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Physical & Chemical Parameter of Effluent Treatment Plant for Thermal Power Plant

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Abstract

The Thermal power is the main source of energy for our society; out of which majority are the coal based thermal power stations. In the power plant huge amount of water is used for several different processes, which is then discharged as a process waste. The work of the present study is aimed at determining the physical and chemical parameters of the waste water or the effluent, at inlet and outlet of the effluent treatment plant located at about 20 kms from Nagpur and also to calculate performance efficiency of the plant. Under this study the various parameters such as temperature, pH, chemical oxygen demand(COD), suspended solids(SS), total dissolved solids(TDS), phosphorus and heavy metals are determined by taking samples at inlet and outlet of effluent treatment plant and compared with the Indian standards for effluent discharge into river[1]. The variation in the parameters at inlet observed to be, 7.4-7.9 for pH, 40-90 for COD and 180-70 for SS and at outlet it is 7.1-7.5 for pH, 32-68 for COD and 42-95 for SS. The average performance efficiency of the plant is calculated for the period of study & observed to be 26.85% for COD, 26.69% for TDS, 15.51% for Phosphate, and 22.81% copper. The mean concentration of the Cr, Fe are found to be beyond the permissible limits set by Indian standards set for discharge of effluent to the rivers, hence it should be closely monitored. Findings of the study shows that the effluent needs to be strictly under scanner and maximum reutilization of the water should be done to prevent environmental pollution, reduce health hazards and generation cost.

Key words: Chemical parameters, Heavy Metals, Physical parameters, Power Plant, wastewater,

1.0 Introduction

Water is essential for all socio-economic development and for maintaining healthy ecosystems. As population increases and development calls for increased allocations of groundwater and surface water for the domestic, agriculture and industrial sectors, the pressure on water resources intensifies, leading to tensions, conflicts among users, and excessive pressure on the environment. As India is a developing country and it is in core stage of its development, it has lots of ongoing projects in every sector such as agriculture, industries, power, infrastructure etc, the increasing demand for water and energy are the main challenges that face the development of the country[2]. In our country, irrigated agriculture has been a major engine for economic growth and poverty reduction and requires bulk of water and is the first sector affected by water shortage, resulting in decreased capacity to maintain per capita food production while meeting water needs for domestic, industrial and environmental purposes. The industrial sector in India is also in booming stage and need huge amount of water, in the absence of which it'll get a major setback.

Meeting the increasing demand of electricity for industrial and agricultural and other sectors is crucial for development of any country, there is direct relation between the growth of the power sector & development of the country. In India about 70-80% of the total power demand is satisfied with the coal based thermal power stations. The thermal power plant need huge amount of water for different processes such as steam generation, fly ash & bottom ash removal, condenser cooling, auxiliary cooling, cleaning gardening etc. and thus it discharge huge amount water as process waste. Waste from such processes release heavy metals into the environment will have potentially negative impacts on soil, groundwater and surface water quality as well as human health [3]. Hence development of the country, development of the power sector and water scarcity go hand in hand, more is the development more is the water scarcity. In order to sustain our needs, we need to focus on the efficient use of all water sources (groundwater, surface water and rainfall) and on water allocation strategies that maximize the economic and social returns to limited water resources, and at the same time enhance the water productivity of all sectors. Thus the need of wastewater reuse in various parts of the world has promoted development of wastewater and secondary effluent treatment technologies [4]. The role of effluent treatment plants, is to receive the waste water discharged by different processes, does the treatment and made it available for reuse. The ETP reduces the water load of the plant, reduces wastage, helps protecting the environment and improves the water productivity of the plant. Among the liquid effluents generated in the plant, the major quantities come from cooling tower blow down. Major pollutants in CTBD can be suspended solids and others like chlorine, zinc, chromium and phosphate. Boiler blow down is done to control dissolved solids in boiler water. ETP consist of oil scrapper, plate settling, aeration chamber, chemical mixing, to separate oil and suspended solids.

The various sources of the effluent are boiler blow downs, cooling tower blow downs, waste water from fly ash and bottom ash evacuation system, various drains etc. The effluent generated in the plant is collected in the intake tank of the central effluent treatment plant. The oil scrapers are provided to remove the oil contamination. The effluent is then pumped to the aeration chamber followed by settling tank and plate settling. The clear water is collected in the clear water tank. This water is then reused for various purposes such as cleaning, gardening and AHP.

