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Determination of the Concentration of Total Cyanide in Waste Water of a Tobacco Company in Southwestern Nigeria

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ABSTRACT: Cyanide has been listed as one of the toxic pollutants that is usually released into the environment. Cyanide is said to be released during the processing of cyanogenic plant parts which tobacco plant is one of them. This work determines the concentration of total cyanide in waste water collected in and around a tobacco company. Distillation was carried out followed by spectrophotometric analysis with pyridine-barbituric acid as the colour forming reagent and absorbance was measured at 578nm using UV-Visible spectrophotometer. The result revealed total cyanide in each sample as follows (mg/l): 0.641 $\pm$ 0.004, 0.443 $\pm$ 0.007, 0.319 $\pm$ 0.007, 0.184 $\pm$ 0.001 and 0.403 $\pm$ 0.004, for untreated wastewater sample, treated waste water sample from the factory, Lake water sample beside the factory where the effluent is released, upstream and downstream of a river located about 1km away from the factory, respectively. Highest value was recorded for sample collected from down-stream of the river while, sample collected from the upstream have the minimum level. The levels are significantly higher than the maximum permissible levels recommended by WHO (0.2mg/l), European Union and National Agency for Food, Drugs and Administration Control (NAFDAC) (0.001mg/l) at P=0.05. Based on these findings, water from the lake and river beside the factory may not be good for drinking. @JASEM

Keywords: Cyanide, tobacco, waste water, colorimetric determination.

Cyanide refers to all the CN^- groups in cyanide compound that can be determined as the cyanide ion, CN^- . Many chemical forms of cyanide are present in the environment, including free cyanide, metallocyanides complexes and synthetic organocyanides called nitriles. Free cyanide (molecular hydrogen cyanide HCN and cyanide ion CN^-) is the primary toxic agent. . Cyanide is listed among the 65 toxic pollutants in the Effluent guideline and standards given in title 40, section 400-475, of the code of federal regulations (*Code of Federal Regulations* ,2008). Though cyanides in environment have been attributed to industrial processes such as; chemical processing industries, steel and iron industries, metallurgical industries, metal plating, finishing industries and petroleum refineries (Brandl,2005). Exposure to cyanides can also occur through tobacco smoke. When the ingredients in tobacco cigarettes are burned, they produce a whole host of chemical compounds, many of which are poisonous and carcinogenic. Hydrogen cyanide, a colourless, poisonous gas, is one of the toxic by products present in cigarette smoke.(Terry Martin, July 09,2008. www.About.com, Health Disease and Condition.) Cyanides has been said to be formed by the combustion of cyanides – releasing substances like tobacco (Brandl, 2005) Cyanide has been reported to be released during the processing of cyanogenic plant parts which tobacco plant is one of them (Bak et al., 2006; Brandl, 2005). The precursors of HCN in smoke are predominantly tobacco nitrate and proteins. It has been reported that effluents from the processing of cyanogenic plant parts contain a mixture of cyanide glycosides, and cyanohydrins (Bak et al., 2006).

Certain strains of *Pseudomonas fluorescens*, a soil bacterium, suppress black root rot of tobacco caused by the fungus *Thielaviopsis basicola* by excreting several metabolites, including Hydrogen cyanide (HCN) (Brandl, 2005). Tobacco smoke has been found to contain about 10-400µg/CN^{-1} per cigarette in main stream and 0.006 – 0.27 µg /CN per cigarette, in side stream (ATSDR, 2006). Cyanides concentrations in blood greater than 0.2mg/l is expected to result to death (ATSDR,2004).Cyanide, an environmental contaminant, can cause serious health effects including goitres, hypothyroidism, and some neuromuscular diseases (ATSDR 2006).

Intoxication of cyanide deprives the body of oxygen by acting as a chemical asphyxiant (Stanley, 1992).Tissues with high metabolic activities especially the nervous system, are therefore most vulnerable to oxygen deprivation. Exposure to high levels of cyanides for a short period harms the central nervous system, respiratory system and cardiovascular system (ATSDR 2006), which can lead to coma and even cause death (ATSDR 2004). Total cyanides in waste water has been analysed directly or transferred to another matrix as HCN (APHA. 1998; E.P.A., 1994). General methods mostly used when dealing with HCN include titration of cyanides with silver nitrate , spectrophotometry methods, ion-selective electrodes, ion chromatography (Bradbury et al., 2009) etc.

