Evaluation of Wastewater (Effluent) from Rubber Latex Concentrate for Microbiological and Phyciso-Chemical Properties.

Omorusi, Victor Irogue

Plant Protection Division, Rubber Research Institute of Nigeria, P.M.B. 1049, Iyanomo, Benin City, Nigeria.
omorusirrin123@yahoo.com

Abstract: Samples of effluent (wastewater) of rubber latex obtained from the rubber latex processing stand at the Rubber Research Institute of Nigeria main station, Iyanomo, were investigated for the microbiological quantities, physical and chemical characteristics. The results revealed high total viable counts (TVC) for bacteria ranging from 7.4 x 10^5–2.05 x 10^6 and 1.07 x 10^6–2.13 x 10^6 cfu/ml for the initial and repeat studies, respectively, while the total counts for fungi recorded for the initial and repeat experiments ranged from 1.4 x 10^5–4.6 x 10^5 and 8.6 x 10^4–4.6 x 10^5 cfu/ml respectively, were obtained. The physiochemical concentrations detected in the samples included calcium (4.92mg/l). magnesium (9.15 mg/l), potassium (7.99 mg/l) and zinc 91.50 mg/l). Lead and cadmium were however, not detected in the sample analyzed. The pH (5.29) level indicated acidity of effluents, while a levels of alkalinity (8.50), temperature (32^{o}C), hardness (54.80) and turbidity (62.00mg/l) were recorded. High values of BOD (320 mg/l) and COD (911.00mg/l) were indicative of high oxygen demand for the oxidation of total solids of organic origin. This work provides information on the hazardous nature of latex effluents on the environment and public health, and suggestions on the safe procedure of handling of effluents.

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1. Introduction

In Nigeria, the rubber industry contributes significantly to her economy especially before the advent and impact of petroleum industry. About 40 rubber industries are known to abound in the rubber growing belt of the Nigeria (Momodu, 1993).
Researcher, Increasedactivities of rubber processing industries usually generates large quantities of waste water (effluent) with high concentrations of organic, nutrient and solid mutter (Rakkoed *et al.* 1999). The processing of latex especially in manufacture of materials such as concentrated latex, sim block rubber, RSS & Remillers factories is usually preserved with ammonia. Such process operations generate wastewater bodies including ponds, rivers and streams and soil environment. The volume of effluent discharged relates to the size and capacity of the rubber factory and according to Nordin *et al.* (1989). An average of 45,000 litres of effluent is discharged from a single 20 – 30 mt of rubber per rubber factory daily. It is obvious that industrial effluent discharge constitutes environmental and public health hazard (Ademoroti, 1990; Ogiehor *et al.,* 2000). Sources of wastewater are mainly from washings from receptacles (Tanks, pits, vats) used for acid coagulation of latex, wash water for wet coagula. The constituent of effluents include processed water, small amounts of uncoagulated latex and considered quantities of proteins, sugar, liquid, carotenoids, organic and inorganic salts obtained from the processing of natural rubber latex.

The effluent quality can be determined by measuring its physical and chemical properties such as pH, chemical oxygen demand (COD), biochemical oxygen demand (BOD), solids, nitrogen, sulphate, etc, bacterial and fungal properties. This paper investigates the assessment of the effluent characteristics and implication on the health and environmental status and suggestions on safe procedure of handling natural rubber effluent.

2. MATERIALS AND METHODS

This survey was conducted at the Rubber Research Institute of Nigeria main station, Iyanomo, Benin City, Nigeria. Suitable containers such as chemically resistant glassware, beakers-, were used for collection of effluent samples. Composite samples of effluent for physical and chemical analysis were carried out. Beakers used for sample collection were cleared of contaminants. Heat sterilized laboratory glass bottles were employed for effluent sample collection for microbiological assessment. All samples were obtained from the point of discharge of treated effluent from the factory. Samples for analysis were transferred to Benin – Owena River Basin and University of Benin Joint Analytical and Research laboratory, Ugbowo, Benin City.