The area under study is a coal based thermal power station with the installed capacity of 210*4 MW, located about 20-25 kms from city. It requires about 14000MT of Coal Per Day which is brought in by Rail. Some quantity of coal is also received by the rope way. The water requirement for various activities in the power station is 91000 M3 per day, of this 65000 M3 per day is fresh requirement the average daily recovery from Ash Bund is 14000 M3 and the average daily recovery from the Effluent Treatment Plant is 12000 M3. It has functional Electrostatic Precipitator to extract the Fly Ash from the Flue Gas. To reduce the effect of flue gases being released in the atmosphere Massive Tree Plantations for sustained development has been done.

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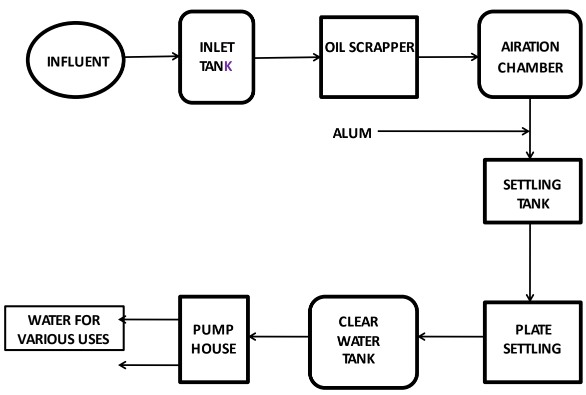

Fig.1.2.shows Effluent Treatment Plant Process of Thermal Power Station

2.0 Methodology

The aim of the present study is to determine the properties of the physical and chemical properties of the effluent discharged to the ETP of the thermal power station located about 20-25 kms from city. Data obtained could be helpful in defining future waste management practices in the plant. ETP wastewater samples were collected during the period of the study that lasted from August 2011 to Apr 2012 at ETP inlet and outlet twice in a month. The procedures used for the collection, preservation and analysis of the samples were Water and Wastewater Standards Methods [5].

The wastewater samples were collected in plastic containers previously cleaned by washing in non-ionic detergent, followed by rinsing with tap water and later soaked in 10% HNO_3 for 24 hours and finally rinsed with demonized water prior to usage. During sampling, sample bottles were rinsed with sampled water three times and then filled to the brim. The samples were labeled and transported to the laboratory, stored in the refrigerator at about 4^0C prior to analysis [6].

The samples were analyzed in G.H.Raisoni College/Environmental Engineering laboratory.

Determination of parameters

In the present analysis temperature, pH, COD, Suspended solids, TDS and heavy metals determined. Temperature & pH were determined using a pH meter, while the levels of total dissolved solids (TDS) were determined by using conductivity meter at the point of sample collections. Chemical Oxygen Demand (COD) was determined by using closed reflux method.

Chemical Oxygen Demand (COD)

It provides a measure of the oxygen equivalent of that portion of the organic matter in a water sample that is susceptible to oxidation under the conditions of the test. It is an important and rapidly measured variable for characterizing water bodies, sewage, industrial wastes and treatment plant effluents.

COD was determined using closed reflux method.

$$\text{COD mg/l} = \frac{(A-B)\ N \times 8000}{V}$$

Where,

A= Volume in ml. Ferrous ammonium sulphate for blank

B= Volume in ml. Ferrous ammonium sulphate for Sample

V= Volume of Sample

N=Normality of ferrous ammonium sulphate

Suspended Solid (SS), 100ml of the wastewater samples were filtered through a pre weighed filtered paper. The filtered papers were dried at 103-105°C. TDS & SS then determined by using the Formula,

$$\text{TDS (mg/l)} = \frac{\text{mg of residue} \times 1000}{\text{ml of sample}}$$

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Determination of heavy metals

The samples (100cm^3) were taken into a beaker with 5ml concentrated HNO_3 and evaporated down to about 20ml. It is then cooled and another 5ml of concentrated HNO_3 was added. The beakers were covered with watch glass and heated. Then small portion of HNO_3 was added until the solutions appear light colored and clear. The beaker wall and watch glass were washed with distilled water and the samples were filtered to remove some insoluble materials that could clog the atomizer. The samples were adjusted to 100cm^3 with distilled water. A blank sample was digested by transferring 100ml of distilled water into a beaker and digested as described above. Determination of, Cr, Cu, Fe & Zn were made directly on each final solution using a Perkin-Elmer Analyst 300 Atomic Absorption Spectroscopy (AAS) [6].

