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# Influence of Colour load on performance of CETP in Central India

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## Abstract

*The present study deals with influence of colour wastewater processed at the Common Effluent Treatment Plant (CETP) situated in the five stars Industrial Area of Butibori in Central India. The efficacy of Common Effluent Treatment Plant (CETP) in Maharashtra (Vidarbha region) employed for treatment of effluent received from industries including Textile and Dyestuff industry. The Effluent of CETP was analyzed for removal/reduction of contaminants like TSS, COD, BOD and color. A significant reduction in TSS, BOD levels but COD and color was observed slightly higher side during the course of treatment in CETP. This is due to higher colour and COD values in dyestuff industry effluent.*

**Keyword**: Effluent, CETP, COD, BOD, color and dyestuff etc.

## Introduction

Currently, the environmental pollution is the biggest threat for sustainable growth and in some cases survival of humans. The various types' organic pollutants are being discharged by the industries. They are directly caused of environmental and health-related problems. Due to this, we have observed detrimental effects on all biotic factors including living creature[1]. Presently, the discharge of treated effluent from varied industrial units to the environment from common effluent treatment plants is receiving an increasing attention as a reliable technique for pollution control and water resource. The idea of common effluent treatment plant (CETP) was originally encourage by the Ministry of Environment and Forests (MOEF) in 1984 for the treatment of effluent from a large number of small and medium scale industries.

The concept CETPs is adopted looking into the specific requirements for treatment of effluent which is generating from small-scale industrial units. The on-site treatment of wastewater for such units is economically unviable. Like many industries, textile industry also requires large volumes of water and chemicals for wet processing of textile[2]. The textile unit generates various types of wastewaters at variance in magnitude and quality. They discharge large quantities of effluent and azo dyes, which constitute about 60 to 70% of all textile dyes produced[3]. The effluent from printing and dyeing units in a textile plant is often rich in color. It is containing residuals of reactive dyes and chemicals. It is requiring appropriate treatment prior to releasing into the environment[4]. There are several methods have been developed for the treatment of dye wastewater like reverse osmosis[5], electrodialysis[6,7]. But this treatment methodology cannot be used individually because at times, dye wastewaters have high salinity, COD, color and non-biodegradable organics[8]. In addition, the conventional biological process is not very effective to treat dyestuff effluent. As many dyestuffs are toxic to the organisms and result in sludge bulking, rising of sludge and pin point floc[8]. Hence, many times pretreatment of dyestuff wastewater is essential to decrease its toxicity levels. This pretreatment involves use of various by physico - chemical treatments. The physico - chemical pretreatment like coagulation and flocculation[9,10], Ozonation[9], Fenton's oxidation[11-13], use of adsorbents such as activated carbon[14] has been proposed to deal with color reduction of dye effluent. Often, the choice of wastewater treatment is dependent on the type of wastewater and its peculiar physico - chemical characteristics.

In order to design an effective treatment process, characterization of wastewater is perhaps the most critical step. The wastewaters generated at various industrial units differ with respect to their quality as well as quantity. The characteristics of this wastewater are very important to understand as the subsequent treatment options are directly related to these characteristics. The wastewater characterization studies constitute an important prerequisite for success of any treatment facility, such as common or combined effluent treatment plants (CETPs). Hence, this study should be done by a qualified professional. And should be use certified analytical laboratory. The certified analytical laboratories are required to meet minimum performance standards and must pass periodic proficiency tests. The analytical methods used are also very important as the choice of method affects the results. The variation obtained due to method followed may interfere with the reliability and in term it's generalize ability.