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Due to the toxicological effect of cyanide especially the cyanide released from tobacco, it becomes pertinent that the level of cyanides in waste water of Tobacco Company be studied.

The aim of this study is to determine the level of total cyanides in both treated and untreated waste water of a Tobacco company and to ascertain how effective is the treatment system of the company in reducing cyanide levels in their waste water below the maximum recommended levels. This work is considered significant to Tobacco Company, regulatory authorities, researchers as well as general public.

MATERIALS AND METHODS

Sampling: The sampling site was a tobacco company situated along the Lagos – Ibadan expressway in Southwest Zone of Nigeria. Sampling were carried out in rain (June) and dry (January) seasons. Five duplicate samples were collected for each season. Each sample was collected in polyethylene bottle (750ml) which has been previously washed, rinsed thoroughly with distilled water and dried. Two samples were collected from the waste water treatment. The third sample was collected from a pond beside the company which is the point of discharge of the company effluent. The fourth and fifth samples were collected from a river which is about 1km from the company; one upstream before the water from the pond discharged into the river and the other was collected downstream after the pond discharge into the river. The water samples are preserved at the time of collection with NaOH to a PH ≥12 and were transported to the laboratory in an ice bag. The samples were preserved in refrigerator in the laboratory where they were analyzed within 14 days after the time of collection.

Laboratory Analysis: The EPA (1994) and APHA (1998) approved methods for the determination of total cyanide in waste water was adopted. Distillation was first carried out followed by the addition of pyridine-barbituric acid to give a red-blue coloured complex and the absorbance was measured in a UV-spectrophotometer at 578nm. This method has very low detection limits, making it ideal for the analysis of cyanide in waste water. Quality control was carried out using blank determination and recovery study.

RESULT AND DISCUSSION

Levels of cyanide analysed in waste water collected from the Tobacco company were recorded in Table 1 for the two seasons. Highest value was recorded for sample collected from down-stream of the river while, sample collected from the upstream have the minimum level. The percentage difference between cyanide concentration in rain and dry seasons was found to be highest for sample collected from downstream of the river, followed by sample collected from waste water tank of the company before treatment while sample collected from upstream of the river have the lowest percentage difference.

Table 1: Mean levels of total cyanides in the samples (Rain and Dry seasons)

Sample	Location of sampling	Mean concentration Of CN (mg/L) Rain Season	Dry Season	% Difference in CN- Level
I	Waste water before treatment	0.646 ± 0.007	0.719± 0.008	10.1
Ii	Waste water after treatment	0.441± 0.003	0.471 ± 0.001	6.37
Iii	Sample from pond.	0.320 ± 0.001	0.329 ± 0.001	2.74
Iv	Sample from river (upstream)	0.187± 0.004	0.191 ± 0.006	2.09
V	Sample from river (downstream)	0.408± 0.007	0.512± 0.001	20.3

Table2: ANOVA cyanide level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.537	4	.134	115.998	.000
Within Groups	.017	15	.001		
Total	.554	19			

There were no significant difference when the levels of cyanide in rain season were compared with the levels in dry season using T-test except for samples 1 and 4 in which the level in dry season are more than the levels in rain season. Levels of cyanide in lake and the river samples were also compared with permissible levels of cyanide in surface water. It was found that these levels exceed the permissible levels, indicating that water from these sites may not be good for drinking. The level of cyanide in the effluent from the company correlates with the levels in lake and river samples meaning that the cyanide in the lake and river water samples may be from the effluent released from the factory. Also, considering the efficiency of the treatment system of the tobacco company in removing cyanide from their waste water sample. Paired –t-test was used to compare cyanide levels in the treated and the untreated water samples. Average percentage efficiency was found to be 68%. It could be deduced that the treatment system of the tobacco company is able to remove cyanide from their waste water at an efficiency of 68% but not so effective to reduce it below the recommended level in surface water. The level of cyanide in the downstream of the river is higher than the level in the upstream of the river. This implies that cyanide might have been introduced or released into the river from other sources e.g. run-off from the processing of cassava tuber (Bradbury, 2009) or run-off from land where cyanide containing pesticides have been applied (ATSDR 2006, 18).

Conclusion: This work have shown that cyanide is present in waste water generated by tobacco company in appreciable amount and that colorimetric method after reflux distillation is effective in determining the presence of cyanide in this waste water. The treatment system of the company is 68% efficient, in removing cyanide from their waste water but its not able to reduce it bellow the recommended permissible levels in surface water.

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