

Human Health Implications Due to Water Toxicity by Pulp and Paper Mill

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KEYWORDS Water Toxicity. Pollution Parameters. Pulp and Paper Mill. Health

ABSTRACT This was a case study to observe the environmental pollution of pulp and paper mill with respect to human health problems. A pulp and paper mill namely Vamasdhara at Srikakulam (Andhra Pradesh, India) was visited for observation, data collection and sample analysis for various pollution parameters like *pH*, suspended solids, total solids, COD and BOD. Samples were collected from different units (viz. black liquor from slant screen, brown stock washers (BSW)-1, paper machine back water, thickner filterate, inlet to effluent treatment plant (ETP_{in}), outlet to effluent treatment plant (ETP_{out}) or final discharge) of the mill. Five samples for each site analyzed in duplicate and averages were taken. General health information of a total of 135 mill workers was also observed and obtained through questionnaire/ interview schedule. Mill has high pollution parameters. *pH*, suspended solids (g/l), total solids (g/l), COD (Mg/l) and BOD₅ (Mg/l) for inlet and outlet to ETP are respectively 7.85, 1.83, 7.96, 1744, 686 and 8.3, 1.25, 4.63, 546, 329. Environmental toxicity specially water toxicity due to some of the hazardous pollutants have more effect on health. Hair loss from hands and fingers without nails (partially and fully) and other dermal problems like rashes and itching on hands were noticed in 9 out of 15 workers at secondary fibre recovery plant of the mill. Improvement in design, processing and advancement in eco-friendly technology will not only improve the productivity of mill but the community health also through better utilization of resources, waste disposal and water treatment generated by pulp and paper industry. Further intervention and research is required for development of water supply surveillance and strategies for improvement in environment and community health.

INTRODUCTION

Approximately 400 pulp and paper mills, which generate significant quantities of solid and liquid wastes, carry significant quantities of fiber, fines, filler and other wet end additives that contribute to total suspended solids (TSS), chemical oxygen demand (COD), and biochemical oxygen demand (BOD) exists in India. The present permissible limits of pollution load allowed by Central Pollution Control Board of India in Indian Papers mills are BOD 30 mg/l, COD 250 mg/l (assuming effluent volume generated in bleaching is 100 cubic/ T of pulp) and total chlorine (TOCl) 2 Kg/T of paper. Broad categories of effluents from pulp and paper industry are 8 types of effluents i.e. oxygen demanding substances, disease causing substances, synthetic organic compounds, plant nutrients, sediments radioactive substances, thermal discharges, organic chemicals and mineral substances (Alan, 1993). Both surface waters and ground waters are at risk from pulp and paper industry pollution in rural area. Waste management by environmentally better technologies improves productivity (Mall, 2000). Fly ash being light, gets airborne very fast and pollutes the atmosphere (Swamy, 2000) and water system.

Working community of people and the people living in surrounding areas near industry are affected by the pollution. PCBs through water can enter in fishes which are consumed by humans and cause diseases (particularly cancer). Occupational exposure to PCBs has been associated with modulation of some biochemical activities and adverse health effects, including increased 17- hydroxycorticosteroid excretion and g-glutamyl transpeptidase activity (Emmett, 1985), decreased serum billirubin and increased lymphocyte levels (Lawton, 1985), increased skin diseases such as chlorane, folliculitis and dermatitis, hepatomegaly (Maroni et al., 1981), increased serum cholesterol and elevated blood pressure (Kreiss et al., 1981). These effects vary in incidence and severity among various exposure groups. PCBs can increase frequency of malignancies and increases mortality due to cancers of the gastrointestinal tract, hematologic neoplasms, and increased frequency of lung cancer (Bertazzi et al., 1982). PCB contaminated fish has been linked with impaired neonatal and early infant health (Chatterjee et al., 1998). PCBs can bind with DNA and can create lot of metabolic problems in body physiologically.

During bleaching process, many chlorinated organic compounds viz. adsorbable organic

halogens (AOX), dioxin, 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2378-TCDD) are produced and many of them are not biodegradable as explained by *environmental change and human health*- a Ciba Foundation Symposium jointly with the European Environmental Research Organisation (1993). Dioxins through waste waters enter in fishes which are consumed by humans and have bad effects on health (USEPA, 1994; Silbergeld, 1995; WHO, 1997; Sama et al., 2000). 2378-TCDD, most toxic organic compound, is not degraded by biological mechanisms and causes acne (causes acneform dermatitis complete with blackheads) in man. Dioxins have cellular and molecular actions. TCDD and similar compounds diffuse across the plasma membrane and bind to a cytosolic receptor (AhR). Many physiological impacts of pollutant (Kent et al., 2000) are still unknown. Work-related activities frequently involve exposure to toxic chemicals, most of which are damaging to reproductive health and cause infertility in humans (Wyrobek et al., 1997).

STUDY AREA

A pulp and paper mill namely Vamasdhara Paper Mills Ltd., located at the bank of Vamasdhara River in District- Srikakulam, Andhra Pradesh (India) was visited with an objective of observation, data collection and sample analysis from 24-02-1999 to 15-03-1999. Health problems were assessed of workers and people living in nearby village, called Maddapam, adjacent to mill.

