

ANALYSIS OF TANNERY EFFLUENTS FROM THE CHALLAWA INDUSTRIAL ESTATE IN KANO, NIGERIA.

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ABSTRACT

Many tanneries are located at Challawa Industrial Estate in Kano. These tanneries discharge their effluents into canals which converge at a point and eventually flow into the Challawa river. Tannery effluent was collected from the effluent confluence point at Challawa Industrial Estate and some physicochemical parameters such as conductivity, solids, chloride, chromium, alkalinity, sulphide, chemical oxygen demand, COD, and biochemical oxygen demand, BOD, of the waste water were determined. The concentrations of these parameters were in each case, higher than the limits set by the Federal Ministry of Environment (FMEEnv) for discharge of effluents by the Tannery Sector. The tannery effluents from Challawa Industrial Estate pollute the Challawa river in Kano.

KEYWORDS: Tannery, Effluent, Pollution, Environment.

INTRODUCTION

Industries are an important source of environmental pollution and satisfactory treatment and disposal of industrial effluent are necessary for a healthy environment. The discharge of untreated effluents into streams and rivers depletes dissolved oxygen and destroys aquatic life. It renders streams and rivers unsuitable for community water supply and for other beneficial uses (Lawal and Singh, 1983).

The leather industry is an important contributor to environmental pollution. It has been estimated that out of 1000kg of raw hides processed, only 150kg of leather is produced. Other products obtained include, 150kg of splits, 700kg of solid waste and 30m³ of effluent containing 400kg of dissolved and suspended waste. Out of this huge amount of tannery waste chromium salt is considered to be the most harmful (Chattopadhyay et al, 2000). Tannery waste water is regarded as one of the most polluting of all industrial waste waters (Prasad et al, 1981) and studies on pollutants in the Nigerian tannery waste water have been reported (Lawal et al, 1986; UNIDO, 2003). These include heavy metals such as chromium, copper, arsenic, lead, zinc and iron. Other pollutants such as phenols, ammonia, sulphates and chlorides are also identified. These pollutant contribute considerably to the depletion of oxygen in the receiving fresh water ecosystem.

Most of the tanneries in Kano are located in Challawa and Sharada Industrial Estates. These tanneries discharge their effluents into canals that run into an important river, Challawa, which is used for irrigation, fishing and drinking. Some tanneries in Kano have installed primary effluent treatment plants while many others have not done so. The aim of this work is to investigate periodically, the level of tannery effluent pollution from the Challawa effluent confluence point and also to determine the extent to which non-compliance to the Federal Government's Effluent Limitation Guidelines, by the Tannery Sector, contributes to environmental pollution in Kano State.

MATERIALS AND METHODS

A sampling point was marked out at the Challawa effluent confluence point and waste water samples were collected from that point in 5-litre plastic containers with screw caps. Immediately after collection, the composite samples were placed in cool boxes containing frozen ice packs to maintain low temperatures. The samples for BOD determination were collected separately in air-tight bottles. The samples were taken to the National Research Institute for Chemical Technology Pollution Control Laboratory Kano, for analyses according to standard methods (APHA-AWWA-WEF, 1992). Field sampling was carried out twice in a month, at the beginning and in the middle of each month. This study was carried out between the months of January and March 2005.

Total chromium was determined by Atomic Absorption Spectrophotometer (Unicam 969) using a Chromium Hollow Cathode Lamp in default condition and flame absorption mode.

RESULTS AND DISCUSSION

SULPHIDE

The lime Sulphide process, for many decades, has been used for the manufacture of leather due to its effective unhairing and consistent quality leather obtained at relatively low cost (Basford, 1983). The need to dispose of the toxic sulphide waste, however, constitutes a major industrial problem (Sykes et al, 1991). The concentration of sulphide in the effluent, Fig. 1, decreased from an initial value of 1200 mgdm⁻³ to a value of 120 mgdm⁻³ in January. It increased uniformly from 120 mgdm⁻³ to 510 mgdm⁻³ between January and February and thereafter decreased uniformly to 40mgdm⁻³ between February and March. Thus, the sulphide concentration decreased by 900% of its initial value in January, it increased by more than 300% between January and February and finally decreased by more than 1000% between February and March. Sulphide content has its

