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Physico Chemical Characteristics Of Bagasse Based Pulp And Paper Mill Effluent By Varying Season

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ABSTRACT:- *Large quantities of bagasse are used as raw material in this type of pulp and paper industry. The study presents the physico-chemical characteristics of bagasse based paper mill effluent by the varying season of pulp and paper industry. The raw wastewater samples were collected from various sections of processing units from paper mill in the beginning of every month for the continuous period of six months from September 2015 to February 2016. The effluent samples were characterized for various parameters such as temperature, pH, conductivity, turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), chlorides and sulphates. The temperature of effluent varied from 31.7°C to 34.3°C and pH of the raw wastewater varied from 4.73 to 6, conductivity of 2.98 to 3.3 millemohs/cm, turbidity of 22 to 24.6 NTU, Total Dissolved Solids from 2072 to 2285 mg/l, Total Suspended Solids from 1015 to 1110 mg/l, Biological Oxygen Demand (BOD) from 610 mg/l to 727 mg/l, Chemical Oxygen Demand (COD) from 3245 to 3490 mg/l, chlorides and sulphates of 345 to 380 mg/l and 255 to 314 mg/l respectively. The statistical values were obtained on physico chemical parameters in the bagasse based paper mill effluent with the varying season and correlation coefficients were also obtained.*

Keywords:- *Bagasse, Correlation, Physio-Chemical characteristics, Pulp and Paper mill effluent, Raw effluent*

I. INTRODUCTION

The pulp and paper industry is one of the oldest industries in India. But there has been a tremendous expansion during last twenty five years. Varieties of papers and similar products are now manufactured in different mills throughout the country. The paper industry, as it stands now, is one of the largest industries in India and it is one of the major producers of paper in the world. [1 and 2] The Indian paper industry accounts for about 3% of the world's production of paper. Large integrated paper mills from private and public sector with a product mix of all varieties of paper (writing, printing, packaging, specialty, paperboards and newsprint) located in all regions and using conventional fibre such as wood and bamboo and also unconventional raw materials like recyclable waste paper, agro-residues, viz. bagasse and wheat straw; approximately 31% are based on wood, 47% on recycled fibre and 22% on agro-residues [3 and 4].

Depending upon the nature of raw material, the wastewater is generated per metric tonne of paper produced [5]. Then also the consumption of paper is increasing in offices, institutions schools, colleges, packaging, writing and printing and also for the household. The paper-making process requires large amount of water for the production processes, hence it is a water-intensive process [1 and 6]. The reason for high water consumption is simple: more water a mill uses, cleaner are the pulp and the processes. The water removes unwelcome contaminants, those that may cause dirt in the pulp, difficulties in bleaching, and incrustations and plugging in the process. [7]

Consumption of water depends upon the raw material used in industrial processes. The pulp and paper industry is a mix of large integrated plants based on wood based raw material and medium and small size paper plants based on agro residues or waste paper [11]. The wastewater from this industry may be organic or inorganic in nature or a combination of both. The volume and characteristics of the pulp and paper mill effluent depends on the type of manufacturing process adopted [8, 9 and 10]. It contains sodium hydroxide, lignin and salts and typically, this effluent is a dark coloured liquid with small quantities of insoluble fibres. Chemical used

for bleaching of pulp and paper are non biodegradable and hence it leads to increase in the COD content [10 and 12]. To remove organic and inorganic substance from the wastewater, various treatments like physico chemical treatment are used. Before going into treatment it is indeed to analyze the physico chemical characteristics of effluent from the bagasse based pulp and paper mill effluent.

II. MATERIALS AND METHODS

2.1 Study Area

Tamilnadu Newsprint and Papers Limited (TNPL), Kagithapuram, is situated at 11°02'58.7"North 77°59'46.8"East and north-west of Karur, Tamilnadu State, India. TNPL is a Government of Tamilnadu Enterprise, owns and successfully operates India's largest bagasse based integrated Pulp and Paper mill, having an installed capacity of 245,000 TPA of Newsprint and Printing & Writing paper.

