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Correlation study on physicochemical characteristics of untreated and treated effluents of pulp and paper industry

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ABSTRACT

The present investigation report the characteristics of treated and untreated wastewater of pulp and paper industry situated at near Bhusawal Dist. Jalgaon (India). The present study we have found even the treated effluent was to be considerably polluted and exceeded the BIS limits. The values of temp., P^H, chloride and total phenols were found below limit, whereas colour, BOD, COD and lignin concentration were above the permissible limits.

Key words: Physicochemical parameters, BIS pulp and paper industrial effluent.

INTRODUCTION

The liquid wastes from the pulp and paper industry is generated from two different sections one from pulping process and other from paper or board making unit. The characteristics of these two wastewaters are quite different, both quality and quantity wise. In most cases, specially employing pulping process, the maximum of this wastewater is not recommended to prior to the treatment. The liquid waste generated from pulping section, popularly known as black liquor mainly consists of organic as well as inorganic dissolved solids and excess of chemicals. During cellulose pulp production lignin is removed in the cooking stage and in subsequent bleaching stage. In the conventional bleaching, chlorolignin as well as low molecular weight chlorinated aromatic and aliphatic compounds are found. Most of the chlorinated compounds are produced in subsequent alkaline extraction stage of the bleaching sequence Osterberg and Lindsterom (1985).

The large pulp and paper mills equipped with soda recovery, discharge about 270-450 lit. effluent kg^{-1} paper, containing 40-50gm. lignin kg^{-1} bleach paper produced, contrary to this the small paper mill without soda recovery discharge nearly 300-400 lit. of black liquor effluent containing 200-250gm. lignin kg^{-1} of paper manufactured Garg and Modi (1999). The pulp and paper industry generate every year 700 billion gallons of highly coloured and toxic effluent mainly containing high molecular weight modified and chlorinated lignin. About 300 different chlorinated organic compounds in bleached pulp mill effluent have been identified till date. About 200 of this compound are chlorinated resins, acids, phenols and dioxanes Huynin et. al. (1995).

Present work was undertaken to access the characterization of physicochemical parameters of pulp and paper mill effluent near Bhusawal Dist. Jalgaon in Maharashtra for one year duration at different sites of industry.

MATERIAL AND METHODS

The effluent were collected from pulp and paper industry situated near Bhusawal Dist. Jalgaon at discharge point for treated and untreated effluent every three months were analyzed for physicochemical characteristics as per Neeri (1988)

Table - 1: Showing the physicochemical characteristics of effluent from Bhusawal based pulp and paper industry collected quarterly intervals from untreated and treated process.

S. No	Parameters	September to November		December to February		March to May		June to August	
		Untreated	Treated	untreated	treated	untreated	treated	untreated	treated
1	Temperature	29.9	27.4	14.8	16.2	31	39.4	32.4	28.9
2	Colour	1866.16	796.7	2017.68	828.29	1427.56	946.4	2564.41	906.8
3	Electrical conductivity	1.883	1.077	1.6	0.85	1.838	1.063	1.635	1.046
4	Dissolved Oxygen	0	0	0	0.2	0	0.2	0	0.4
5	PH	7.4	7.6	6.7	7	5.9	6.8	6.6	6.9
6	Lignin concentration	5091.77	2511	4171.42	0.63	5120.22	2449	4830.18	2299
7	Total Phenols	0.68	0.1	0.42	0.07	0.4	0.03	0.41	0.05
8	BOD	556	147	578	170	355	154	531	113
9	COD	1204	168.3	1234.7	290.4	1023.2	102.9	1174.8	150.7
10	Chloride	335	107	339	111.4	212	69.7	230.6	106

and APHA (1995).The characteristics were compared with Burro of Indian Standards (BIS).For study temperature of effluent and ambient temperature was measured using portable digital multi steam thermometer (HANNA Instrument Co.; Italy) with external sensing probe. P^H of the effluent sample was measured by digital portable pH meter (HANNA Instrument Co.; Italy). The electrical conductivity (EC) of effluent was measured on sampling sides using digital portable conductivity meter at 25^0 C (HANNA Instrument Co.; Italy). Colour unit were measured spectrophotometrically using method of Bajpai et. al. (1993). Lignin contains in the effluent was measured by modified nitrosation method Pearl and Benson (1940). The absorbance was read as 430nm using spectrophotometer. Total phenols in effluent sample were measured by using 4-aminoantipyrine colorimetric method APHA (1995).