2.1 Assessment of viable bacterial and fungal populations in rubber latex effluent.

The procedure for isolating total counts (TVC) for bacteria and fungi involved dispensing lml of latex effluent into 9ml of sterile distilled water for appropriate serial dilution. Portions of 1ml dilutions were taken and pour plated into 20ml of potato dextrose agar (PDA) (Manufacturer – May and baker, England) and nutrient agar (NA) (Manufacturer – International Diagnostic Group pic, United kingdom) in three 9cm Petri plate replications. The media used for the isolation of bacteria and fungi were prepared according to standard methods (Tuite, 1969). The effluent dilutions plated for bacteria and fungal growth were incubated for 24hr and 7 days, respectively under diffused laboratory light and temperature conditions before their examination for viable colony counts. To prevent bacterial growth on PDA plates, streptomycin and penicillin antibiotics, were added to the PDA plates, streptomycin and penicillin antibtotics, were added to the PDP at the rate of 0.2ml of a stock solution per 20 ml PDA (Ayanru, 1982). The composition of the stock solution consisted of 0.1g of streptomycin and 10^6 international units (I.U.) of penicillin added to 20ml of sterile distilled water. The experiment was repeated once.

2.2 Physical – Chemical Analysis

The pH of the effluent sample was determined with the use of a pH meter to ascertain the level of acidity of the effluent. Ordinarily, the effluent obtained is usually acidic as a result of acids used in the coagulation process.

The physical and chemical characteristics of effluent samples from latex concentrate examined included pH, temperature, dissolved solids, hardness, alkalinity, calcium, magnesium, potassium, sodium, sulphate, nitrate, iron, zinc, chemical oxygen demand (COD) and Biological oxygen demand (BOD).

2.3 Total Dissolved Solids

Dissolved solids determination was obtained as residue after evaporation of the effluent filtrate which was after the removal of the materials.

2.4 Sulphate

Sulphate content in effluent sample was determined by the gravimetric method. BaoH solution was added to sample leading to the precipitation of $BaS0_4$. The sulphate content in the effluent was then calculated from the weight of $BaS0_4$.

2.5 Nitrate

The concentration of nitrate in the effluent sample was determined by the colorimetric method (Cottenie *et al.,* 1976). The method involves the addition of sodium salicylate to the effluent sample to form a very intense yellow coloured of sodium pavanitro-salicylate complex. The intensity of the colour was measured at 460nm.

2.6 Other Elemental Concentrations

The concentrations of the following elements in effluent samples including Ca, Mg, K, Na, Fe, Pb, Cd were determined. The sample was initially ashed and residue obtained was dissolved in nitric acid. The atomic absorption spectro-photometer was used in the determination by flame photometry method (llTA, 1979).

2.7 Chemical Oxygen Demand (COD)

The determination of COD involves the procedure for measuring COD value by oxidation of organic matter by refluxing the sample for 2 hours with potassium dichromate and concentrated sulphuric acid in the presence of silver sulphate as a catalyst. Mercuric sulphate was also added to remove chloride interference. The excess of potassium dichromate is determined by filtration with standard ferrous ammonium sulphate using orthophenantholine ferrous complex as indicator. The amount of oxidisable organic matter measured as oxygen equivalent is proportional to the amount of potassium dichromate consumed.

2.8 Biological Oxygen Demand (BOD)

This type of empirical bioassay procedure, involves the measurement of the quantity of oxygen consumed during biological oxidation of organic matter under controlled conditions. The combination of the permanganate-sodium Azide Modification of the Winkler method was adopted for the determination of BOD in the effluent sample. The principle involves the dissolved oxygen determination before and after the incubation period. The difference gave the BOD of the sample after allowance has been made for dilution. The incubation is a period of 5 days at 20^0c (BODs).

The procedure for BOD measurement involves taking a sample and diluting it between 25 to 10,000 lines, depending on the BOD level with specially prepared dilution water. The diluted effluent sample is incubated for the required period after which the organic matter was oxidized with concentrated sulphuric acid and potassium permanganate. Excess permanganate was cleared by reduction with sodium oxalate. Manganese sulphate and alkaline iodine-azide solutions added followed concentrated sulphuric acid. This resulted in the liberation of iodine which was determined on a standard aliquot by titration with standard sodium thiosulphate solution using starch as indicator. The amount of oxygen in the sample is calculated from the amount of sodium thiodulphate used.

3.0 Results

Table 1 shows bacterial and fungal colony counts isolated from samples of rubber latex effluent. Initial and repeat studies revealed high microbial load found in the effluent samples. Bacterial population was found to be higher that that of fungi. The total viable count (TVC) for bacteria in effluent samples ranged from 7.4 x 10^5 – 2.05 x 10^6 and 1.07 x 1.07 x 10^6 – 2.04 x 10^6 Cfu/ml for the initial and repeat studies, respectively. However, the repeat study yielded greater preponderance of bacterial load compared with the initial experiment. For the total viable count of fungi, a similar range of 1.4 x 10^5 – 4.6 x 10^5 cfu/ml for the initial study, and 8.6 x 10^4 – 4.6 x 10^5 cfu/ml for the repeat experiment was obtained (Table 1).

