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BACTERIOLOGICAL AND PHYSICO-CHEMICAL QUALITIES OF WASTE WATER FROM A BOTTLING COMPANY IN OWERRI, NIGERIA.

VINCENT I. IBEKWE, OGUERI NWAIWU and JOY O. OFFORBUIKE

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ABSTRACT

Waste water in the accumulation pond and final discharge point of Nigerian Bottling Company PLC in Owerri, Nigeria was analyzed to determine their bacteriological and physico-chemical characteristics. Species of organisms isolated included *Staphyloccus, Bacillus, Lactobacillus,* and *Streptococcus*. Others include *Klebsiella, Escherichia, proteus* and *serratia*. However, species of *Lactobacillus* and *proteus* were isolated from the final discharge point only. Bacterial count after 72 hours was higher with a maximum count of $6x10^7$ cfu/ml in the final discharge point. The waste water from both points were clear and had the same residual chlorine (1ppm) and iron (1ppm) concentration, while the accumulation pond showed more acidity with a pH of 6.6±1.2. The final discharge contained more dissolved solids (20±1.8ppm) which was double that of the accumulation pond (10±2.2ppm). It was also found that dissolved oxygen was slightly higher (6.0±.26mg/ml) in the final discharge point than accumulation pond (5.0±.33mg/ml). Results of this study were found to be within the permissible limits for effluent discharge specified by the Federal Ministry of environment in Nigeria.

KEYWORDS: Waste water, bacteriological characteristics, physico-chemical characteristics, accumulation pond, final discharge point.

INTRODUCTION

The pressure of increasing population and developing economy all over the world and the present situation of water quality management is far from satisfactory (Huang and Xia, 2001). Water pollution is usually by chemical, physical or biological substances generated by construction, production and operations that affect natural conditions of water or its intended use for the environment (Igbokwe and Mba, 1997). Non-degradable waste which cannot be broken down by organic and inorganic action can be generated from different manufacturing process. Catastrophic events can occur from consumption of fish contaminated with industrial effluent (Nwaedozie, 2000).

As long as assimilation capacity of a receiving water body system, land or air exceeds the pollution load, the importance of environmental degradation would not be readily appreciated because the system would always purify itself (Maduemezia *et al.*, 2002). Hence the need for environmentally sound technologies for management of waste in food and beverage industries especially now that environmental protection is a source of global concern (Idowu, 2000).

The aim of this work therefore, was to determine the quality of waste water released into the environment by Nigerian Bottling Company PLC, Owerri, Nigeria, in order to ascertain environmental safety on release of its waste water.

MATERIAL AND METHODS

Sample Collection

Samples were collected from two main waste water points in the Nigerian Bottling Company, Owerri situated at plot 326 of the Owerri industrial layout. They include accumulation pond where the waste water is collected, and the final discharge point from where the effluent flows into the environment. The accumulation pond is inside the factory and the effluent collected undergoes sedimentation before flowing to the final discharge. It is cemented to avoid contact with the soil and chlorinated daily. The final discharge located outside the factory, flows on bare soil inside a shallow drain for more than 50 meters before entering the drainage system of the industrial network.

Samples were collected in duplicates with sterilized conical flasks from five different points in the accumulation pond. Also samples were collected from the discharge point and four other points, ten meters apart in the drains leading to the industrial network. Samples were covered with aluminum foil immediately after collection. Bacteriological and physico-chemical tests were carried out within one hour after collection.

Isolation, Count and Identification of Bacteria.

Isolation of bacteria was done using the membrane filtration method as described in laboratory standard operating procedure document of Nigerian Bottling Company (NBC, 2002). The colonies that emerged were sub-cultured and identified using biochemical tests as described by Cheesbrough (1985).

