CONTROL AND MANAGEMENT OF ENVIRONMENTAL PROBLEMS ASSOCIATED WITH RUBBER INDUSTRIES FOR SUSTAINABLE DEVELOPMENT IN NIGERIA.

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Abstract

White liquid obtained from rubber trees, called rubber latex, is used as a raw material for five intermediate forms of rubber before they are used in downstream rubber product industries. These intermediate products are: Ribbed smoked sheets (RSS), Air Dried Sheets (ADS), Blocks Rubber, Crepe Rubber and concentrated rubber latex. These downstream products of the natural rubber are: rubber tyres, medical gloves, condoms, rubber bands, flexible tubings and a hosts of others. Production of each form of the natural rubber causes environmental impacts or problems such as air and water pollution as a result of the waste associated with the production processes. This paper thus focuses on the hazardous nature of wastes generated during these processes, environmental problems it can cause to man, control techniques and appropriate technologies needed in dealing with the smoke particles and waste problems emanating from rubber industries.

Introduction

In Nigeria, Edo State has been known as one of the largest producers of natural rubber *(Hevea brasiliensis)* for over three decades. This accounts for the location of most of the rubber industries and research institutes within and its neighboring states like Delta and Ondo State. Thailand is known to be world's highest producer of rubber. Rubber latex is the raw material for the production of intermediate forms of rubber before they are used in downstream rubber product

industries. These intermediate products from natural rubber industries are: Ribbed smoked sheet (RSS), Air dried sheets (ADS), block rubber, crepe rubber and concentrated rubber latex (Tekasakul and Tekaakul 2006). The production processes involved in the manufacture of these intermediate products usually give rise to a lot of environmental pollutants. These problems are air and water pollution.

The major pollutants associated with rubber sheets drying factory is the smoke particles from fuel wood burning because of the presence of hazardous components such as polycyclic aromatic hydrocarbons (PAHs) in the particles. The (PAHs) are highly carcinogenic substances and their concentrations have been reported to very high in the work places and this could have adverse effect on worker's health (Furuuchi Tekasakul, Murase and Otani (2006), Tekasakul, Furuuchi, Otani and Sakano, (2005). Problems in rubber latex industries where concentrated rubber latex are produced are particularly water and air pollution while the problem in blocked rubber processing is air pollution (Intamanee, (1997) and Prabnakorn (2000).

Environmental problems in industries that use the various intermediate rubber products as raw materials depends on the type of the product(s).

Environmental Pollution Due to Rubber Processing

Problems in rubber latex industry are particularly water and air pollution, while the main problem in block rubber is air pollution (Intamanee, (1997) and Prabnakorn (2000).

Hazardous Nature of Waste from Rubber Drying Factory

Most large-scale industries and community based rubber factories reside in areas where rubber trees are planted. They use mainly rubber wood as a source of heat to dry the rubber sheet. During the drying process, fresh rubber latex collected in a pool is diluted with water and mixed with formic acid to form solidified slabs. These slabs are then transported in a water rail to a squeezing machine and are squeezed to form thin sheets of about 2-3mm. The raw rubber sheets are then hung on a cart to let the water evaporate and then are dried in a heating room (Tekasakul and Tekasakul (2006).

In Ribbed Smoked Sheets (RSS) production, the rubber sheets are in contact with smoke from rubber wood combustion during the drying process, while in Air Dried Sheets (ADS) production, only heat is used to dry the rubber sheets. Burning of the fresh rubber wood causes a high concentration of smoke particles in the air.

Particulate Matters (Smoke Particles)

These particles cloud the workplace in the factories due to poor ventilation system. Moreover, these can be transported in atmospheric air and may then cause serious environmental concern to the residents or cities nearby (Tekasakul, Furuuchi, Otani and Sakano, 2005).

Tekasakul, Furuuchi, Otani and Sakano, (2005) also studied the size

distribution characteristics of aerosol particles from rubber wood burning and found that the aerosol is dominantly single mode with average mass media aerodynamic diameter (MMAD) of 0.95 micron. The mass concentration of the smoke particles was found to depend strongly on the moisture content of the wood ranging from 1.358 to 47mgm^{-3} for a rubber wood moisture content between 34.5 to 107.5%. The value of total suspended particles concentration (TSP) were also observed to be as shown on table 1.

Table 1: Total Suspended Particles (TSP) concentration at each sample site.

Location	**Tsp (mgm^{-3})**
Sources	1.992
Work space	0.186
Urban	0.067
Urban (Downtown)	0.045

Concentration of particles inside workspace is quite high even though it is within the acceptable limit of 0.330 mgm^{-3} regulated by the United State Environmental Protection Agency (USEPA). The concentration at urban areas are very much within the limits for atmospheric air.

