Pulp and Paper Mill Wastewater Characteristics and its Impact on the Quality of Ground Water in the Neighbouring Region

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Abstract

The liquid waste from Pulp and Paper industry is mainly generated from two different sections, one from pulping and the other from Paper and Board making unit. The characteristic of these wastewaters are quite different both in terms of quality and quantity. However, both the streams are combined together in to a single stream with 'one quality' as far as Nagaon Paper Mill (NPM) is concerned, before the biological treatment. The Pulp and Paper Mill wastewater is organic rich mainly due to the presence of different compounds in combination with Lignin. The Lgnin contributes colour to the effluents.The parameters like pH, suspended solid, alkalinity, TDS, COD, BOD, chloride, sulphide etc., in effluent showed very much fluctuations in process streams but showed a steady and decreasing trend after treatment and also in disposal route. It is revealed from the study carried out in four seasons, that the reduction in values of different parameters from the point of generation to the point of river confluence are quite encouraging. The physico-chemical analysis of ground waters in six locations within a radius of 10 km of the Pulp and Paper Mill, revealed that, ground water sources are practically uncontaminated which indicates the effluent has not infiltrated into the ground water.

INTRODUCTION

An integrated Pulp and Paper Mill, generally uses 150 to 250 M^3 of water per tonne of paper produced and almost the entire amount of water used, comes out as wastewater. The effluent quantity varies from mill to mill although the same products are produced. Raw materials used for Pulp making, have different properties and this has been mainly responsible for widely varying quality of Pulp and Paper Mill effluent. Raw material preparation through washing, cleaning, barking and chipping introduces a considerable amount of suspended solids into the wastewater, increasing the total solid load. Pulp making through digestion of chips give rise to black liquor, that contains a considerable amount of Lignin and its derivative. Lignin is mainly responsible for the dark colour of the effluent. During digestion of chips and bleaching operations, volatile and non-volatile toxic compounds are produced. No.-volatile eg. Resin acids, unsaturated fatty acids and their chlorinated derivatives are released during pulping, bleaching and caustic extraction. Volatiles like Hydrogen Sulphide and Methyl marcaptans impart a bad taste and odour to the effluent (1,2). The bleach plant effluent is a complex mixture of chlorinated and non-chlorinated organic compounds (3,4). The chlorinated compounds being formed especially when elemental chlorine is predominantly used in the bleaching process. Since the elemental chlorine has the multiple effect of forming number of compounds, it is considered to be the only source of toxic chlorinated compounds that come under parameter AOX. (5,6).

All these compounds largely determine the environment situation and therefore their minimization in the effluents is a major goal for the environmentalist today.

Materials and Methods

The effluent under study is taken from NPM, a large integrated Pulp and Paper Mill. Samples were collected from both inside and outside the factory premises i.e. before and after treatment, taking care that the sampling remains from the same positions as far as practicable. The water quality monitoring of both effluents and ground water were done for a period of two years during 2001-2002 at an interval of three months covering all the seasons. Ground water samples were taken from 3 tube wells and 3 dug wells within a radius of 10 Km of the Paper Mill under study, during the same period.

The parameters chosen for this work were - pH, conductivity, solids, temperature, turbidity, hardness, colour, chloride, sulphate, sulphide, DO, BOD, COD and mercury. As because there is a chlor-alkali unit in the Paper Mill whose effluent was also under the study, the parameter Mercury was chosen, anticipating the possible contamination with the metal. Phosphate and sulphide,

determined as phosphate, is added as nutrient in the biological treatment process and Sulphide is one of the constituents in the White Liquor (cooking liquor). In determining the water quality parameters, the standard methods (APHA, 1985) were used (7).

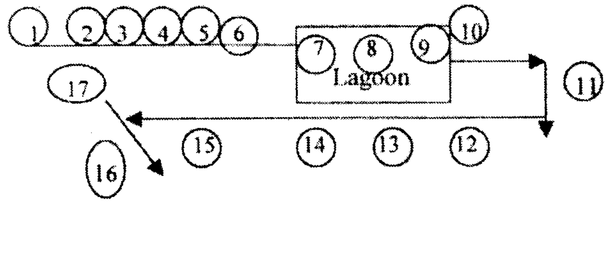

Fig. 1 Sampling points from processes to river Kolong

RESULTS & DISCUSSION

Characteristics of Wastewater before and after treatment

All together 17 sampling points have been chosen to monitor the Wastewater quality before and after treatment. A flow sheet of different sampling points is shown in Fig.1. Point 1 represents Paper Machine wastewater, Point 2 Soda Recovery, Point 3 Pulp Mill, Point 4 Low Solid, Point 5 High Solid, Point 6 Combined Effluent, Point 7 Aeration Pond, Point 8 Polishing Pond, Point 9 ETP outlet, Point 10 Outfall at Beel, Point 11 Village Taranga, Point 12 Village Chakumaku, Point 13 Village Aujari, Point 14 Village Moloibari, Point 15 before confluence of river Kolong, Point 16 river down stream and Point 17 river upstream.