VINCENT I. IBEKWE, Department of Industrial Microbiology, Federal University of Technology, Owerri, - Nigeria
OGUERI NWAIWU, Department of Industrial Microbiology, Federal University of Technology, Owerri, - Nigeria
JOY O. OFFORBUIKE, Department of Industrial Microbiology, Federal University of Technology, Owerri,- Nigeria

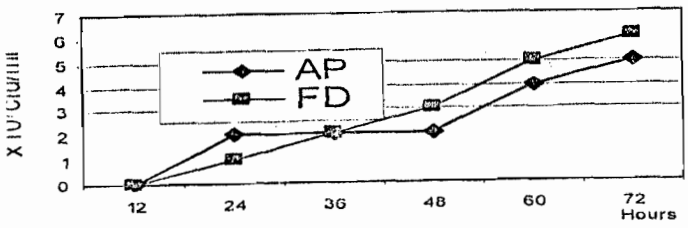

Fig. 1 Bacterial count of waste water from accumulation pond and final discharge

TABLE 1:

PERCENTAGE OCCURRENCE OF ORGANISMS ISOLATED FROM WASTE WATER OF ACCUMULATION POND AND FINAL DISCHARGE.

PROBABLE ORGANISM ISOLATED	ACCUMULATION POND	FINAL DISCHARGE
Staphylococcus species	80	60
Bacillus species	40	40
Lactobacillus species		100
Streptococcus species	20	40
Klebsiella species	100	80
Escherichia species	80	80
Proteus species	-	10
Serratia species	40	60

Physico-chemical analysis
The physicochemical analyses carried out include pH, color. Iron, chloride, dissolved oxygen (DO) and total dissolved solids (TDS).

Total Dissolved Solid and pH
Total dissolved solids (TDS) and pH were measured with HANNA test meter (HI 9812 PH-EC-TDS). A 100ml of the sample was poured into a clean beaker. The meter probe was dropped into the beaker. The instrument was set on TDS mode. Value displayed was recorded for total dissolved solids in parts per million (ppm). Without removing the probe the instrument was then switched to pH mode. Value displayed was also recorded for pH.

Chlorine and Iron Content
A colour comparator (Lovibond) was used to measure chlorine and iron content.

Dissolved Oxygen (DO)
A dissolved oxygen kit (HACH) was used to determine DO of accumulation pond and final discharge waste water.

Color
The sample was collected, poured into a sterile beaker and observed under tensor light (intense light) for color.

RESULTS

The results of this work show that eight organisms were isolated which included probable species of *Staphylococcus*, *Bacillus*, *Lactobacillus*, *Streptococcus, Klebsiella, Escherichia, Proteus* and *Serratia*. However, *Lactobacillus* and *Proteus* species were not isolated from accumulation pond (Table 1)

In both samples *Klebsiella* specie was the most dominant organism. It occurred more in accumulation pond than in the final discharge. The least occurring organism was *proteus* specie which occurred only in the final discharge. Also *Lactobacillus* only, was isolated in all the plates of final discharge.

It was observed that *Escherichia coli* and *Bacillus* species appeared in equal proportion in both effluents while *Serratia* specie appeared more in final discharge than in the accumulation pond and *Staphylococcus* specie more in accumulation pond than in final discharge.

Higher Bacterial count was seen in the final discharge than in accumulation pond (Fig 1). A short lag phase was observed for both effluents. Growth of organisms was observed 24 hours after incubation. Bacterial count of the final discharge was observed to be highest at the point of discharge (Fig 2). The count decreased after 10 meters but at 40 meters distance, the count increased.

The effluent was observed to be clear and colourless in both samples (Table 2). The pH of final discharge was more alkaline than that of accumulation pond. Chlorine and iron content were the same for both effluents. TDS was higher in the final discharge showing that it contains more solutes than the accumulation pond. Also DO was higher in final discharge.

DISCUSSION

All the bacteriological and physico-chemical results obtained in this study are within the range of observations made by Maduemezia *et. al.* (2002) that carried out a similar work in the same environment.

The higher bacterial count and the greater number of species in the final discharge may be attributed to its contact with soil. While the drains leading into the accumulation pond are cemented, that of final discharge is not. It flows directly on soil. It is possible that a lot of

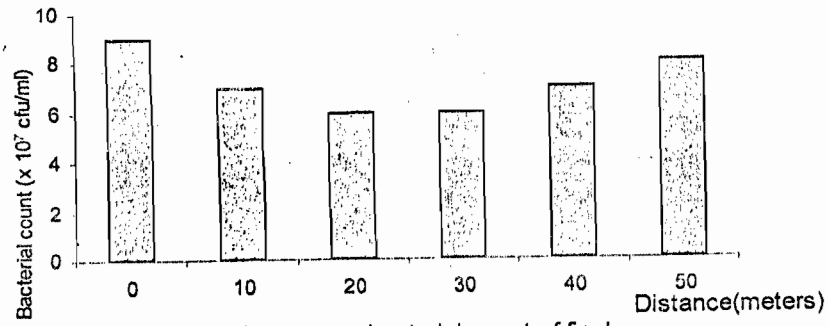

Fig.2. Effect of distance on bacterial count of final discharge waste water.