The importance of wastewater characterization is evident from the previously reported observations by Sen and Demirer[15-17], Chang[11] Lin S H and Peng[18] who have reported application of varied techniques for the treatment of wastewater, however, the treated effluents discharged from the CETP plants were not completely devoid of color. One of the observations was the important variation in the characteristics of the wastewater arising from a cluster of industries, which presented difficulty in

ensuring the competence and effectiveness of the CETP. Under the act of, water (prevention and control of pollution) act, 1974, every industry in India has to treat its effluent before discharging on land, river, stream or sea. With due consideration of these fact government of India (as per direction of Supreme Court Monitoring Committee of India), initiated common effluent treatment plant scheme. Maharashtra being one of the highly industrialized states of India is dominated of small and medium scale industries. CETP's are based on the concept of collection of effluent of different industries having different characteristics. The permissible standards of Influent (design) of this plant are mentioned in table-1. In backdrop of this information, present study was conducted to understand wastewater characteristics and influence colour load on performance of CETP situated in the central India, MIDC, Butibori area. Since it the only such facility in the central India, the results would provide a valuable insight for devising treatability options for treatment of the textile industry wastewater.

**Table-1**
**The Permissible Influent norms (Design) of CETP**

| S.N | Parameter | Values |
|---|---|---|
| 1 | pH | 6 – 7 |
| 2 | TSS | 500 |
| 3 | TDS | 2100 |
| 4 | COD | 1200 |
| 5 | BOD | 500 |
| 6 | O and G | 75 |
| 7 | Ammonical nitrogen | 40 – 160 |
| 8 | Phenolic compound | 5 |
| 9 | Sulphate | 1000 |
| 10 | Chloride | 1000 |
| 11 | Cynide | 0.1 |
| 12 | Copper (Cu) | 3 |
| 13 | Total chromium | 2 |
| 14 | Lead | 0.1 |
| 15 | Nickel | 3 |
| 16 | Zinc | 5 |
| 17 | Mercury | 0.05 |
| 18 | Cadmium | 1 |
| 19 | Selenium | 0.05 |
| 20 | fluoride | 2 |
| 21 | Sulphide | 1 |

Note: all parameters in mg/l except pH

## Material and Methods

**Experimental -Sampling details:** The data was collected daily for a period of consecutive three months (from February 2011 through April 2011). Total 6 samplings of the effluent water were performed in the month of February followed by 11 samplings in March and 14 in April. An inlet flow of 3,101 KL wastewater was recorded in February 2011 whereas the same was observed to be 2,845 and 3,130 KL in the month of March and April, respectively. Effluent water sample was collected in dry, sterile, polypropylene bottles, which has been kept in ice during transportation. These samples had been stored in the refrigerator (4$^{o}$C).

**Wastewater treatment scheme at CETP:** The CETP consisted of three treatment units' viz. Primary treatment unit, Secondary treatment unit and Tertiary treatment unit. Please see figure-1 for Flow sheet diagram of common ETP. Primary treatment unit, Physico-chemical treatment including equalization, pH correction, flash mixture, flocculator and clarifier (settling tank). Secondary treatment unit- Biological (aerobic) system with diffused aeration and clarifier. Tertiary treatment unit– tertiary treatment system includes pressure sand filter (PSF) and activated carbon filter in a series (ACF).

**Physiochemical analysis of the effluent:** pH of the samples were recorded on the spot. Analysis of the other parameter has been carried out according to Standard Methods for the Examination of Water and Wastewater[1]. pH – pH meter; TSS – Gravimetric method; COD – Open reflux digestion method; BOD – Winkler's method; Colour – Colorimetric (Pt.Co) method.

## Results and Discussion

To assess the functioning of CETP, the nature (physic - chemical properties) of the wastewater before and after treatment has to be taken into consideration.

**Characterization of raw wastewater (table-2):** The raw wastewater was highly alkaline in nature with an average pH value ranging from 8.15-8.89. BOD and COD ranged from 310-326 and 1296-1427 mg/L, respectively. The TSS of the raw waste water were found to be 334-499 mg/L. Color impurity recorded was in the range of 4742 - 5586 Pt.co. Presence of such a high pH and color impurity in the textile / dyestuff waste water was found to be in accordance with that observed by other researchers wherein the effluent from textile mills have found to be coloured, alkaline and foul smelling[20,21]. The Colour problems have been observed due to chemicals used in various industries like dyestuff, textile, galvanizing etc. The increased pH was due to excessive use of carbonate, bicarbonate, $H_2O_2$ and NaOH during bleeching process[22]. High BOD and COD levels indicated an increase load of organic pollutants in the effluent.