The sampling points have been grouped into three categories: Point 1 to 6 represents the wastewater samples from different process streams, Point 7 to 9 covers the Effluents Treatment Plant (ETP) and Point 10 to 15 are on the disposal route of the treated effluent, as also indicated in Fig. 1.

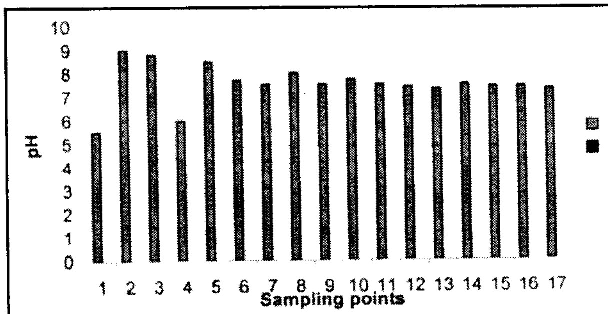

Fig. 2 pH variations along sampling points

The pH values reveal no abnormality throughout the entire period of investigation. The Paper Machine effluent (Point 1) remained on acidic side (avg. 5.7) due to use of Alum in the process. Because of alkaline process the pH of Recovery (Point 2) and Pulp Mill (Point 3) effluents were found to be 9.8 and 8.7 respectively. The pH of other sample up to the point of discharge in the river remained within the limit of 6.5 to 8.5. The fluctuations in the average values of pH is

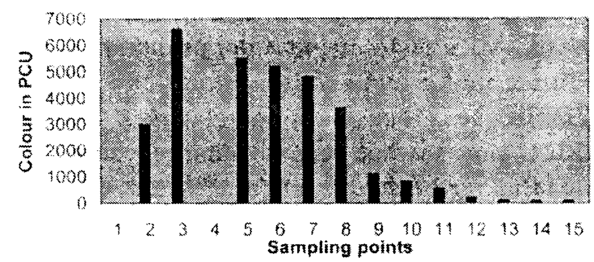

Fig. 3 Colour variations along the sampling points

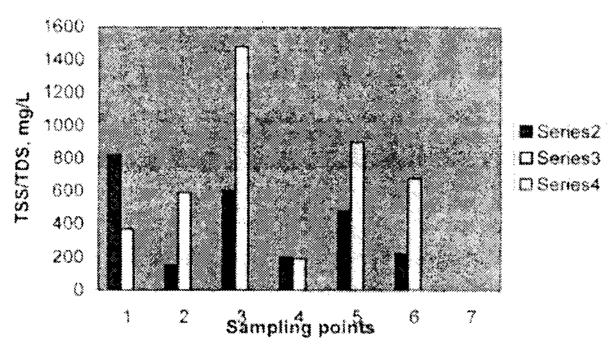

Fig. 4 TSS and TDS variations in process uints

shown in Fig.2.

Pulp Mill wastewater (Point 3) is the main colour contributor to the effluent due to the presence of dissolved Lignin in alkali, in a range from 3,800-8,300 PCU. On the other hand, the colour of the effluent at the river confluence was

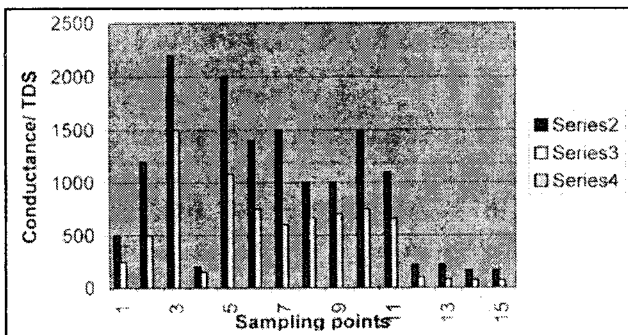

Fig. 5 Conductance and TDS along the sampling points

only 90 PCU, the decrease being largely due to natural dilution and oxidation, which is shown in Fig. 3.

The Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) data obtained are represented in Fig. 4. It is observed that the TDS value in Pulp Mill is as high as 1590 mg/l,

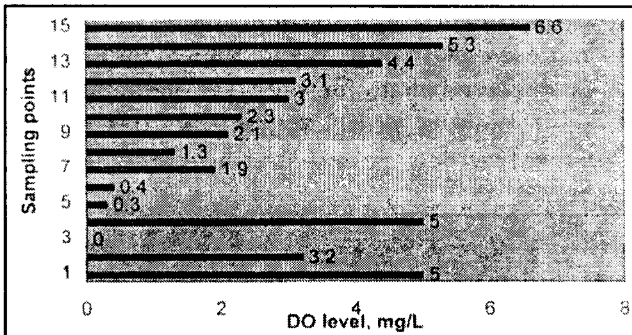

Fig. 6 Dissolved Oxygen level along the sampling a points

because of contamination with process chemicals such as Sodium compounds. A comparative representation is shown in Fig.5, between the Conductance and the TDS from sampling Points 1 to 15.

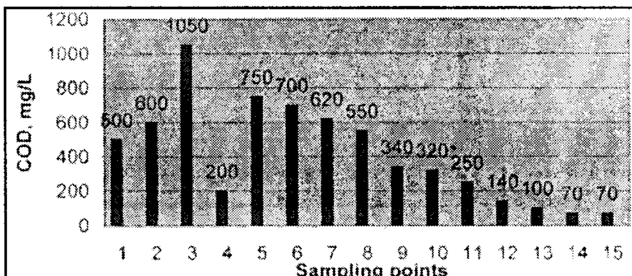

Fig. 7 COD load along the different sampling points

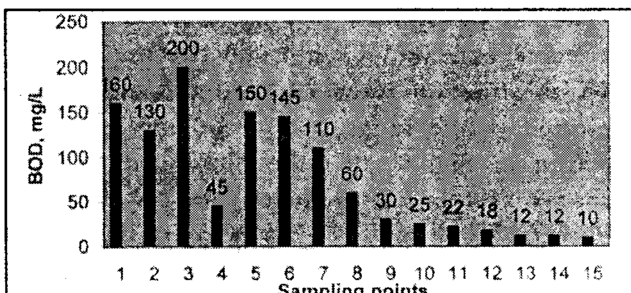

Fig. 8 BOD load from process streams to river confluence

The presence of Sulphide and dissolved organic matter inhibit the presence of Dissolved Oxygen (DO), and thus the DO level recorded low at the points before treatment and it was even zero at some of the Points. For example, Pulp Mill effluent (Point 3) did not have any DO during all the sets of measurements (Fig.6). The Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) variations before and after treatment and also along the disposal route is represented in Fig. 7 and Fig. 8 respectively. It is observed that, for both the parameters the trend follows a nearly exponential relationship for the first few points starting from Point 10.

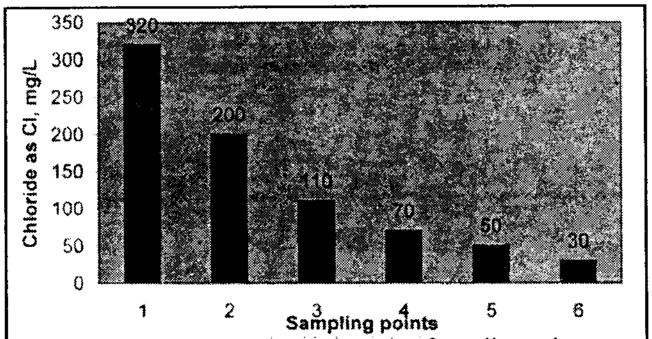

Fig. 9 Reduction in chloride level starting from disposal route to river confluence

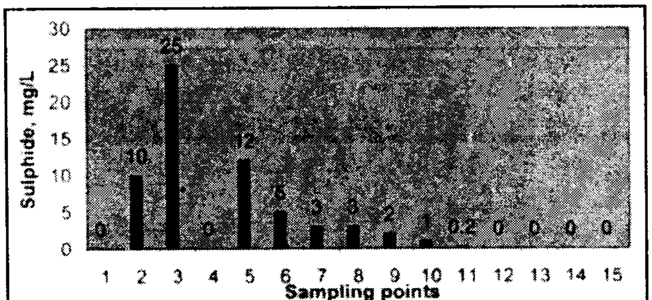

Fig. 10 Sulphide content at different sampling points

The use of chlorine in Pulp Mill for bleaching of Pulp, contributes chlorides to the effluent. The chlorination stage backwater itself contains chloride in the range 2000-3000 mg/l as Cl. It is seen in Fig. 9, that the biological treatment process at the ETP reduces the chloride from an average 436 mg/l (Point 7) to an average 346 mg/l (Point 9). The natural dilution on the other hand, in disposal route reduces chloride content from 320 mg/l (Point 10) to 31mg/l at the river confluence (Point 15). The results of the present investigation are in agreement with the values obtained in another large Paper Mill using chlorine as a bleaching chemical in India. A similar pattern figure for Sulphide content in effluent cas be seen in Fig. 10.