METHODS

Samples for analysis of various pollution parameters like pH, suspended solids, total solids, COD and BOD were collected from different units (viz. black liquor from slant screen, brown stock washers or BSW-1, paper machine back water, thickner filtrate, inlet to effluent treatment plant or ETP_{in}, outlet to effluent treatment plant or ETP_{out} or final discharge) of the mill. COD and BOD were estimated at Central Pulp and Paper Research Institute, Saharanpur (Uttar Pradesh, India); and, rest of the parameters were analyzed at mill itself. Five samples for each site analyzed in duplicate and averages were taken. General health information of a total of 135 mill workers was observed and obtained through questionnaire/ interview schedule. All the mill workers are residents of Maddapam village that is situated within a radius of half kilometer of the mill.

RESULTS

Some important and common pollution parameters of the mill viz. pH, suspended solids (g/l), total solids (g/l), COD (Mg/l) and BOD5 (Mg/l) for inlet and outlet to ETP (Fig.1 and 2) are respectively 7.85, 1.83, 7.96, 1744, 686 and 8.3, 1.25, 4.63, 546, 329. Community health has direct bearing on these parameters and on various levels of air and water pollutants. The toxicity of some of the pollutants is well established on human health. There is dermal toxicity from exposure of various pollutants. Hair loss from

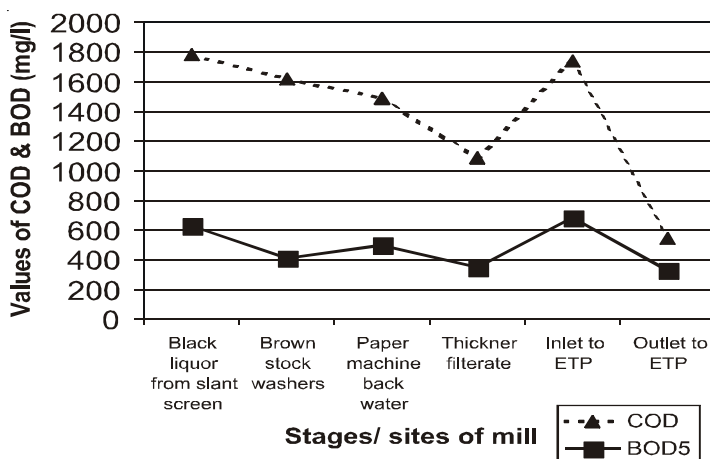


Fig. 1. COD & BOX (mg/l) at various stages/sites for mill.

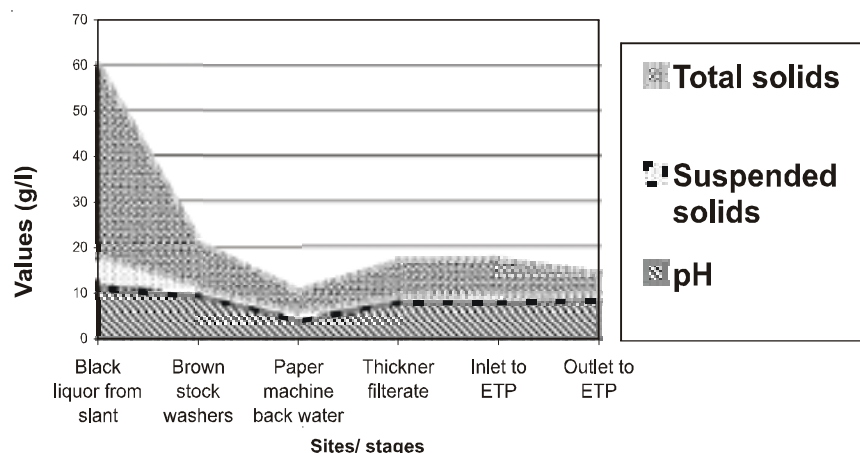


Fig. 1. Total solids, suspended solids & pH at various stages for mill.

hands and finger without nails (fully or partially) were noticed at Vamasdhara Paper Mill (Andhra Pradesh) among 9 persons out of 15 workers working at secondary fibre recovery plant. Moreover, asthma (breathing problem plus other associated symptoms like in asthma is considered as asthma) was observed in 21 workers (14 men and 7 women) and only 8 men and 3 women were smokers; proper smelling ability was lost in 32 workers who are working in the mill from at least last six years for 12 hours daily. Three workers were commonly suffering from both asthma and lost smelling ability.

