent concentration of any parameter in mg/l.
Results have been tabulated.

**"Table. 5. The efficiency of the plant in removing the following impurities"**

| S No | Parameter | Removal efficiency of the plant |
|---|---|---|
| 1 | Total Suspended Solids | 98.5 % |
| 2 | COD | 77 % |
| 3 | BOD at 20$^0$C | 94 % |

## "4. Conclusions"

Based on the above results it is found that the overall efficiency of the plant is found to be satisfactory. As per ISI standards the values of the parameters are within the permissible limits, hence it will be fit for irrigation purpose. The removal efficiency of BOD is found to be 94%. The removal efficiency of the plant in removing TSS is extremely good and stood at 98.5%. The removal efficiency of COD is found to be 77%. The overall efficiency of the plant is found to be 90 %.

## "5 References"

[1] S.V.Core, A.P.Desai, and Core V.S., "performance evaluation of water treatment plant – a case study" IJAEST, 2013, Vol No. 12, Issue No. 2, 010 – 015.

[2] Environmental Protection Agency, US, "Process design manual for upgrading existing waste water treatment plant" 1974, Technology Transfer,13-17.

[3] Kaul, S. N., Mukherjee, P. K., Sirowala, T. A Kulkarni, H. and Nandy, T. , "Performance evaluation of full scale waste waterTreatment facility for finished leather industry", 1993, Journal of Environmental Science and Health, 28. 1277 - 1286.

[4] APHA, "Standard Methods for the Examination of Water and Wastewater", 20th edition, American Public Health Association, Washington,DC, New York, USA, 1998.

[5] Birdie G.S. "Water Supply and Sanitary Engineering" 2012, Dhanpat Rai Publishing Company.

[6] BC Punmia, "Water Supply Engineering Vol - I & Vol – II, 2009, Laxmi Publications, India.

[7] Metcalf, Eddy, "Waste Water Engineering" 1981, Tata McGraw Hills, India.

[8]http://www.defence.gov.au/jlc/Documents/DSCC/ADF%20Health%20Manual%20Vol%2020,%20part8,%20chp2.pdf