Results of inorganic and heavy metals content detected in the latex effluent analyzed indicated varying concentrations as shown in Table 2. Value of calcium (4.92mg/l), Magnesium (9.15mg/l), Potassium (7.99mg/l), Sodium (2.46 mg/l) and Sulphate (3.40mg.l) with the exception of Nitrate (1.80 mg/l) in trace amount were recorded (Table 2). Concentrations of heavy metals – iron and zinc were detected in trace 0.80 and 1.50mg/l, respectively. However, lead and cadmium were not detected in samples evaluated.

The physical values analysis (Table 2) showed that the Ph of the effluent was slightly acidic (5.29) with acidity revolving round 4.70. High alkalinity level of 8.50 was also detected. High levels of temperature (32.^{o}C), hardness (54.80), turbidity (62.00 mg/l), COD (911.00 mg/l) and BOD (302 mg/l) were recorded in the effluent samples investigated.

4.0 Discussion

The high content of the bacterial and fungal total viable counts (TVCs) in both the initial and repeat experiments is implicative of the level of contamination of the effluent by microorganisms generated from rubber factories and this is attributed to poor sanitary practices by the factory workers. This observation agrees with observations by Ogiehor *et al.* (2000). The impact of the microbial activities on the biota of the receiving body is known to be associated with the disturbance of the equilibrium of the ecology of such receipt body (Ajayi and Osibanjo, 1981; Nemerow, 1978).

The high level of nitrate evaluated in the effluent was due to oxidation of ammonical nitrogen by microorganisms. Ogiehor *et al.* (2000) have reported the presence of nitrate in receiving water which can lead to extensive undesirable algal growth associated with eutrophication. The high sulphate concentration due to the use of the sulphuric acid in the coagulation process of latex concentrate effluent (Ponniah *et al.,* 1976). Also, the high phosphate recorded may be present in the effluents according to Hemence (1958) as inorganic phosphate (ortho-, meta-, pyro- or poly-phosphate) and combined in organic substances. The high sulphate and phosphate concentration detected in the effluents are also known to cause entrophication and algal boom, (Ogiehor *et al.,* 2000). The implication is the drastic reduction of photosynthetic activities of biota in the receiving water due to impairment of sunlight into the water body.

The high values of BOD and COD recorded is indicative of the presence of total solids in the effluents which are known to be of organic with high oxygen demands for their oxidation under required conditions of temperature and oxidants and time, as a result, will naturally lead to the depletion of dissolved oxygen in water body. In addition to BOD and COD, the levels of turbidity and hardness of the effluents are implicated in the reduction of oxygen and light penetration, production of offensive odour from microbial activities. These observations are consistent with the report of Ogiehor *et al.* (2000).

The pH recorded showed of the low level of pH which is usually due to the use of acids in the coagulation of latex. The low pH is also known to be responsible for the low and high counts of fungi and bacteria, respectively, similar to observations of Ogiehor *et al.* (2000).

The decomposable nitrogenous organic matter serves as an appropriate indication of high amount of nitrogen (Nitrate) in the rubber latex effluent.

5.0 Conclusion

The level of activities of microbial quantities, the physiochemical characteristics of the latex effluents with high organic nature, together with BOD and COD point to the fact of the effluent susceptibility to biodegradation. The consequent of these would require some precautionary measures such as the development facilities designed for the removal of nitrogen in the treatment of rubber wastewater as noted by Rakkoed *et al.* (1999) as well as the regional high level of toxic heavy metals treatment, are imperative at ensuring safe rubber latex effluent standards to be achieved in accordance with the World Health Organization (WHO) specifications.