**Table-2**
**Composition of the raw effluent at CETP**

| Parameter | Units | Observations | | |
|---|---|---|---|---|
| | | Mean | Minimum | Maximum |
| pH | | 8.56 | 8.15 | 8.89 |
| TSS | Mg/l | 409 | 334 | 449 |
| COD | Mg/l | 1344 | 1296 | 1427 |
| BOD | Mg/l | 311 | 301 | 326 |
| Color | Pt-co | 5033 | 4742 | 5586 |

**Physico-chemical characteristics of treated effluent:** Physico-chemical composition of the treated effluent has been mentioned table-3. The pH of treated water was found to go on decreasing gradually from 8.6 to the least of 7.8 after every treatment (primary, secondary and tertiary). It was, however, observed that the pH decreased noticeably after the secondary treatment. Tables-4,5,6 show percent removal of the various physico-chemical factors of wastewater after each purification stage in February 2011, March 2011 and April 2011, respectively. Figure-2 depicts quality of the treated effluent in terms- total % removal of selected parameters. It can be seen from the figure that ~ 77% TSS, ~76% COD, ~90% BOD and ~74% of color were removed in the treated effluent. The data revealed that TSS, COD, BOD as well as color of the raw wastewater were reduced after each successive treatment. It is noteworthy that there was remarkable reduction in the COD and BOD of the wastewater after secondary treatment which was apparently due to the combined effect of air stripping as well as biological system. Similar type of reduction in COD was observed by Kornoros and lyberatos[23]. According to the result, biological treatment process along with aeration facility appears as a promising pretreatment step for wastewaters of dye manufacturing units. It is helping for removing a great amount of the (potentially) biodegradable compounds. A pretreatment step is generally required when integrated schemes of effluent treatment (CETP) are developed for industrial units which are containing remarkable amounts of biodegradable compounds.

**Table-3**
**Composition of the effluent after treatment**

| Parameter | Units | Observations | | |
|---|---|---|---|---|
| | | Mean | Minimum | Maximum |
| pH | | 7.86 | 7.85 | 8.08 |
| TSS | Mg/l | 96.33 | 78 | 117 |
| COD | Mg/l | 326.66 | 316 | 342 |
| BOD | Mg/l | 31.33 | 30 | 32 |
| Color | Pt-co | 1289 | 1097 | 1404 |

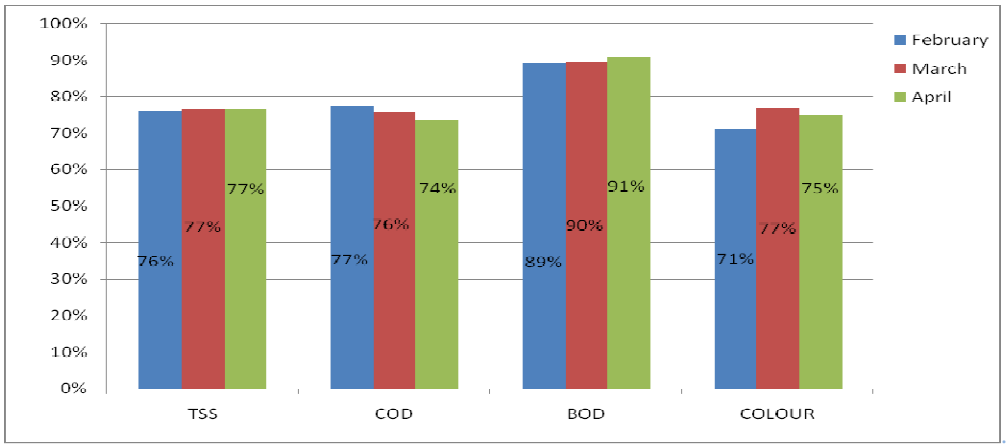


**Figure-1**
**Treated effluent quality (percent removal of the given parameters from the wastewater) of the CETP with time**