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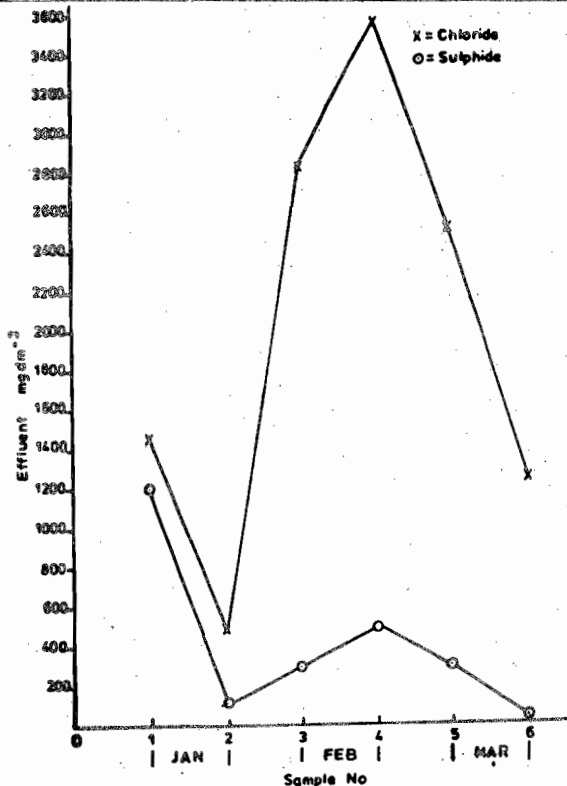


FIG. 1: VARIATION OF CHLORIDE AND SULPHIDE BETWEEN JANUARY AND MARCH

highest value of 1200 mgdm⁻³ in January and its lowest value of 40 mgdm⁻³ in March with a Mean value of 413 mgdm⁻³ and Standard Deviation of 418 mgdm⁻³. Hence sulphide value decreased by 29 times between January and March. From Fig. 1, the unhairing of hides and skins appears to take place mainly in January and hence a high sulphide content in the effluent was obtained in January.

The sulphide values obtained were high compared to the limits (1.0 mgdm⁻³) set by the Federal Ministry of Environment, (FMEEnv). Studies by Steven (1983) and UNIDO (2003) have shown that if the pH value of the effluent is reduced to about 8.5, hydrogen sulphide may be released and this may be very toxic and give rise to highly objectionable odour. When discharged into a stream, sulphide levels of about 8 – 10 mgdm⁻³ can cause fish mortality.

CHLORIDE

Chloride inhibits the growth of plants, bacteria and fish in surface waters and high chloride levels can lead to the breakdown of cell structure. If used for irrigation, surface salinity increases through evaporation and crop yield may fail. When flushed from the soil by rain, chloride re-enters the ecosystem and may ultimately end up in the ground water (UNIDO, 2003).

The effluent Chloride value decreased from 1471 mgdm⁻³ to 496 mgdm⁻³ in January, (Fig 1), and increased substantially to 3563 mgdm⁻³ in February. The value decreased from 3563 mgdm⁻³ to 1250 mgdm⁻³ between February and March. Thus, chloride concentration declined in value by 197% in January but increased in value by over 600% between January and February and finally decreased by 185% between February and March. Chloride has its highest value of 3563 mgdm⁻³ in February, which is 142% higher than its initial value in January, and its lowest value of 496 mgdm⁻³ was obtained in the middle of January. Apart from this lowest value of 496 mgdm⁻³, all the other values obtained were higher than the maximum limits (500 mgdm⁻³) set by the FMEEnv. Chloride had a Mean value of 2030 mgdm⁻³ and a Standard Deviation of 1148 mgdm⁻³.