Biological oxygen demand (BOD), Chemical Oxygen Demand (COD), fluoride of effluent sample were measured according to APHA (1995)

RESULTS AND DISCUSSION

Quarterly variations among the physicochemical parameters of pulp and paper industry situated near Bhusawal city of Jalgaon district are summarized in table and fig.1 to 10. The effluent temperatures of untreated effluent were maximum32.4 and minimum 14.8^0C respectively. Visibly, the effluent a dark brown to yellowish brown appearance. The colour of effluent decrease markedly with treated effluent. The value of colour contents for untreated 2564.41 maximum and for treated 796.7 was minimum. The mean value of electrical conductivity for untreated effluent was 1.838 maximum and minimum 1.600. For treated effluent minimum was 0.850 and maximum 1.077 throughout the year 2005

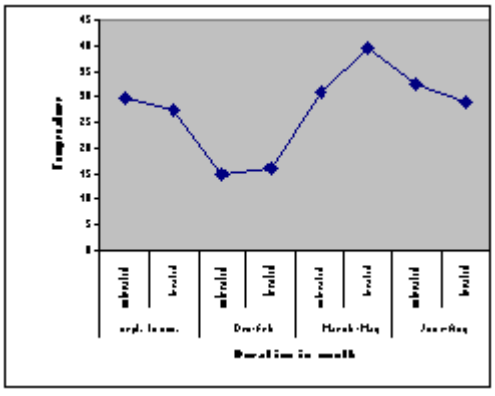
There was no dissolved oxygen was present in effluent sample throughout the year for untreated effluent. This may be due to heavy pollution load and microbial activity which have consume all oxygen present in effluent for treated maximum was 0.4 and minimum 0.2

Quarterly variation among chemical characteristics of pulp and paper industrial effluents at untreated and treated sites. The P^H showed a slight shift towards neutrality to milk alkalinity in untreated and treated effluent respectively. In respect of quarterly variations, minimum P^H (most acidic) was in month of March to May (5.9) and maximum alkaline in September to November (7.6).The lignin contents for untreated effluent were 5120.22 maximum and minimum were 4171.22 for treated wastewater. The minimum was 0.63 and maximum 2511.47 mg/lt^{-1} as quoted in table. 1 and fig. -1 respectively.

The value of total phenols for untreated effluent were maximum in September to November months i.e. 0.68 and minimum were 0.40mg/lt^{-1} for treated effluents total phenols were 0.003 minimum and maximum 0.42mg/lt^{-1} respectively.

The BOD value for untreated effluent were high in the month of December to February i.e.578 mg./lt^{-1} and minimum were 355mg /lt^{-1} respectively BOD (Biological Oxygen Demand at 250c in 5 days incubation). For treated effluent 113.0 mg. / lit were minimum and maximum were 170.0 mg./lit respectively. The chemical oxygen Demand (COD) was maximum 1234.7mg./lt-1 and minimum 1023.2 mg. / lt^{-1} for untreated effluent and treated effluent the maximum was 290.4mg./lt^{-1} and minimum were 102.9 mg./lt-1 respectively.

The chloride (Cl^-)contents for untreated effluent were maximum in December to February i.e. 339.0mg./lt^{-1} and minimum were 212.0mg./lt^{-1}



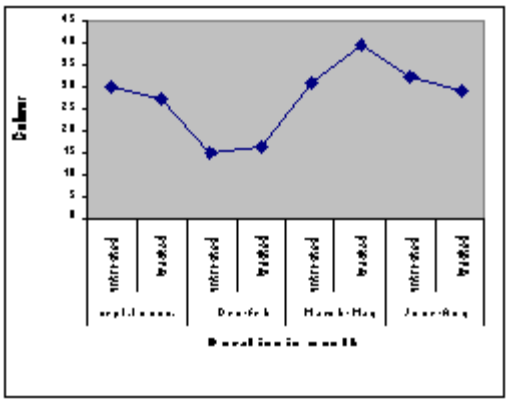
Graph1: Showing variation in Temperature

in March to May months respectively for treated effluent maximum reading was observed 107mg./ lt^{-1} in September to November months and minimum for treated 69.7 mg./lt^{-1} in month of March to May respectively.

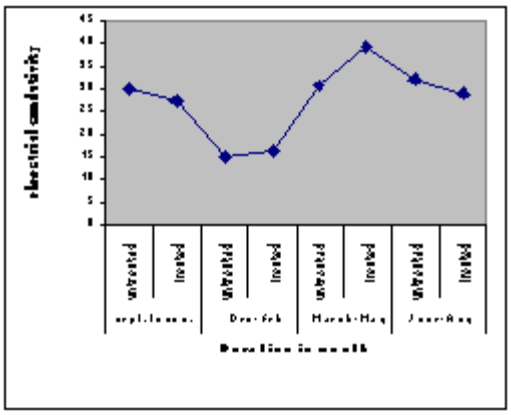
The data presented in table 1 reveals that temperature and P^H of effluent in all the months were below the BIS permissible limits (40^0C and 6.5 to 8.5 respectively). For discharge of effluents in inland surface water as well as on land for irrigation. The DO was found to be nil and therefore below BIS permissible limits in all the months throughout the year which indicated a high pollution load in treated and untreated effluent of pulp and paper industry located at Bhusawal.

