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Procedia Environmental Sciences 2 (2010) 595–599

Procedia Environmental Sciences

International Society for Environmental Information Scie nces 2010 Annual Conference (ISEIS)

Physico-chemical analysis of the industrial effluents and their impact on the soil microflora

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Abstract

Industrial Effluents entering the water bodies is one of major sources of environmental toxicity. It not only affects the quality of drinking water but also has deleterious impact on the soil microflora and aquatic ecosystems. Soil is the most favourable habitat for a wide range of microorganisms that includes bacteria, fungi, algae, viruses and protozoa. Industries keep on releasing effluents, which is quite toxic whether its sugar mill or fertilizer industries, or chemical treatment given to the fields also cause problems for the survival of the soil micro flora. In the present study we have analyzed the effluents of sugar and textile industry and their deleterious effects on the soil microflora. Analysis of the textile effluents shows that the ph (8.1 – 9.1); TSS (190 – 163); TDS (4354 – 5768), BOD (181 - 306) and COD is (3853 – 4691) whereas in the sugar effluents ph (7.1 – 9.1); TSS (301 - 494); TDS (2560 - 3978), BOD (2225 - 4526) and COD is (10896 - 16843). The values exceed the NEQS and FMENV values. The microbial flora too is affected by it as compared to the control water sample due to the high BOD and COD values.

Key words: Textile Effluents; Sugar industry effluents; BOD; COD; TDS; TSS; pH

1. Introduction

Industrial Effluents entering the water bodies is one of major sources of environmental toxicity. It not only affects the quality of drinking water but also has deleterious impact on the soil microflora and aquatic ecosystems. Soil is the most favourable habitat for a wide range of microorganisms that includes bacteria, fungi, algae, viruses and protozoa. More than a million microorganisms represent the population per gram of then sample studied with bacteria and fungi being the prominent species prevalent. Industries keep on releasing effluents which is quite toxic whether its sugar mill or fertilizer industries, or chemical treatment given to the fields also cause problems for the survival of the soil micro flora

Sugar processing requires hot water for a number of steps – such as water for imbibitions, raw sugar, remelting and various washings. Wastewater with varying levels of pollution load is generated at nearly all stages of sugar production. Relatively mild effluents from the mill house, containing oil, grease, and some sugar content, are generated from the lubricating and cooling systems, floor washings, the large quantity of water used for juice extraction, and some leakage and spill over. Washing the filter cloths used for sludge from the clarifier increases the suspended solids concentration and BOD of the wastewater. Combined with floor washings, which also add washing chemicals and more sugar, the process house effluents are considered more contaminated than effluents from the mill house. For mills that have an attached distillery, the numerous distillation stages produce a highly contaminated effluent, with BOD and COD concentrations of about 40,000 –100,000 mg/l, called stillage. In general, sugar mill effluents contain acidic and alkaline compounds, a significant concentration of suspended solids and a high BOD, COD, and sugar concentration [1, 2, 3].

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doi:10.1016/j.proenv.2010.10.065

Textile industry is one of the major sources of industrial effluents affecting the environment. The effluent which is untreated contains high concentrations of consumed metal dyes, phenol, aromatic amines etc. [4, 5, 6]. Metal based coloured dyes and foaming chemicals used retard the biological activity due to reduction in the availability of light and cause metal toxicity to the aquatic and terrestrial habitats [7, 8, 9, 10]

Water wastes released from the crude oil processing and petrochemical effluents are characterized by large amounts of hydrocarbons, crude oil products, polycyclic and aromatic hydrocarbons, metal derivatives, surface-active substances, sulphides and other chemicals. They lead to the accumulation of the toxic products in the waste-water and cause deleterious effects to the ecosystem reported the positive correlation between pollutants from the refinery and effects on the aquatic inhabitants and microflora (11, 12, 13, 14, 15, 16, 17].

2. Methods & Methodology:

2.1 Study Site :

Panipat is known for the Textile & Sugar industries. Effluent samples from the textile as well as sugar industry were collected as per standard procedure [18] and were analyzed in the Environmental Biotechnology Laboratory of the department.

2.2 Methods:

2.2.1 Physico-chemical analysis of the textile industry effluents

The site of sample collection was identified at point where the effluent is discharged from the factory. The colour of the effluent and odour was observed at the time of collection of the sample in sterile bottles. The wastewater discharged from the textile industries is characterized by a variety of chemicals generated from dyeing, bleaching and washing processes. It also constitutes suspended solids, organic and inorganic matters, acid and alkalis. Textile wastewater contains substantial pollution loads in terms of BOD, COD, TSS and heavy metals. The environmental concern of discharged textile wastewater is mainly its high chemical oxygen demand (COD) as well as high strength of colour content. The analysis were carried out as per the standard methods as given by [18].