Quality of Ground Water in the Neighbouring Region

When the wastewater from an industry is discharged into a water body, water gets absorbed by the soil due to its natural property and may infiltrate into ground water sources contaminating them in the process. In many cases, industrial wastes and sewage are discharged directly to spreading grounds or leaching fields to permit the liquid to percolate to the ground water. To see whether the ground water quality is adversely affected by the Paper Mill effluents, water quality of three dug wells and three tube wells were studied in this work. The location of these is:

Dug wells (1 to 3), Tube wells (4 to 6):

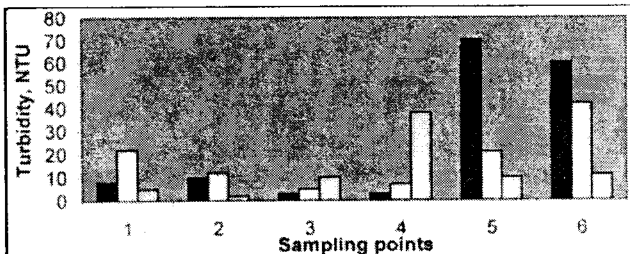

Fig. 11 Turbidity in dug wells, 1-Amlighat, 2-Sindhikar, 3-Deosal

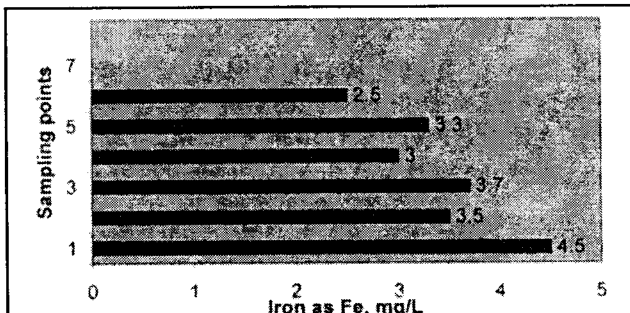

Fig. 12 Iron content in ground water samples

1. Village Amlighat (8 Km Eastern direction of the Mill)

2. Village Sindikar (6 Km Eastern direction of the Mill)

3. Village Deosal (3 Km Eastern direction of the Mill)

4. Village Naokhali (0.5 Km Northern direction of the Mill)

5. Village Chakumaku (3 Km North-west direction from the Mill)

6. Village Aujari (5 Km North-west direction

of the Mill)

The average values from the six sets of measurement carried out during the period are considered for representing figures on parameters.

The turbidity variation for different sets of measurement, in case of dug wells is shown in Fig. 11. Chlorine in water of the study area were in the range of 10-64 mg/l in case of dug wells and 2-20 mg/l in case of tube well water. On average, the dug well water contains more (6-20 mg/l) than in tube wells (0-6mg/l). Iron content in ground water has been observed to be very high for a very long period. The results of the present study are also in conformity with the general trend. The ranges and the average values for the ground water samples are shown in Fig. 12. The DO values are low, which is as expected due to the fact that, ground water normally contains less DO as there is less contact with atmospheric oxygen (3-6 mg/l) and also in case of dug wells, the water is stagnant (2-6 mg/l). The parameter Mercury was found to be absent in all sets of measurement.

CONCLUSION

It is observed from the data presented that almost all wastewater parameters showed fluctuations and the water quality varied from season to season. Samples collected from different process streams (Point 1 to 5) showed much fluctuations due to process variations from time to time. To much variations in the wastewater quality affects the efficiency of biological treatment since it is difficult to maintain the relation between BOD and nutrient addition. It is understood that measures to control the discharge of wastes from the analysis data, it is found that, the water quality along the disposal route maintained a decreasing trend of all parameters and increasing trend of DO, and thus conforming the specifications laid down in national standards before being discharged into natural water bodies. The water sources, studied in this work, did not show any abnormality with respect to water quality and the results indicate that the Pulp and Paper Mill effluents have not infiltrated into the ground water sources of the area.

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