Table 1: Microbial Count (Cfu/ml) in rubber effluent sample

NO. A ASS	No of Bacteria		Rubber Effluent Treatment Bacteria		Fungi i	
	A^{x}	B	C	A	B	C
Initial Experiment						
1.	1.56 x 10^{6y}	1.44 x 10^{6}	2.05 x 10^{6}	1.7 x 10^{5z}	14 x 10^{5}	3.0 x 10^{5}
2.	8.6 x 10^{5}	7.4 x 10^{5}	1.28 x 10^{6}	2.9 x 10^{5}	2.7 x 10^{5}	3.5 x 10^{5}
3.	9.7 x 10^{5}	1.07 x 10^{6}	1.61 x 10^{6}	3.1 x 10^{5}	2.9 x 10^{5}	4.6 x 10^{5}
Repeat Experiment						
1.	1.56 x 10^{6y}	1.43 x 10^{6}	2.04 x 10^{6}	1.1 x 10^{5}	8.6 x 10^{4}	1.9 x 10^{5}
2.	1.66 x 10^{6}	1.45 x 10^{6}	2.13 x 10^{6}	2.8 x 10^{5}	2.6 x 10^{5}	3.4 x 10^{5}
3.	1.27 x 10^{6}	1.07 x 10^{6}	2.02 x 10^{6}	3.1 x 10^{6}	2.9 x 10^{5}	4.6 x 10^{5}

x Replicate samples (Three samples each replicate).
y Total viable count (TVC) of bacteria in replicate sample (cfu/ml) in 9-cm on PDA
z Total fungal count in replicate sample (Cfu/ml) in 9-cm on nutrient high.

Table 2: Elemental and Heavy Metal Concentrations and physicochemical Parameters in Rubber Latex Effluent Samples Parameters (mg/l)

Elemental Conc. (mg/l)								Heavy metal conc.(Mg/l)			
Ca	Mg	K	Na	So4	P0	N0		Fe	Zn	Pb	Cd
4.92	9.15	7.99	2.46	3.40	1.10	1.80		0.80	1.50	ND	ND

Physiochemical Parameters

pH	Temp	Conductivity Us Cm^{-1}	Hardness (mg/l)	Alkalinity (mg/l)	COD (mg/l)	BOD (mg/l)	Turbidity (NTU)	Acidity (mg/l)	Organic Carbon (mg/l)
5.29	32^{o}C	0.04	54.80	8.50	11.00	320	62.00	4.70	0.78

REFERENCES

1. Ademoroti, C.MA (1996).Environmental Chemistry and Toxicology Foludex Press, Ibadan 201 PP.
2. Ajayi, S.O. and Osibanjo. (1981) – Pollution studies on Nigerian River.
3. II: Water quality of some Nigerian Rivers. *Environmental pollut.* (Senes B) 2:87 – 95.
4. Ayanru, D.K.G. (1982). The control of damping off of cotton seedlings by Fungicidal seed treatment. *Niger. Agric. J.* 17/18**:**63-72.
5. Conttenie, A; Diaese, A. and Velghe, C. (1976). De Chemische Analyse Van Water. Riiksuniversiteit Gent. 65pp.
6. Hemence, J.H. (1958), recommended methods for the analysis of trade effluents. The society for Analytical chemistry, London. 124pp.
7. International Institute of Tropical Agriculture (IITA). (1979). *Annual Report* for 1979, Ibadan, Nigeria. 152 pp.
8. Momodu, I.O. (1993) Environmental Polluting by Rubber Industry. Paper presented at the Export Commodities Co-ordaining Committee (ECCC). Export Commodities Conference, 1993.
9. Nemerrow, N.L. (1978). Industrial Water Pollution. Origin characteristics and treatment. Addison-Wesley Publishing Coy.Reading Massachusetts, U.S.A. 263pp.
10. Nordin, A.A; Kadir, B.M. and Karimi, A.B. (1989). Treatment of Rubber Effluent with High Rate Algal Pond. Proc. Rubber Research Institute of Malaysia. PL TRS Conference, Kuala Lumpur.
11. Ogiehor, I.S; Momodu, I. O. and Ize-Iyamu, K.O. (2000). Characterization of effluent produced by rubber factories in some selected towns of Nigeria. *Tropical Journal of Environmental Science & Health 3* (1) : 24-28.
12. Ponniah, C.D; John C.K. and Henry, L. (1976). Treatment of Effluent from latex concentrate factories: Preliminary Report. Proc. Rubber Research Institute. Malaysia Pirs' Conf. Kuala Lumpur 310-322.
13. Rokkoed, A; Danteravanich, S and Puetpaiboon, U. (1999). Nitrogen Removal in attached growth waste stabilization ponds of wastewater from a rubber factory. *Wat Sc. Tech.* 40 (1); 45-52.
14. Tuite, J. (1969). Plant Pathological Methods. Burgess Publishing Co. Minn. USA. 239 pp.

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