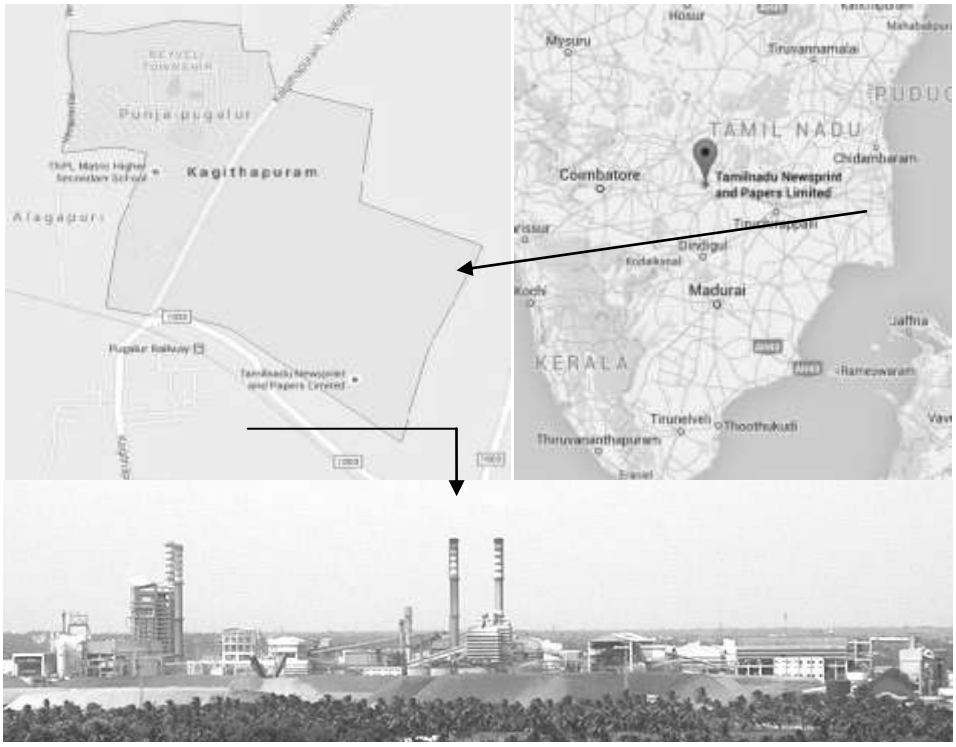

Fig.1 Location map of Tamilnadu Newsprint and Papers Limited (TNPL), Kagithapuram

2.2 Collection Of Samples And Analysis

The raw wastewater samples were collected from pulp paper industry of TNPL Kagithapuram, Karur at various sections of processing units from paper mill in the beginning of every month for the continuous period of six months from September 2015 to February 2016. The grab samples were collected in the plastic containers and brought to the environmental laboratory in Department of Civil engineering, Annamalai University and which were refrigerated at 4° C prior to further analysis in the laboratory.

The pH and temperature was measured by pH meter and thermo-probe at the site of collection. Colour of the effluent was noted by visual observation. The conductivity of the effluent was measured by conductivity meter (Elico conductivity meter CM 180 model). Nephelo-Turbidity meter (Systronics Digital Nephelo turbidity meter 132 model) was used for the analysis of turbidity, while sulphate was analyzed by colourimetrically using spectrophotometer (Systronics spectrophotometer 169 model). The remaining wastewater characteristics parameter, i.e., total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD) and chlorides were analyzed by volumetrically/ titrimetrically as per standard methods of analysis of water and wastewater [10]. The data were statistically analyzed and correlation coefficients were also obtained by using the MS-Excel 2007 software.

III. RESULTS AND DISCUSSION

The paper mill produces variety of writing and printing paper using using bagasse, a sugarcane residue, as a primary raw material. The wastewater generated from the paper mill consists of white water from stock preparation, paper machine and from the bleach section etc .The colour of the effluent was appeared to be light brown to yellowish brown in colour against the standard limit. This may be due to the presence of lignin

compound present in the raw material used for paper production. The seasonal variations of physico chemical parameters for largest bagasse based paper mill effluent were represented on fig 3.1 and fig 3.2 respectively for the continuous period of six months from September 2015 to February 2016. The descriptive statistical values viz. minimum, maximum, mean and standard deviation of physico chemical parameters of paper mill effluent were represented on the table 3.1.

Table 3.1 Statistical values of physico chemical parameters of paper mill effluent

Sl. No.	Parameters	Minimum	Maximum	Mean	Std deviation
1	Temperature °C	31.7	34.3	33.08333	1.004821709
2	pH	4.73	6	5.411667	0.504476626
3	EC millimohs/cm	2.98	3.3	3.151667	0.143724273
4	Turbidity NTU	22	24.6	23.73333	0.915787457
5	TDS (mg/l)	2072	2285	2167.833	75.94581402
6	TSS (mg/l)	1015	1110	1059.667	40.57914078
7	BOD (mg/l)	610	727	665	51.29522395
8	COD (mg/l)	3245	3490	3403.333	84.71520918
9	Chlorides (mg/l)	345	380	356.5	13.03456942
10	Sulphates (mg/l)	255	314	290.3333	21.11555509

The temperature of the effluent is basically important factor for its effect on the other properties ofwastewaterand it was lie in between 33.083±1.0048°C and the minimum temperature was observed in the month of December and maximum was at September. The mean pH of the effluent was observed as 5.412±0.5045 that was slightly in acidic range may due to the formation of organic acids while processing. Electrical conductivity (EC) is a useful indicator to show the salinity or total salt content of the effluents. The mean value of electrical conductivity was 3.152±0.144 millimhos/cm and there was not much significant variation in standard deviation. Maximum EC (3.3 millimhos/cm) was measured in the month of January and minimum (2.98 millimhos/cm) in the month of February. Turbidity is an expression of the optical property that causes light to be scattered rather than transmitted in straight lines through the wastewater sample. It is caused by suspended mater, such as organic and inorganic matter, soluble coloured organic compounds, and plankton [11]. The mean value of turbidity was measured as 23.733 NTU with the standard deviation of 0.916. Minimum and maximum turbidity were observed in the month of November and December as 22 and 24.6 NTU respectively due to the suspended matter of sugarcane residue.