The effluent has dark brown color at origin in untreated effluent which gradually turned in light brown to pale color in treated wastewater from origin. However the color of treated effluent in all the months was much above the minimum national standards (MINAS). This specified that the industry should make all efforts to remove color and unpleasant odour as far as possible, before discharge or effluent into environment (Shukla 1989) Biological Oxygen Demand $BOD_{(5)}$ of effluent, measure of biodegradable organic matter was found to be much higher in all the months throughout the year. The permissible limit for inland surface water is 30mg. / lt^{-1} as well as for land irrigation100mg./lt^{-1} Chemical Oxygen Demand (COD) which is measure of oxygen required to completed oxidize the organic carbon was also found to be much above them the permissible limit i.e. 250mg./lt^{-1} for both inland surface water and land irrigation COD value for untreated effluent was found to be above the permissible limit and treated effluent were below the permissible limit throughout the year respectively. However, lignin concentration was found to be very high in throughout the year. Chloride contents was below the permissible limit for both inland surface water (600mg./lt^{-1}) and for land irrigation (250mg./lt^{-1}).

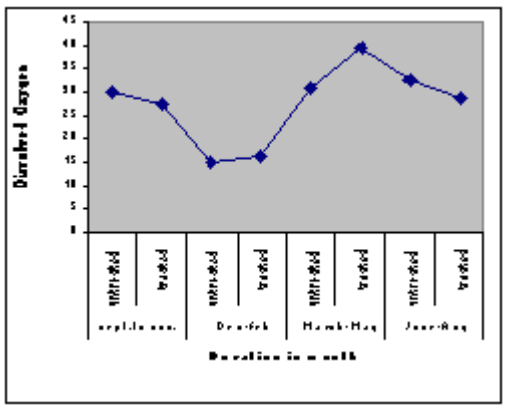
Thus the mean value of temperature , P^H and chloride, total phenols of untreated effluent were above the limit and treated effluent were within the permissible limits whereas color, BOD, COD and



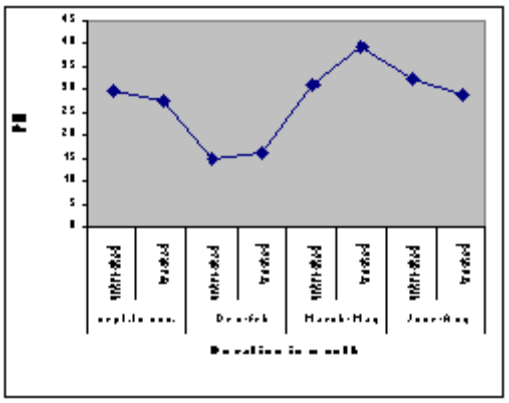
Graph 2: Showing variation in Colour



Graph 3: Showing variation in electrical Conductivity



Graph 4: Showing variation in Dissolved Oxygen

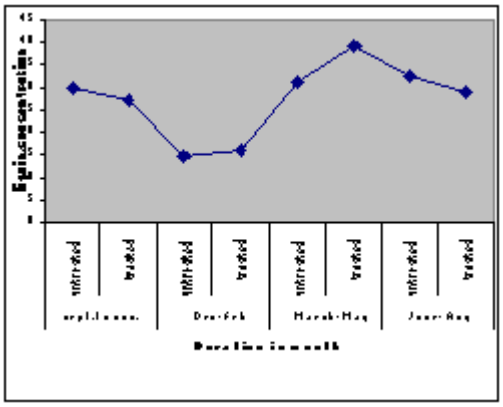


Graph 5: Showing variation in PH

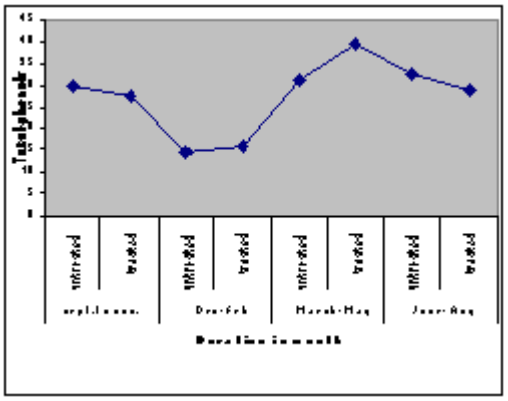
lignin concentration were found to be above permissible limit for both treated and untreated effluent.

