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Effluents of Paper Mill: Physico-Chemical Properties of Water

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Abstract: Industrial effluents represent a significant environmental and economic problem. The pulp and paper industry typically generates large quantities of wastewater whose correct treatment prior to discharge into the environment is critical. The wastewater from the paper industry is characterized by colour, extreme quantities of COD, BOD, pH, TDS, DO and SS. The wastewater samples were collected from the inlet and outlet of the effluent treatment plant of paper mill. The samples were analyzed and compared with the Indian standards of effluent discharge. The inferences were drawn on the basis of analysis. Result shows that the pH, COD, BOD and TDS is in the permissible limits.
Keywords: Pulp, COD, TDS and paper industry.

1. Introduction

Depending upon the nature of raw material ,the wastewater is generated per metric tonne of paper produced. Globalization of the economy merges the paper industries worldwide with their best qualities of paper with competitive prices. To be on par with world class trade, paper makers modernize and upgrade their plants with increasing capacity. The world demand for paper will be 5-6 % per annum and the estimate production capacity of the mills by the year 2020 will be 14 million tones [1]. The water consumption per tonne of paper is about 250-300m^3[2]. The generation of waste water is almost equal to the same quantity of consumed water. The paper mill waste water contains high BOD and COD due to organics like, lignin, cellulose, fatty acids, tannins, resin acids, terpenes, phenolic compounds, chlorinated organic compounds and coal. Inorganics like sodium, calcium, Al_2O_3, Fe_2O_3, silicates, muds, grits, sulphur and sulphur compounds and other salts. The colloidal or suspended solids has a deleterious effect on the receiving streams as anaerobic decomposition of these solids consumes dissolved oxygen in the overlaying water and thus adversely affects the aquatic life. It is also harmful to agricultural crops and human beings [3]. The high volume of effluent discharge and the economic constraints make paper industries to restrict themselves to treat the effluent upto secondary treatment, where the quality of effluent comes within the norms of pollution control boards and other authorities. In this stage, it is equally important to reduce the effluent generation rather than treatment. Internal generation of effluents load is the characteristics of individual process [5]. Pollution of groundwater due to industrial effluents and municipal waste in water bodies is a major concern in many cities and industrial clusters in India. Hence there is a need and concern for the protection and management of ground water quality. The main object of the physicochemical analysis of water is to determine the status of different chemical

constituents, which are present in the natural and disturbed aquatic ecosystem. The quality of water may be affected in various ways due to pollution. The present investigation aims towards analysis of the water quality from the final outlet of a paper mill industry with special reference to Total Dissolved Solids, Total Hardness, Total Acidity, Total Alkalinity, pH, Calcium, Magnesium, Sulphates, and Chlorides.

2. Materials and Methods

The samples for the analysis were collected from the effluent treatment plant of recycled paper industry of Tamilnadu. The samples were collected from the inlet (raw water) and outlet (finally treated wastewater) of the effluent treatment plant of the papermill for analysis.

Samples are collected twice in a day for a month in plastic container and refrigerated at 20°C. The collected samples were mixed thoroughly and used for analysis. The samples were analyzed using standard methods of analysis of water and waste water of APHA [4]. Titrimetric methods were used for the determination of total hardness, calcium hardness, chemical oxygen demand, biological oxygen demand and chlorides. Gravimetric methods used for the analysis of sulphates, calcium, R_2O_3 and magnesium oxides. pH meter, metro ohm 644 conductometer, PFP7 Flame photometer, Buck scientific Ltd, instruments were used to record pH, conductivity, sodium and potassium. Standard solution of pt.co was used for colour measurements. 1.246 g of potassium hexachloroplatinate and 1 g of cobaltous chloride are dissolved in 100 mL of conc. HCl and made upto 1 litre with distilled water. The concentration of this solution is 500 pt.co (ppm) units. 25 ppm to 70 ppm standard colour solution is prepared by diluting the solution of 500 ppm standard solution. Unknown colour is matched with standard solution. Whatmann No.3 filter paper was used for the filtration of dissolved solids and also used for the filtration of effluent in colour measurement. Whatmann No.40 filter paper was used to filter the precipitates of silica, calcium and magnesium. Whatmann No.41 was used for the filtration of R_2O_3 and Whatmann No.42 was used for filtration of Barium sulphate precipitates.

3. Results and Discussion

Parameters	**Raw Water**	**Final Outlet of water treatment plant in a paper mill**
pH	11.2	8.2
Conductivity (µmhos/cm)	7395	3564
Color (pt.co units)	42	280
Total hardness (ppm as $CaCO_3$)	42	640
Calcium (ppm as $CaCO_3$)	38	456
Magnesium (ppm as $CaCO_3$)	4	184
Sodium (mg/L)	730	328
Potassium (mg/L)	5	48
Total Solids (ppm)	2518	1852
Total Dissolved Solids (ppm)	2302	1792
Suspended Solids (ppm)	216	60
SiO_2 (ppm)	70	170
COD (mg/L)	15	205
BOD (mg/L)	1	14

pH:

pH is a measure of acidity and basicity of an aqueous solution. pH measurement is useful in effluent treatment to find design, types and efficiency. Discharges from water treatment plant have both acidic and alkaline effluents. The influent water recorded the pH value of 11.2 which is alkaline as reported [6]. But for the finally treated waterpH was found to be 8.2. However WHO guidelines the tolerance limit of the pH value of the paper industry effluent as 6 to 9[7]. The discharge of waste water into water bodies may cause a drop or increase in their pH due to the size and activities of microbial population. Paper machine discharges will be slightly alkaline pH, because of the alkaline size paper making.