Tekasakul, Furnuchi, Otani and Sakano, (2005) investigated the concentration of ten (10) different polycyclic aromatic hydrocarbons (PAHs) components associated with aerosol particles. These PAHs are Naphthalene, Acenephthalene, Phenanthrene, Flucren, Anthracene, Pyrene, Chrysene, Fluranthracene, Benzo(a) Anthracene and Benzo (a) Pyrene. Smoke particles from fresh rubber wood combustion were found to contain 10-110 times higher portions than in the ambient particles almost regardless of the particle size. This indicates that the rubber wood burning is a serious emission source of PAHs, which are persistent organic pollutants and highly carcinogenic. The PAHs concentration in the work space is still high enough, over ten times higher than that in the ambient for some PAHs components, making the working environments to be highly unsafe to human health as reported by Tekasakul, Furuuchi, Otani and Sakano (2005) on table 2 below.

Table 2: Total Polycyclic Aromatic Hydrocarbons (PAHs) mass fraction in aerosol particles.

Location	**PAHs Mass Fraction Per Unit Particulate Mass**
Sources	0.001-100
Work space	0.012-1.2
Ambient	0.001-0.1

Wastewater from Rubber Drying Factories

Wastewater from rubber sheet production in the rubber factories come from four sources; namely:

- remains of water in the rubber sheets formation containers.
- transporting of the rubber sheets in a water rail to the squeezing machine.

- spraying of the rubber sheets during a squeezing process
- washing of the containers and factory floor.

The wastewater from rubber factories is about 5.2-13.4m^3 of dry products (Boonchuay, 1998). The analysis by Boonchuay (1998) of wastewater from the four sources mentioned above showed that the waste water is acidic because of the use of formic acid during the rubber sheet coagulation process as shown below.

Table 3: Average Values of Waste Characteristics from Rubber Sheet Production in Rubber Factories.

Sources of wastewater.

Property	**A**	**B**	**C**	**D**	**E**
pH	5.0	5.3	5.3	5.8	5.9
Temperature (^{0}C)	26.0	26.7	26.7	26.7	26.3
DO (mgl^{-1})	1.13	0.45	3.92	0.58	2.08
BOD_5 (mgl^{-1})	9.433	3.433	7.019	1.391	4.783
COD (mgl^{-1})	15.069	5.137	11.344	1.928	6.675
SS (mgl^{-1})	164	93	195	525	167
TKN (mgl-1)	162.1	79.5	190.9	60.2	132.0
NH_3-N (mgl^{-1})	85.1	45.0	110.0	28.7	75.9
TP 9mgl^{-1})	21.6	20.0	17.8	19.4	14.9
Sulphate (mgl^{-1})	472.6	225.8	442.2	136.0	188.1
Acidity ($mgl^{-1}CaCO_3$)	986.5	347.8	581.8	130.1	391.7
BOD_5 reading (Kg BOD_5/day	29.4	9.8	5.8	1.0	37.3

Source:(Boonchuary, 1988).

NOTE:

DO = Dissolved Oxygen
BOD_5 = Biochemical Oxygen Demand
COD = Chemical Oxygen Demand
SS = Suspended Solids
TKN = Total Kjeldahl Nitrogen
TP = Total Phosphorus
A = The remainder of the water in the rubber sheets formation containers
B = the water in the transport rail that moves rubber slabs to the squeezing machine.
C = the water used in spraying the rubber sheets in the squeezing machine
D = the water in washing the containers and factory floor.
E = the overall water from the rubber sheet production factory.

The values of **BOD_5, COD, TKN, NH_3-N, TP** and sulphate are extremely high, especially for the remainder of the water in the rubber sheets formation containers. This is because the water leftover in the container contains higher amount of rubber serum than water from other sources and when discharged into water bodies (e.g. river) causes serious water pollution.

Hazardous Nature of Wastes from Rubber Latex Industries

The rubber latex industries are where water and other impurities are removed to up to 40% rubber latex by centrifugation. The concentrated latex is used as raw material for rubber product industries (e.g. rubber gloves). It is usually

treated with ammonia (0.2% or 0.7%), tetramethyltriuran disulphide (TM TD), zinc Oxide (ZnO) and Diammonium phosphate (DAP) to extend its life and remove the magnesium by sedimentation prior to the centrifugation (Tekprasit, (2000). The left over from centrifugation called skimlatex contains 5-10% of rubber content.

Ammonia is removed from the skimlatex and H_2S0_4 is added to recover the rubber prior to the process to make skim crepe or skim block. The skimlatex and wastewater from the skimlatex production contain pollutants and other substances according to Bunnual, Srisuwan, Arrykul and Donteravanich (1995) as shown on table 4. below.

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