Final effluent or outlet of ETP is drained into Vamasdhara River which is source of fish for local people. Apart from irrigation, water of river is also utilized for drinking and bathing of domestic animals of villagers. Some of the villagers are also taking bath occasionally in the river. There is no information whether river water is used or not for human consumption. Some of the chemicals like 2378-TCDD can enter human body through fish and interfere with human physiology. Same environmental conditions exit at many Indian pulp and paper mills. Strategies for improvement of water quality to improve water quality of drains/ rivers adjacent to the industry can be a step towards better community health

DISCUSSION

Discharged effluents of Mill were not within limits as prescribed by Central Pollution Control Board, Government of India. BOD and COD are

important parameters for determination of pollution strength of waste water. High chemical contamination means high levels of BOD and COD which permits favorable environment for pathogenic micro-organisms growth. The total and fecal coliforms are the most common parameters tested for ascertaining the bacteriological suitability of water for drinking purposes. The recommended limit is 10 colonies/100 ml. of sample for total coliforms. The provision of an adequate supply of safe water was one of the eight components of primary health care identified by the International Conference on Primary Health Care in Alma-Ata in 1978. As indicated in chapter 18 of "Agenda 21" of UNCED, an estimated 80 % of all diseases and over 1/3 of the deaths in developing countries are caused by the consumption of contaminated water.

The potential adverse impact of the chemicals depends on many factors, including the level and duration of the exposure, the potency of chemicals, the mechanism of action of the chemicals, and interactions among the chemicals that comprise mixtures (Safe, 1998). This makes it difficult to identify the relative contributions of individual substances to the physiologic alterations noted and to determine the degree of toxicity present in environments that contain diverse mixtures and various concentrations of substances and pollutants; however impact of some pollutant is well known. Numerous studies have demonstrated that some environmental toxic agents may have adverse effects on male reproductive system, either by affecting neuro-

endocrine function (Stevens, 1998) or by directly affecting the process of spermatogenesis, resulting in poor semen quality (Robins et al., 1997). In case of occupational exposure to toxics, the workers frequently are exposed simultaneously to different substances (Celis et al., 1996). The most thoroughly studied toxic agents that may have an effect on male reproductive function are several aromatic hydrocarbons (Wagner et al., 1990), certain halogenated hydrocarbons like dibromochloropropane (Whorton and Foliat, 1983), polychlorinated biphenyls (Wassermann et al., 1979), polybrominated biphenyls, some organochlorine compounds like the pesticide kepone (Guzelian, 1982), heavy metals like lead (Assennato et al., 1987), and certain physical agents like ionizing radiation (Ash, 1980). Pollution impact in a pulp and paper mill on workers' health for single pollutant is difficult to evaluate while cumulative effect assessment is easier. It is possible that the observed associations between particles and adverse health effects may be due to confounding by other correlated pollutants and not to the fine particles themselves (Chen et al., 1999; Lipfert and Wyzga, 1999). Some risk factors in smoker and non-smoker workers suffering from asthma were estimated using formulas described by Leon Gordis (2000).

Pulp and paper industry contributes almost all type of pollution i.e. air, water, noise and soil pollution, and therefore all aspects of all type of pollutant have to be studied in details with respect to the health of workers. The inter-relationship between water and sanitation is such that one without the other will have little impact on the health of the workers and community (WHO, 1995). Health policies are chosen on the basis of effectiveness, need, and economic reasoning (Brinkmann and Brinkmann, 1995). There is well established linkage between health, quality, availability and pollution of drinking water supply (Matzer and Moench, 1994). The large fractions of contaminants in cells indicate that PCBs and lindane sorbed to bile, oleic acid, and digestive proteins contributed to the uptake flux towards the cells (Oomen et al., 2001). Neonatal exposure to high doses of organo-chlorines could favour the development of MNU- induced mammary lesions (Desaulniers, 2001). Polychlorinated biphenyls (PCBs), dioxins, and many other chemicals are lipophilic organochlorines, they accumulate in fat, and they are present at the mg to mg/ Kg levels in human tissues and milk (Kannan

et al., 1988; Faroon et al., 1993; Dewailly et al., 1992) confirming direct exposure of the mammary tissues. Sustained high LH levels have been seen in association with exposure to dioxins (Egeland et al., 1994). Effect of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2378-TCDD) doses on humans with respect to body burden is well established.

CONCLUSIONS

To reduce environmental pollution for better health of people and community, efforts should be made at each mill. Toxicity testing can play an important role in implementing all phases of effective control strategies for complex effluents: identifying environmental problems, establishing priorities for pollution control efforts, setting discharge limits for effluents, identifying and implementing appropriate control measures, monitoring compliance with regulatory limits on toxicity. The consequence of controlling effluents without using toxicity test may be significant impairment of some of the most vital designated best uses of water such as drinking water etc. A most effective way to analyze for water pollution and to establish standards for control is an integrated approach based chemical specific standards, biologically based toxicity standards, and hydrological analysis. The concentration at which a specific effluent (or individual chemical) is toxic depends on the period of exposure and toxicity may be acute (short-term) or chronic (long-term). Hence, the magnitude, duration and frequency of exceedance are important parameters for evaluating toxic impact of a pollutant on health. Hence, further research is required to improve the working conditions in Indian mills for better health of workers and community people in surrounding areas.

ACKNOWLEDGEMENT

The author wish to thank Prof. (Dr.) M. Bhattacharya, Head, Department of Community Health Administration, Prof. (Dr.) N. K. Sethi, Director and Dr. P. C. Samantaray, National Consultant, National Institute of Health and Family Welfare (NIHFW), New Delhi; Dr. Almas Ali, Chief Advisor, Population Foundation of India, New Delhi for inspiration and encouragement.

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