3.0 Results & Discussions

Temperature

The range of temperature values observed were 31-33^{0}c at inlet and 30-32^{0}c at outlet. Temperature is basically important for its effect on chemical reactions, reaction rate, aquatic life and the suitability of water for beneficial uses [7]. Temperature of waste water is commonly high because of addition of warm water from different activities.

pH

Fig.1 shows the variation in pH at Inlet & Outlet of ETP. The pH observed to be ranged from 7.1-7.5 which is well within the permissible limits of 5.5-9.0 set by Indian standards. pH is the measurement of intensity of acidity and alkalinity and measures the concentration of hydrogen ion in water. The pH determination is important objective in treatment of waste. Variation in pH values of effluent can affect the rate of biological reactions and survival of various microorganisms.

BAR CHART FOR-pH(Aug-Apr)

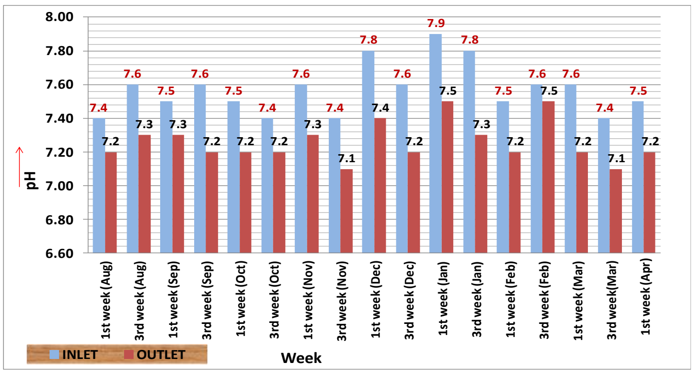

Fig.1 shows variation in pH from inlet and outlet of ETP

COD

Fig.2 shows the variation in COD (mg/l) at Inlet & Outlet of ETP. The COD variation observed 32-68 mg/lit at outlet which is well within the permissible limit of 250mg/lit given by Indian standards for discharge of liquid effluents for Thermal Power Plants. It is the amount of oxygen required by organic matter for its oxidation by strong COD substance in water. The waste is measure in terms of equality of oxygen required for oxidation of organic matter to produce CO_2 and water.

BAR CHART FOR-COD(Aug-Apr)

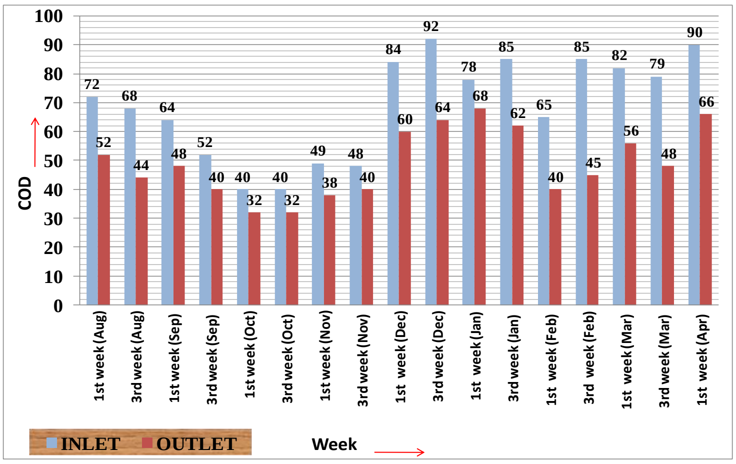

Fig.2 shows variation in COD from inlet and outlet of ETP

TDS

Fig.3 shows variation in TDS from inlet and outlet of ETP. The TDS concentration observed from 1612-1838 mg/lit at ETP outlet which is within limit of 2000mg/l set by Indian standards for the discharge of wastewater into river. The solid contained in the filtrate that passes through a filter with a normal pore size of 2 micrometer or less are classified as dissolved solids.