The mean value of total suspended solids (TSS) was measured in bagasse based paper mill effluent as 1060 mg/l with the standard deviation of 40.58 but the higher concentration was due to the presence of bagasse fibres. This might cause the turbidity in the effluent. It was observed that there was no significant variation in the TSS for the all the seasons from September to February and the maximum (1110mg/l) was at the month of December and minimum (1015 mg/l) was at the month of January. The mean value of total dissolved solids (TDS) was 2168±75.95 mg/l with significant change in the standard deviation. A total dissolved solid (TDS) is a parameter, which gives us the index of dissolved compounds, both organic as well as inorganic present in the said wastewaters. Among the inorganic dissolved components, free chlorine, sulphates, sulphides, carbonates, bicarbonates, predominate as the major anions; and calcium, magnesium, aluminium, iron and other heavy metal ions as the prevalent cations. Both inorganic and organic dissolved solids raise the TDS (mg/l) to a very high level [14]. The organic dissolved compounds consist mainly of chlorinated compounds which were aroused from salts and chemicals used for the bleaching process. The maximum (2285 mg/l) and minimum (2072 mg/l) value of TDS was at the month of November and December respectively. Biological oxygen demand (BOD) measures the amount of oxygen required by the microorganisms for breaking down organic matter. The mean value of BOD was varying with standard deviation of 665±51.3 mg/l. Maximum (727 mg/l) and minimum value (610 mg/l) of BOD was observed in the month of December and January respectively. Chemical oxygen demand (COD) measures the amount of oxygen required to break down both organic and inorganic mattes. Both BOD and COD are the most commonly used parameter for determining the pollution load for municipal and industrial wastewater discharge. These parameters can also be used to evaluate the efficiency of treatment processes. Mean value of COD was 3403.33mg/l. It was varied from month to month with the significant changes in the standard deviation of 84.72 and minimum (3245 mg/l) and maximum (3490 mg/l) was recorded in the month of November and December respectively. This may be due to the different raw materials and chemicals used in the processing especially during pulping. Chlorides were observed with the mean value of 356.5±13.04 mg/l and the concentration was within the prescribed limit. There was no much variation in the

varying month from September to February. Finally the sulphates were observed from 255 mg/l to 314 mg/l. It shown, the concentration of sulphates was slightly higher than the prescribed limit for all through the six month period. This may inhibit the microbial activities in the biological treatment process due to the formation of the hydrogen sulphide (H_2S) toxicity.

A widely used correlation criterion between two variables is in simple correlation coefficient, which indicates the sufficiency of one variable to predict the other. The correlation coefficients among physicochemical parameters of paper mill effluent were computed and these values are presented in the form of correlation matrix [15]. Table 3.2 illustrates the correlation among the various physicochemical parameters of paper mill effluent. Very good positive correlation found among COD and turbidity (r=0.991) and significant positive correlation exists among the turbidity with TDS and sulphates (r=0.707 and 0.697), TDS with BOD and COD (r=0.776 and 0.758) and COD with sulphates (r=0.713). Further insignificant correlation exits between the chlorides with sulphates (r=0.609) and TDS with chlorides (r=0.593). The temperature with pH and TDS showed a negative correlation (r=0.887and 0.547). Further significant negative correlation exists between EC and chlorides (r=0.765).