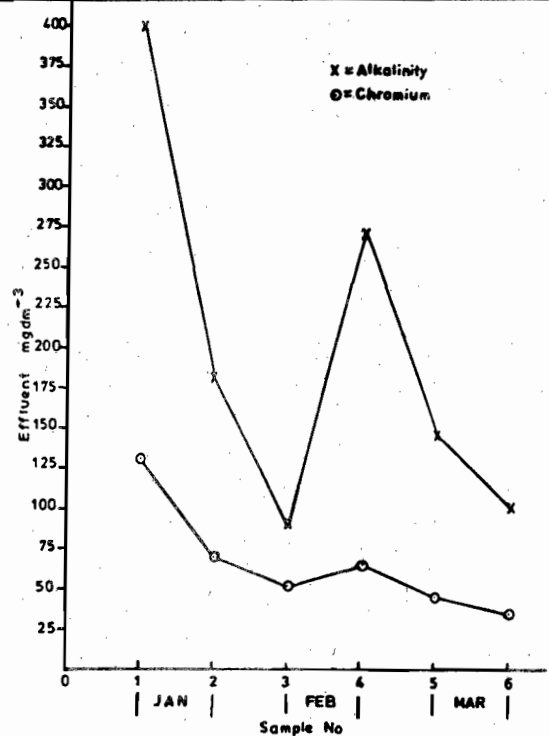


FIG. 2: VARIATION OF ALKALINITY AND CHROMIUM BETWEEN JANUARY AND MARCH

ALKALINITY

The alkalinity value of the effluent, (Fig.2), decreased from 400 mgdm⁻³ to 180 mgdm⁻³ in January and decreased further to 90 mgdm⁻³ at the beginning of February. It increased from 90 mgdm⁻³ to 270 mgdm⁻³ in February and finally decreased to 100 mgdm⁻³ in March, thus, alkalinity value decreased by 122% in January and decreased by over 340% between January and February. The alkalinity value, (Fig. 2), also increased by 200% in February and declined by 170% between the middle of February and March. Alkalinity had its highest value of 400 mgdm⁻³ in January while its lowest value of 90 mgdm⁻³ was obtained in February. It had a Mean value of 197 mgdm⁻³ and Standard Deviation of 118 mgdm⁻³. Alkalinity is the sum of all titratable bases and it is significant in the treatment of waste water. The high value of Alkalinity obtained were due to the addition of slaked lime during the process of unhairing the hides and skins.

CHROMIUM

Metal compounds are not egradable and are regarded as long term environmental features (Handa, 1988). Chattopodhyay et al (2000) had reported a high concentration of chromium (0.125 – 59.86g/lkg) in the sludge/sediment of a river bed in East Calcutta India, as a result of tannery operations. Chromium (vi) is a known epithelial irritant and human carcinogen (IARC, 1990). It is also toxic to many plants, aquatic animals and bacteria (USEPA, 1985). Exposure to Chromium (vi) may damage the lungs, liver, nervous system, and kidney and may cause skin diseases (Gardea - Torresdey et al, 2004).

The chromium concentration in the effluent, (Fig. 2), decreased from 131.6 mgdm⁻³ to 70.3 mgdm⁻³ in January and decreased further to 51.1 mgdm⁻³ at the beginning of February. It increased from 51.1 mgdm⁻³ to 65.8 mgdm⁻³ in February and finally decreased to 31.5 mgdm⁻³ in March. The highest chromium value of 131.6 mgdm⁻³ was obtained in January while its lowest value of 31.5 mgdm⁻³ was obtained in March. Chromium had a Mean value of 66.0 mgdm⁻³ and a Standard Deviation of 35.0 mgdm⁻³. Chromium value

decreased by over 300% between January and March. The chromium values obtained in this study were higher than the limits (0.1 mgdm⁻³) set by the FME_{env}.

BIOCHEMICAL OXYGEN DEMAND

Many complex components in effluents are broken down by bacteria into simple components. Oxygen is required for both the survival of these aerobic bacteria and the breakdown of the components. Depending on their composition (APHA, 1992; UNIDO, 2003), this breakdown can be quite rapid or may take a long time. The Biochemical Oxygen Demand (BOD) value of the effluent (Fig. 3) decreased from 2000 mgdm⁻³ to 1850 mgdm⁻³ in January. It decreased from 3050 mgdm⁻³ to 2850 mgdm⁻³ in February and also decreased from 3860 mgdm⁻³ to 1800 mgdm⁻³ in March. The BOD value increased from 1850 mgdm⁻³ to 3050 mgdm⁻³ between January and February and also increased from 2850 mgdm⁻³ to 3860 mgdm⁻³ between February and March. BOD values decreased and increased alternately between January and March. However, it decreased by 8% and 7% in January and February respectively and also decreased by 114% in March. The BOD had its highest value of 3860 mgdm⁻³ in March and this was over 90% more than the initial value in January, while its lowest value of 1800 mgdm⁻³ was also obtained in March. It had a mean value of 2568 mgdm⁻³ and a Standard Deviation of 825 mgdm⁻³.