2.2.2 Physico-chemical analysis of the sugar industry effluents

Wastewater from sugar mills were collected and analysed in the laboratory. The effluents with its high BOD rapidly deplete available oxygen supply when discharged into water bodies endangering fish and other aquatic life. The high BOD also creates septic conditions, generating foul-smelling hydrogen sulphide, which in turn can precipitate iron and any dissolved salts, turning the water black and highly toxic for aquatic life [1, 2, 3].

2.2.3 Bacterial analysis of the soil samples

The soil samples were collected from the site of discharge of the effluents to the environment. Soil organic matter and other plant till analyses were conducted. Samples were brought to the laboratory and stored at 4°C. S1 sample is the soil sample collected from the site of discharge of Textile effluent whereas S2 is the soil sample collected from the site of discharge of Sugar industry effluent.

1 gram of soil was mixed with 9 ml of sterilized water and shook it thoroughly. 1 ml from the solution was then mixed in 9 ml sterilized water to make 10-2 dilution of this solution and in the same pattern dilutions up to 10-3. 20 grams of Nutrient Agar was put in 1 litre graduated flask and the volume was made up to the mark by adding sterilized water. pH of media was adjusted with the help of conc. NaOH or conc. by pH meter. The medium was then sterilized in autoclave at 15 psi and 120°C for 20 min and cooled to a pouring temperature of about 37°C. Serial soil dilutions were prepared for appropriate counting of the bacterial population. One ml of the required dilution was spread evenly on an agar-medium petri plates to determine number of populations per gram soil Incubation of the petri plates was done in a room set at 30±2ºC [19].

3.0 Results and Discussion:

The parameters analysed for the textile effluents in Table 1 are higher than the permissible limits for pH, TSS, TDS, BOD and COD.

Table 1: Physico-chemical analysis of the textile effluent samples

Parameters	S1	S2	S3	S4	FMENV Limit
pH	8.1	8.9	8.6	9.1	6 - 9
TSS	190	300	214	178	30
TDS	4354	5182	4986	5768	2000
BOD	181.6	271.3	197.4	306.3	50
COD	3893.2	3401.4	3101.5	4691	80

The results indicate the high levels of the ph (8.1 – 9.1) and fall within the permissible limits. The pH in the effluent is towards the higher value indicating the alkalinity conditions and thus will have an adverse effect on the soil permeability and soil microflora. The values of TSS and TDS are (190 – 163) and (4354 – 5768) respectively. These exceed the permissible limits and are high for the control sample as well indicating pollution of the sample. The concentration of the solids is another matter of concern and the carcinogenicity of the dyes used adds to it. The values of BOD (181 - 306) and COD (3893 – 4691) as compared to the control sample is indicating the high level of pollution in the waters discharged fr4om the industries into the environment. The high levels of BOD are indicators of the pollution strength of the waters. They also indicate that less oxygen is available for the living organisms in the wastewaters. The high levels of COD indicate the toxicity of the effluents and the presence of large amounts of biologically resistant organic substances [20, 21, 22, 9, 10].

The parameters analysed for the textile effluents in Table 2 show that the value of pH range from 7.1 – 9.1 which is within the pH values prescribed by BIS (5.5 to 9.0).

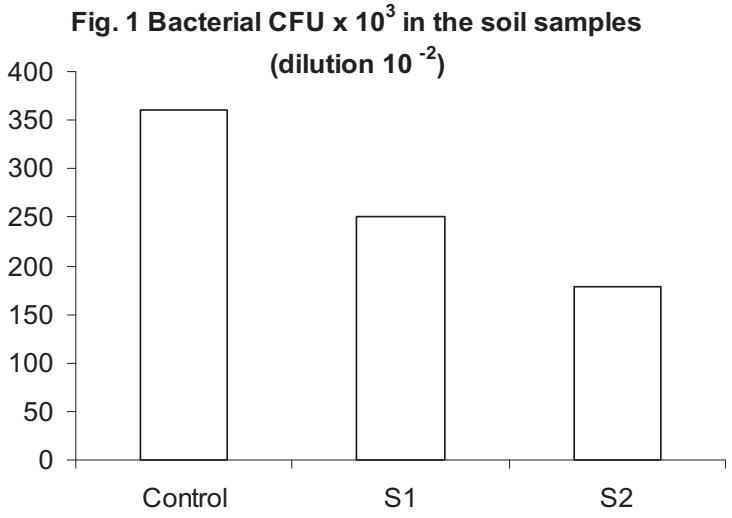
Table 2: Physico-chemical analysis of the sugar industry effluent samples