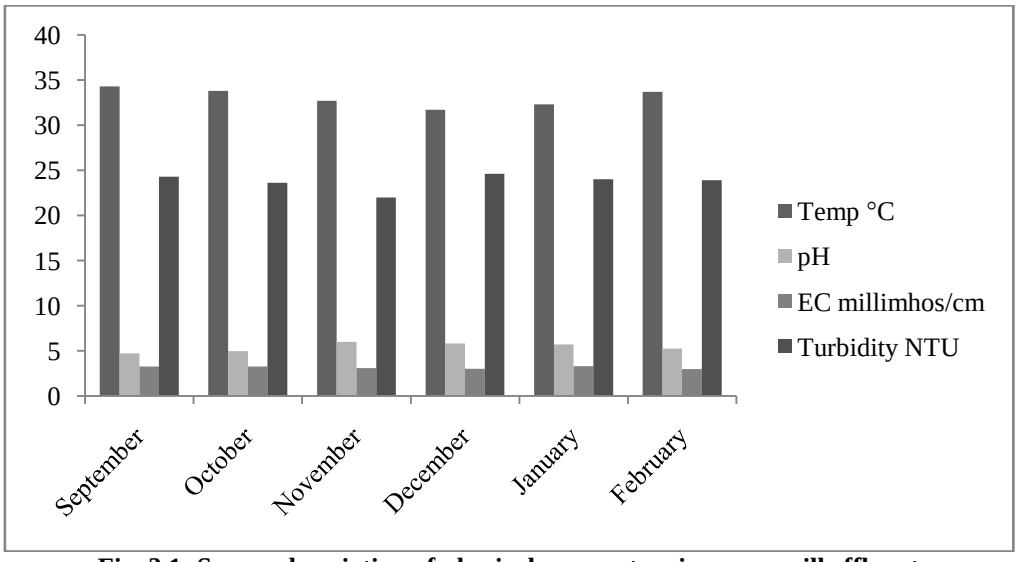

Fig. 3.1: Seasonal variation of physical parameters in paper mill effluent

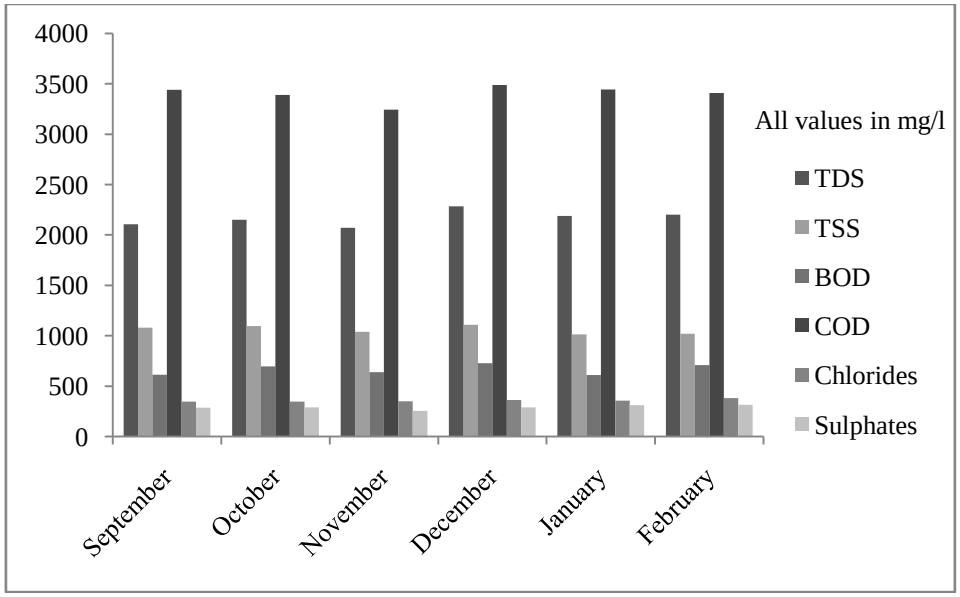

Fig. 3.2: Seasonal variation of chemical parameters in paper mill effluent

Table 3.2 Correlation matrix of physico chemical characteristics of paper mill effluent

	Temp	pH	EC	Turbidity	TDS	TSS	BOD	COD	Chlorides	Sulphates
Temp	1									
pH	-0.8872729	1								
EC	0.3242918	-0.397257	1							
Turbidity	-0.0101427	-0.4148689	0.0435594	1						
TDS	-0.5472708	0.2066232	-0.4615252	0.7072108	1					
TSS	-0.003597	-0.2860275	-0.0084588	0.3738599	0.2434712	1				
BOD	-0.3133322	0.1170785	-0.5359989	0.3252744	0.7764839	0.3068724	1			
COD	-0.1237415	-0.3137028	0.0569443	0.9907908	0.758291	0.3456798	0.3591987	1		
Chlorides	-0.1565194	0.1750401	-0.7649259	0.2395933	0.5926736	-0.3845488	0.5474938	0.2363646	1	
Sulphates	0.0474454	-0.2679858	-0.012082	0.6974409	0.6220024	-0.2939445	0.4087725	0.7131376	0.6089404	1

IV. CONCLUSION

The paper mill is fast growing and produces different varieties of paper. The physico-chemical characteristics of effluent from this mill revealed that the effluent is light brown in colour where the other parameters such as temperature, pH, conductivity, turbidity, TSS, TDS, BOD, COD, Chlorides and Sulphates were slightly varying with the varying season from September to February. The statistical analysis showed that the TDS and COD were significantly varied and temperature, pH, chlorides and sulphates were intercorrelated while the other parameters were seldom correlated.

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