**Table-4**
**Percent removal of the various physico-chemical factors of wastewater after each purification stage in February 2011**

| February 2011 | | % Removal | | | |
|---|---|---|---|---|---|
| Inlet Flow (KL) | Parameter Tested | Primary stage | Secondary Stage | Tertiary Stage | Total(Mean) |
| 3,101 | TSS | 37 | 38 | 39 | 76 |
| | COD | 35 | 58 | 18 | 79 |
| | BOD | 14 | 85 | 16 | 89 |
| | Color | 21 | 11 | 59 | 71 |

**Table-5**
**Percent removal of the various physico-chemical factors of wastewater after each purification stage in March 2011**

| March 2011 | | % Removal | | | |
|---|---|---|---|---|---|
| Inlet Flow (KL) | Parameter Tested | Primary stage | Secondary Stage | Tertiary Stage | Total(Mean) |
| 2,845 | TSS | 32 | 48 | 33 | 77 |
| | COD | 36 | 42 | 35 | 76 |
| | BOD | 17 | 82 | 29 | 90 |
| | Color | 20 | 13 | 67 | 77 |

**Table-6**
**Percent removal of the various physico-chemical factors of wastewater after each purification stage in April 2011**

| April 2011 | | % Removal | | | |
|---|---|---|---|---|---|
| Inlet Flow (KL) | Parameter Tested | Primary stage | Secondary Stage | Tertiary Stage | Total(Mean) |
| 3,130 | TSS | 33 | 34 | 47 | 77 |
| | COD | 25 | 50 | 30 | 74 |
| | BOD | 13 | 87 | 21 | 91 |
| | Color | 21 | 14 | 63 | 75 |

**Characteristics of Dyestuff industry:** The characteristics of suspected effluent stream of industry which is causing influence of colour load on performance of treated effluent are mentioned in the table-7

**Table-7**
**The characteristics of suspected effluent stream of industry which is causing influence of colour load on performance of treated effluent**

| S.N. | Parameter | Units | February-11 | March-11 | April-11 |
|---|---|---|---|---|---|
| 1 | pH | | 9.16 | 8.38 | 9.24 |
| 2 | TSS | mg/l | 1,236 | 1,066 | 1,122 |
| 3 | COD | mg/l | 13,621 | 9,214 | 10,527 |
| 4 | BOD | mg/l | 1,867 | 1,673 | 1,656 |
| 5 | Colour | pt-co | 126500 | 98432 | 110754 |

**Color removal performance:** It was observed that color impurity of the wastewater which could not be removed even after secondary treatment was reduced significantly to some extent after tertiary treatment, which consisted of PSF and ACF. An adsorption technique is employing solid sorbents such as activated carbon. This is widely used to remove chemical pollutants from waters, especially those that are practically unaffected by conventional biological treatment. However, amongst all the proposed sorbent materials, activated carbon is the most popular for the removal of pollutants from wastewater[24]. This capacity is mainly due to their porous texture which gives them a large surface area, and their chemical nature which can be easily modified by chemical treatment.

## Conclusion

After surveillance, it was found that effluent of dyestuff industry was being created a Colour load on the performance of CETP. The quality parameter of the Dyestuff industry contains with high COD, high BOD, high TSS and highly colored effluent. Very little quantity of dye stuff effluent (0.1 KL/d) is disturbing the system design by CETP. The 0.1 KL effluent is diluted in to 3500 KL per day. But due to highly colored effluent of dyestuff industry was creating colour load on the performance of CETP.
The suggestion has been given to CETP to divert this suspected effluent to other stream and treat in different individual treatment unit with special care.

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