The value for various physicochemical characteristics obtained in the present study are in good agreement with the characteristic of pulp and paper mill effluents as reported by other P^H ranged from 6.5 to 8.2 Singh et .al.(1996) reported PH range of 6.9-8.6 in combined effluents of Shreyans paper mill ltd., Ahemadgarh, Punjab. Similarly most workers have reported the color of the discharged effluent was dark brown to light brown (Mahajan, 1985; Singh et. al., 1996, Thorat and Masrral Sultana, 2000 and Thorat, 2000)

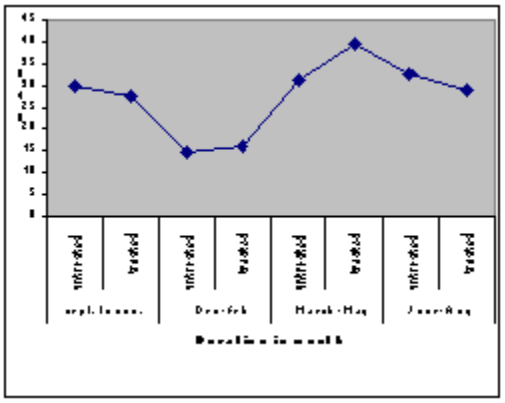
For BOD and COD respectively as reported by Singh et. al. (1996), but lower than the range of 1286-1764 mg./ lt^{-1} and 2653-3369mg./lt^{-1} for BOD and COD respectively as reported by Chakravarthi et .al. (1995) for Shri. R.R .Paper mill, Nuzrid, These difference may be due to variation in manufacturing process, production capacity and efficiency of in mal treatment plants as well as sites of effluent collection Sahoo et. al. (1997) also found high values of COD in months of September to February for Modi Cement Factory Madhya Pradesh. Thus it may be concluded that the high values for these pollution parameters reflect the reduced activity of indigenous micro flora present in effluent, responsible for natural bioremediation. Archibald et. al. (1998) found that photolysis plays an important role in mineralization of organic pollutants from the biologically treated pulp and paper mill effluent.



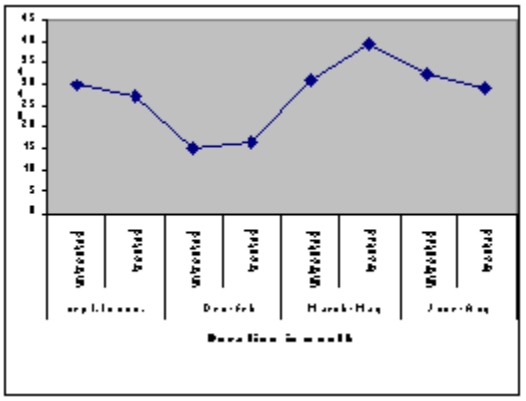
Graph 6: Showing variation in lignin concentration



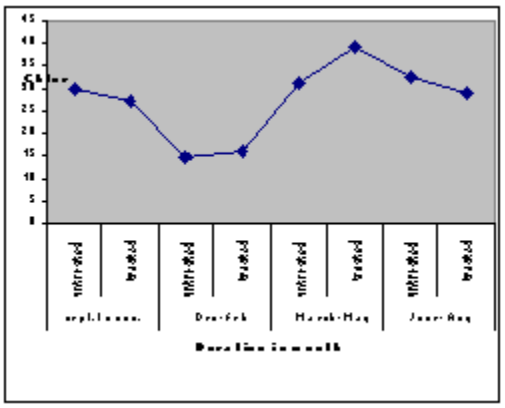
Graph 7: Showing variation in total phenols



Graph 8: Showing variation in BOD



Graph 9: Showing variation in COD



Graph 10: Showing variation in Chloride

The present study on significant changes in effluent quality parameters with a quarterly distribution emphasizes the need for using identical sides and yearly analyzed for comparing effluent characteristics. The waste generated from pulping section is heavily polluted and need elaborate treatment which may include primary units like sedimentation, coagulation, flocculation etc. and secondary limits like conventional biological process, for small and medium industries, this combined treatment may not be economically viable. Instead, solar evaporating pans may be most suitable in the hot climate. The waste coming out from paper making structure after processing it through save all for fibre recovery can be partly recycled and the remaining can be disposed without any treatment inplant major can be considerably reduce the pollution problem.

The databank generated by quarterly monitoring studies of pulp and paper industrial effluent could be successfully used in prediction of tedious and time consuming parameters by laboratory by laboratory assessment of easily measurable simple parameters (Thorat and Wagh, 2000)

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