Parameters	S1	S2	S3	S4	NEQS / BIS
pH	8.1	7.1	8.4	9.1	5.5 -9.0
TSS	300	278	351	408-0	200
TDS	2560	3567	2754	3960	2100
BOD	2225	2965	3756	4526	100+
COD	10896	12865	13955	16843	250

The values of TSS are 301 – 494 and TDS also 2560 – 3978 are also very high. Total Dissolved Solids (TDS) refers to all dissolved materials present in the water. Combined sugar mill effluents generally do not have a TDS measure high enough to have an adverse environmental impact. Discharge of water with a high TDS level would have adverse impact on aquatic life, render the receiving water unfit for drinking, reduce crop yields if used for irrigation, and exacerbate corrosion in water systems and Industrial effluents generally change the natural pH level of the receiving water body to some extent. Such changes can tip the ecological balance of the aquatic system, excessive acidity particularly; can result in the release of hydrogen sulphide to the air [1, 2, 3].

The BOD is 2225 - 4526 and COD is 10896 - 16843. The values of BOD and COD exceed the limit. A high COD, a measure of the inorganic and partly organic non-biodegradable content of the effluents, has effects on the receiving water body similar to that of a high BOD. Suspended solids reduce light penetration and, as a result, plant production in the receiving water body by increasing turbidity and can also clog fish gills. Benthic decomposition of components can decrease oxygen availability while anaerobic decomposition can produce hydrogen sulphide and release by-products that increase BOD. The results are in correlation with those as observed in other studies [23, 24].

The results in Fig 1. indicate a decrease in the bacterial soil microflora as compared to the control. The sugar industry effluent pollutes the soil to a greater extent than the effluent from the textile industry. It could be due to the higher BOD and COD values of the effluents.



The results from Table 3 indicate that the soil microflora dominating in the effluent affected soil samples are mainly the ammonifying group of bacteria as the colour of the nutrient agar is brown.

Table 3 Colouration of the Agar observed after 48 hrs of incubation at 30º C

Sr. No.	Sample No.	Dilutions	Colour of the Agar
1	Control soil sample	10^{-2}	Yellow
		10^{-3}	Yellow
2	S1 - Soil sample collected from the site of discharge of Textile effluent	10^{-2}	Dark brown
		10^{-3}	Muddy brown
3	S2 - Soil sample collected from the site of discharge of Sugar industry effluent	10^{-2}	Dark brown
		10^{-3}	Muddy brown

The intensity of the colour change is also observable when the dilutions of the soil samples are compared. The results show that the bacterial counts have decreased as a result of the pollution of the soil samples by the effluents from the textile and sugar industry.

4.0 Conclusion

India is a developing country where small scale industrial units mainly in textile industry form a major part and effluent treatments are not taken care of. The costs of water treatment add to woes of the ailing smaller units. Hence, the values pH, TSS, TDS, BOD and COD are above the permissible limits. These effluents have deleterious effects on the soil sample collected from the site of effluent discharge. The results indicate that the effluents make the soil unsuitable for cultivation purpose. The effluents from the sugar industry also show a similar trend. The ammonifying bacteria dominate the soil microflora, which disturbs the normal diversity of the bacteria flourishing in the soil samples. The high levels of TDS and TSS are of major cause of concern due to the increased incidences of cancer.

Acknowledgements

The authors greatly acknowledge Prof. B.R. Marwah, Executive Director; Prof. S.K. Satsangi, Director and Prof. R. Sahai, Head, Department of Biotechnology, N. C. College of Engineering for the support and valuable suggestions during the course of study.

References

[1] Verma, S.R. and Shukla, G.R. Pollution in a perennial stream, 'Khala' the sugar factory effluent near lakes. Env. Health. 1969; 11: 145-162.

[2] Behra, B.K. and Mishra, B.N. The effect of a sugar mill effluent on enzyme activities of rice seedlings. Industrial Research 1969 37: 390-8.

[3] Roy,R.P., Prasad, J. and Joshi, A.P. (2007) Effect of sugar factory effluent on some physic-chemical properties of soils – a case study. J. Environ. Sci. 2000; 49(4):277-282.

[4] Malik, A. and M. Ahmed. Seasonal variation in bacterial flora of the wastewater and soil in the vicinity of industrial area. Environ. Monit. Assess, 2002; 73: 263-273.