TABLE 2: PHYSICO-CHEMICAL PARAMETERS OF WASTE WATER

	COLOUR	pH	DO (mg/ml)	CL (ppm)	Fe (ppm)	TDS (ppm)
ACCUMULATION POND	Clear	6.6±1.2	5.0±.33	1.0±0	1.0±0	10±2.2
FINAL DISCHARGE	Clear	9.1±1.1	6.0±.26	1.0±0	1.0±0	20±1.8

KEY: DO = Dissolved oxygen; CL = Chlorine; Fe = Iron; TDS = Total Dissolved Solids.

soil microorganisms passed from the soil into the effluent of the final discharge. The soil contains a variety of living organisms and bacteria are the most numerous soil inhabitants ranging from fewer than a thousand to several million per gram of soil (Nester, *et al.*, 1983).

The decrease in the bacterial count of the final discharge after a distance of 30 meters from the company as shown in (Fig.2) may be due to leaching out of nutrients from the effluent into the soil (Nester *et. al.*, 1983). Again in adapting to a new environment, organisms sometimes show a short lag phase before going on to a rapid exponential growth (Cheesebrough, 1985). The increase thereafter is probably due to microbial succession.

The presence of *Proteus* and *Escherichia* species indicate faecal contamination, which is undesirable in portable or recreational water (Gabelli, 1983). Since the septic tanks in the company do not empty into the drains, it is possible that these coli are free living. Gauthier and Archibald (2001) isolated ten strains of *Escherichia coli* from paper mill water without faecal input and found them to be non-toxigenic free living harmless serotypes. However faeces from insects, birds and lizards seen in the vicinity may be responsible.

The pH of final discharge was less acidic than that of the accumulation pond. It is likely that the accumulation pond had higher $C0_2$ content than the final discharge since it had lower dissolved oxygen. Carbon dioxide can increase acidity (Camp and Messerve, 1974). The higher pH values for the final discharge may be attributed to dilution effect of increased water resulting from rainfall and influx of carbonates from runoff (Ogbeibu and Victor, 1989).

Mackenthun (1969) reported that a pH less than 5 might reduce the productivity of aquatic life while Igbokwe and Mbah (1997) suggested an optimum pH value of 6.7 to 8.6 for survival of fish. This is close to what was obtained for this work as shown in table 2.

Chlorine content was the same for both effluents indicating that the increase in acidity in the system by the formation of hypochlorous acid was minimal. The presence of high level of free available chlorine in water is not desirable because it can react with ammonia and phenol to form chloramines and chlorophenol (Nester *et al.*, 1983). The chlorine values obtained for this work are within Federal Ministry of Environment Limits (Maduemezia, *et al.*, 2002).

The dissolved oxygen of the final discharge observed to be higher than that of accumulation pond is beneficial. Moderately high dissolved oxygen is necessary for the maintenance of healthy aquatic ecosystems and particularly for the most prized game fish such as salmon and trout (Dunne and Leopold, 1978). Alabaster and Lloyd (1974) suggested a minimal value of 5mg/ml to maintain good fish population. The results of this work are within the range.

Camp and Messerve (1974) reported a TDS level not greater than 100 mg/ml for most industrial and domestic water effluent. The TDS observed in this study is well within this range showing that there are few non-filterable or dissolved substances in the effluent water.

No doubt, it has been observed that industries are source of power to the society. In particular food, beverage, breweries and bottling industries in Nigeria are a great asset to the socioeconomic needs of the people. However, they can equally constitute a serious threat to the survival of the human race if care is not taken to control, regulate and monitor their waste disposal activities.

It is recommended that other industries should emulate the good environmental management system of Nigerian Bottling Company. In other to ensure full compliance, government must enforce the submission of environment audit report of all industries every year.

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