BAR CHART FOR-TDS(Aug-Apr)

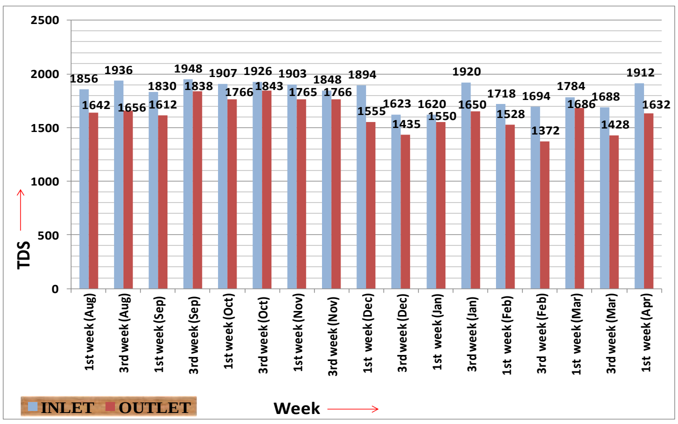

Fig.3 shows variation in TDS from inlet and outlet of ETP

Suspended Solids

Fig.4 shows variation in SS from inlet and outlet of ETP. In the suspended solid contents ranged 42-94 mg/lit at outlet which is well within the permissible limit of 100mg/lit given by Indian standards Total suspended solids play an important role in waste water treatment. TSS test results are routinely to assess the performance of conventional treatment processes and need for effluent filtration in reuse application.

BAR CHART FOR - Suspended Solids(Aug-Apr)

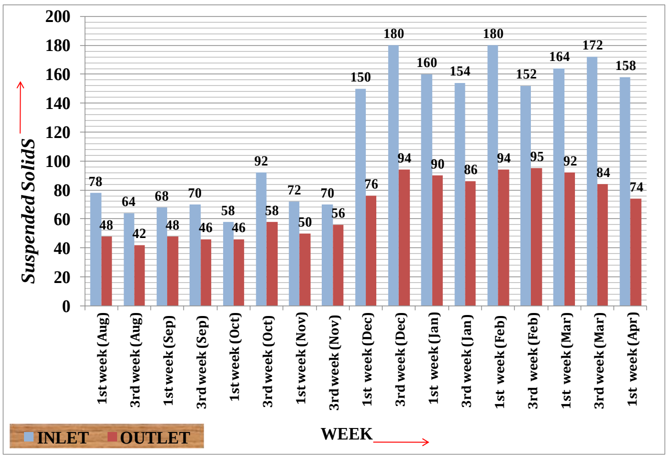

Fig.4 shows variation in SS from inlet and outlet of ETP

Heavy metals

Fig. 5 shows variation in pH from inlet and outlet of ETP.The concentration level of heavy metals is discussed below, The levels of PO_4 ranged from 0.40-0.60 mg/l in Inlet & 0.38-0.52mg/l in Outlet of the ETP. The Indian Standards Permissible limits for PO_4 is 5.0 mg/lil for discharge of liquid effluent to the river

BAR CHART FOR –Phosphate (PO_4) (FOR 4 MONTH)

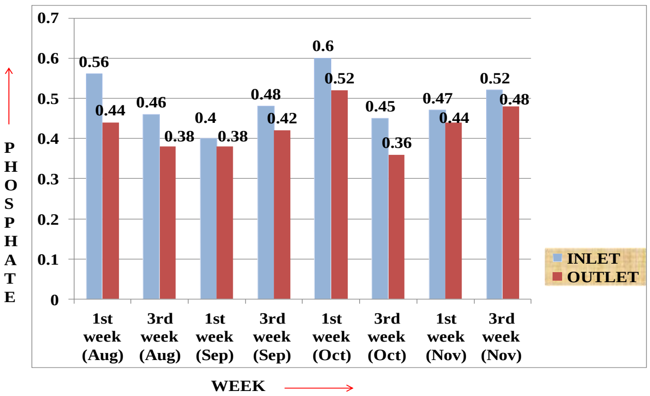

Fig. 5 shows variation in pH from inlet and outlet of ETP

Fig.6 shows variation in Cr from inlet and outlet of ETP. The level of Chromium (Cr) is 0.22-0.34 mg/lit at Inlet & 0.18-0.26 mg/lit at outlet. Fig.7shows the Level of Copper (Cu) is 0.18-0.33 mg/l at Inlet & 0.15-0.32 mg/lit at outlet. Fig.8 shows the content of Zinc (Zn) is 0.20-0.32 at mg/lit inlet and 0.17-0.28 mg/lit at outlet, also Fig.9 shows the Iron (Fe) varies from 1.07-1.44 mg/lit at inlet and 0.94-1.38 mg/lit at outlet. The concentration range of Cr, Cu, and Zn was found to have concentration within the permissible limit of 1.0 mg/lit given by the Indian standard for the discharge of wastewater into river. The concentration of Fe is found to be higher than the permissible standards.