[5] Ademorotti, C.M.A., Ukponmwan, D.O. and Omode, A.A. Studies of textile effluent discharges in Nigeria. Environ. Stud., 1992; 39: 291-6.

[6] Correia, V.M., T. Stephanson and S.J. Judd. (). Characterization of textile wastewaters – a review. Environ Technol. 1994; 15: 917-29.

[7] Tariq, J., M. Ashraf, M. Jaffar and M. Afzal.(). Pollution status of Indus River Pakistan through heavy metal and micronutrient content of fish, sediment and water. Water Research, 1996; 30(6): 1337-1344.

[8] Kirk, T.K., E. Schultz, W.J. Connors, L.F. Lorenz and J.G. Zeikus. Influence of culture parameters on lignin metabolism by Phanerochaete chrysosporium. Arch Microbiol., 1978; 117: 277-285

[9] Yusuff, R.O. and Sonibare, J.A. Characterization of textile industries Effluents in Kaduna, Nigeria and Pollution implications. Global Nest: the Int. J. 2004. 6(3):212-221.

[10] Geetha, A., Palanisamy, P.N., Sivakumar, P., Ganesh, P.K. and Sujatha, M. Assessment of underground water contamination and effect of textile effluents on Noyyal river basin in and around Tiruppur town, Tamil Nadu. E.J. of Chem., 2008; 5(4): 696-705.

[11] Staples, C.A., Dorn, P.B., Klecka, G.M., O'Block, S.T. & Harris, L.R. A review of the environmental fate, effects and exposures of bisphenol A. Chemosphere 1998; 36: 2149–2173.

[12] DeGraeve, G.M., Geiger, D.L., Meyer, J.S. & Bergman, H.L. Acute and embryolarval toxicity of phenolic compounds to aquatic biota. Arch. of Environ.l Contam. and Toxicol.1980; 9: 557–68.

[13] Onwumere, B.G. & Oladimeji, A.A. Accumulation of metals and histopathology in Oreochromis niloticus exposed to treated NNPC Kaduna (Nigeria) petroleum refinery effluent. – Ecotoxicol. and Environ.Safety 1990; 19: 123–134.

[14] Kuehn, R.L., Berlin, K.D., Hawkins, W.E. & Ostrander, G.K. Relationships among petroleum refining, water and sediment contamination, and fish health. J.of Toxicol. and Environ. Health 1995; 46: 101–116.

[15] Mizell, M. & Romig, E.S. The aquatic vertebrate embryo a sentinel for toxins: zebrafish embryo dichorionation and perivitelline space microinjection. Int. J.of Dev.Biol. 1997; 41: 411–423.

[16] Grant, A. & Briggs, A.D. Toxicity of sediments from around a North Sea oil platform: are metals or hydrocarbons responsible for ecological impacts. Mar. Environ. Res. 2002; 53: 95–116.

[17] Jewett, S.C., Dean, T.A., Woodin, B.R., Hoberg, M.K. & Stegeman, J.J. Exposure to hydrocarbons 10 years after the Exxon Valdez oil spill: evidence from cytochrome P4501A expression and biliary FACs in nearshore demersal fishes. Mar. Environ. Res 2002; 54: 21–48.

[18] Clesceri, L.S., Greenberg, A.E. and Trussel, R.R.. Standard methods for the examination of water and wastewater. 17th ed. 1989; APHA, AWWA, WPCF.

[19] Harley, J.P. and Prescott, L.M.. Basic laboratory and culture techniques. In: Laboratory exercises in Microbiology. 2nd Ed. 1993; W.C. Brown Publishers, Dubuque, pp. 14-46.

[20] Sawyer, C.C. and McCarty, P.L. Chemistry or Environmental Engineers, ; McGraw Hill, New York, 1978, pp 331 – 514.

[21] McMullan, G., Poonam, N.S., Franklin, S. and Oxspring, D. Bioremediation and chemical analysis of textile industry waste water. Biotechnol. Lett., 1995; 17: 760-764.

[22] Robinson, T, Chandran, B and Nigam, P. Textile effluent decolorization and dye-adsorbed agricultural residue biodegradation: Biores. Tech. 2002; 84, 299 – 301

[23] Ashok, K., Srivastava, A.K. and Renu, S. Physico-chemical and biological characteristics of a sugar factory effluent. Indian J . Ecol. 1988; 15(2): 192-3

[24] Baruah A.K., Sharma, R.N. and Borah, G.C. (1993) Impact of sugar mill and distillery effluents on water quality of river Gelabil Assam. Indian J. Env. Health 1993; 35(4): 288-93.