Conductivity:

Electrical conductivity is the ability of an aqueous solution to carry an electric current. It is a useful indicator to show the salinity or total salt content of the effluents. The EC value of the influent was observed as 7395 µmhos/cm which was very high than that of the finally treated effluent sample and its EC value was 3564 µmhos/cm. This is higher than that of WHO guidelines (i.e.) 1000 µmhos/cm. Increase in EC values indicates the presence of higher concentration of ions [6].

Color:

The color is usually the first contaminant to be recognized in wastewaters that affects the aesthetics, water transparency and gas solubility of water bodies [5]. The final outlet of the water treatment plant has the value of 280 pt.co units. This color is due the high concentration of lignin content in the outlet sample. Color derived from lignin is an indicator of the presence of potentially inhibitory compounds and in addition, may have direct inhibitory effects on some of the lower organisms in the food chain.

Total hardness:

The presence of calcium and magnesium contributes to water hardness. Total hardness is more (640 ppm as $CaCO_3$) in the final outlet compared to that of raw water. Calcium content of final outlet was observed to be greater than 200 mg/L [8]. High Ca content in the water makes it unfit for human consumption and damage the industrial machineries where it used for cooling purpose [9]. The Magnesium (Mg^{2+}) content of final outlet (184 mg/L) was beyond 50 mg/L rendering the water unpalatable [10]. Generally calcium and magnesium maintain a state of equilibrium in most waters. Presence of more magnesium in water will adversely affect the soil quality converting it to alkaline and decreases crop yields.

Sodium:

Sodium is an important cation occurs in all natural fresh water sources from 0.1 to 181 ppm [10]. In the present observation high sodium content(730 mg/L) was found in the raw water when compared to that of the finally treated effluent.

Pottasium:

Due to the disposal of industrial effluent, an increased level (48 mg/L) of potassium was observed in the final outlet.

Total solids:

Total solids affect water clarity. Higher solids decrease the passage of light through water, thereby slowing photo synthesis by aquatic plants. Water heat up more rapidly and hold more heat, in turn, might adversely affect aquatic life that has adapted to a lower temperature regime. In the present investigation total solids were reduced slightly (1852 ppm) due to presence of fibers in the waste water.

Total dissolved solids:

The value of total dissolved solids (TDS) for the final outlet was 1792 ppm which is found to be lesser than that of raw water. TDS is found to be lesser than the WHO standard of 2000 ppm for the discharge of wastewater into surface water. The TDS may increase salinity of the water and thus may render it unfit for irrigation and drinking purposes. Consumption of water with high concentrations of total dissolved solids has been reported to cause disorders of alimentary canal, respiratory system, nervous system, coronary system besides, causing miscarriage and cancer [11].

Suspended Solids:

The undissolved matter present in water or waste water is usually referred as suspended solids. Suspended solids reduce the photo synthesis activities of water plants by smothering benthic organism. The quantity of suspended solids was greatly reduced from 216 ppm for raw water to 60 ppm of final outlet.

SiO_2:

Silica is mostly found as silicates. The average abundance of silica is 7-80% in rocks, 50-80% in soils and upto 14 mg/l in surface and ground waters. Chronic exposure to silica dust can be toxic. A very high silica content of 170 ppm was observed in the final outlet of the water treatment plant.

Chemical Oxygen Demand (COD):

Dissolved oxygen is the measure of the degree of pollution by organic matter, the destruction of organic substances as well as the self purification capacity of the water body. Chemical Oxygen Demand is the measure of amount of oxygen required to breakdown both organic and inorganic matters. The COD value of the outlet sample was recorded as 205 mg/L. This sample value was also found to be lower than that of WHO guidelines value of 1000 mg/L[12]. High COD levels indicate the toxic state of the waste water along with the presence of biologically resistant organic substances [13].

Biological Oxygen Demand (BOD):

Biological Oxygen Demand is the measure of the oxygen required by microorganisms whilst breaking down organic matter. BOD measures the organic loading of streams and thereby quantifies the dissolved oxygen levels. BOD results help to measure the purification capacity of streams, by regulatory authorities and to check the qualities of effluent discharged to the water streams. In the present study, BOD of the final effluent was 14 mg/L. While WHO guidelines of BOD value was 50 mg/L . The high BOD levels are indications of the pollution strength of the waste waters. The high BOD and low oxygen content of effluent will affect survival of gill breathing animals of the receiving water body [14].

Conclusion

Color of the effluent is dark brown in pulp mill discharges due to dissolved lignin. On the basis of above discussion it is concluded that the final effluent discharged from paper industry is not much contaminated and most of the parameters except Na, K, Ca and Mg have limited values as prescribed by the standards of WHO.

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