BAR CHART FOR -CHROMIUM(Cr) (FOR 4 MONTH)

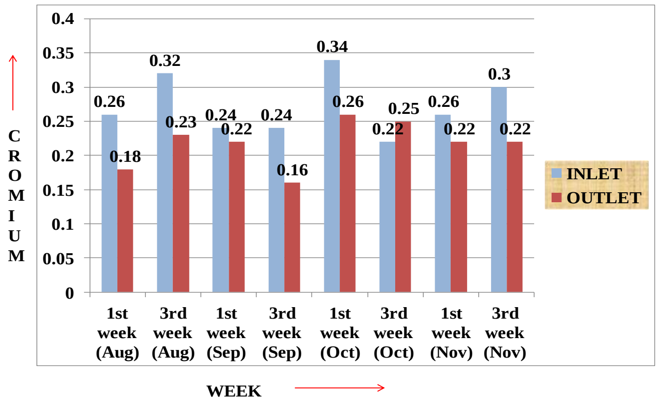

Fig.6 shows variation in Cr from inlet and outlet of ETP

BAR CHART FOR COPPER(Cu) For 4 Month

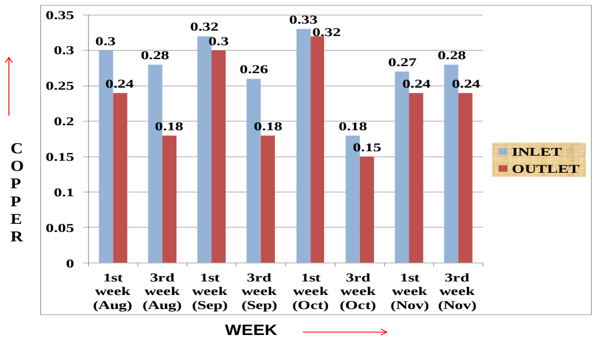

Fig.7 shows variation in Cu from inlet and outlet of ETP

BAR CHART FOR - IRON(Fe) (FOR 4 MONTH)

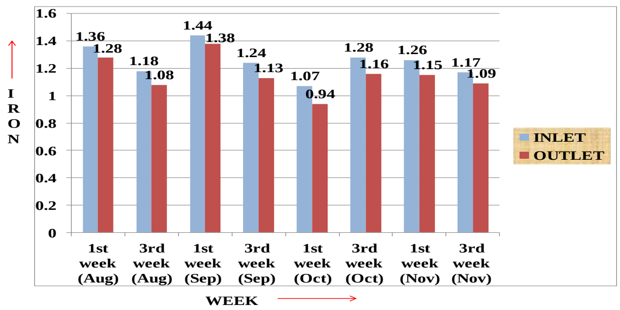

Fig.8 shows variation in Fe from inlet and outlet of ETP

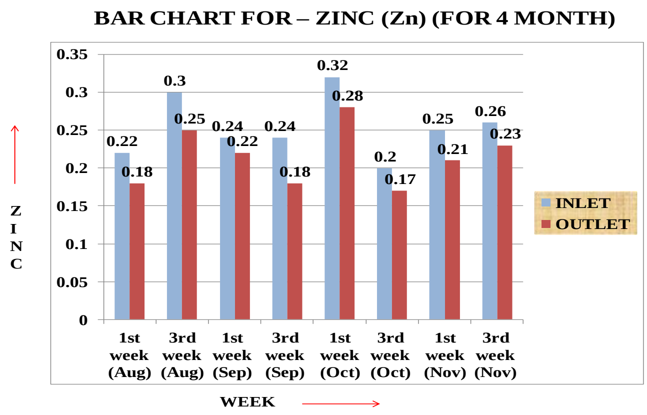

Fig.9 shows variation in Zn from inlet and outlet of ETP

4.0 Conclusion

The pH, COD removal efficiencies were observed to be 8%, 55% respectively and that of Heavy metals, PO_4, the removal efficiencies were observed to be 37%, 41% respectively. The performance efficiency of the plant is consistent over the highly fluctuating, waste water flow. The concentration of Fe is found to be higher than the permissible standards; hence the treatment process need to be closely monitored and necessary action should be taken.. The treated water at ETP is used for various purposes such as gardening, cleaning, fly ash and bottom ash removal. This reduces the specific water consumption of the plant and thus reduces the generation cost as well.

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