As a measure of the oxygen requirements of bacterial action under controlled conditions, the BOD values obtained in this study were higher than the limits (100 mgdm⁻³) set by the FME_{env}. The unhairing and tanning of hides and skins involve a lot of organic matter. This phenomenon gives rise to high BOD values which in turn, strips oxygen from polluted water and deprives aquatic life of oxygen for survival.

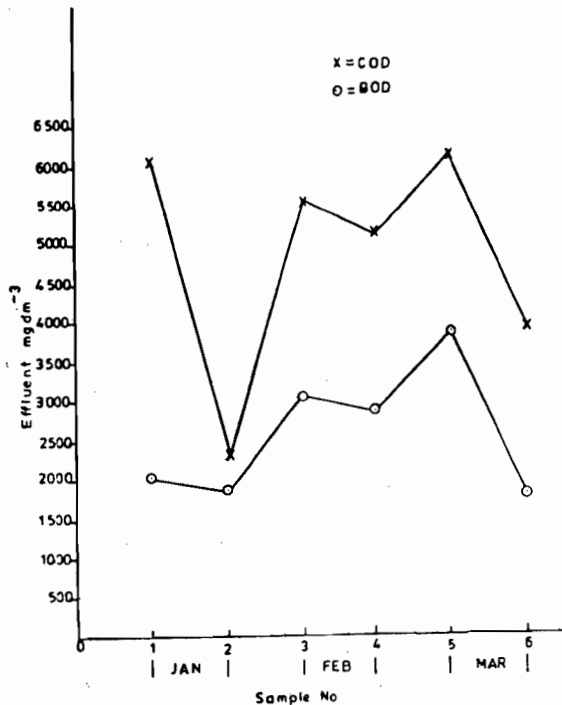


FIG. 3: VARIATION OF CHEMICAL OXYGEN DEMAND (COD) AND BIOCHEMICAL OXYGEN DEMAND (BOD) BETWEEN JANUARY AND MARCH

CHEMICAL OXYGEN DEMAND

The chemical oxygen demand (COD) value of the effluent, (Fig.3), decreased from 6050 mgdm⁻³ to 2300 mgdm⁻³ in January. It decreased from 5540 mgdm⁻³ to 5107 mgdm⁻³ in February and also decreased from 6132 mgdm⁻³ to 3906 mgdm⁻³ in March. The COD value increased from 2300 mgdm⁻³ to 5540 mgdm⁻³ between January and February and also increased from 5107 mgdm⁻³ to 6132 mgdm⁻³ between February and March. Thus, the COD value decreased by 163% and 57% in January and March respectively but increased by 140% between January and February. The COD had its highest value of 6132 mgdm⁻³ in March and its lowest value of 2300 mgdm⁻³ in January, with a Mean value of 4839 mgdm⁻³ and a Standard Deviation of 1484 mgdm⁻³.

The COD is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant and can be related empirically to BOD, organic carbon or organic matter. The values obtained in this study are relatively high which indicates that the effluent is polluted. The COD values are also higher than the BOD values which implies that the effluent is also polluted by non-oxygen dependent (anaerobic) bacteria, leading to toxic water condition (APHA, 1992., UNIDO, 2003)

SOLIDS

The value of the Total Dissolved Solids (TDS) in the effluent, (Fig. 4), decreased substantially from 8630 mgdm⁻³ to 2620 mgdm⁻³ in January and increased to 7190 mgdm⁻³ in February. It then decreased gradually to 4472 mgdm⁻³ in March. Thus, the TDS value decreased by more than 200% of its original value in January, and increased by over 170% between January and February. It thereafter decreased by

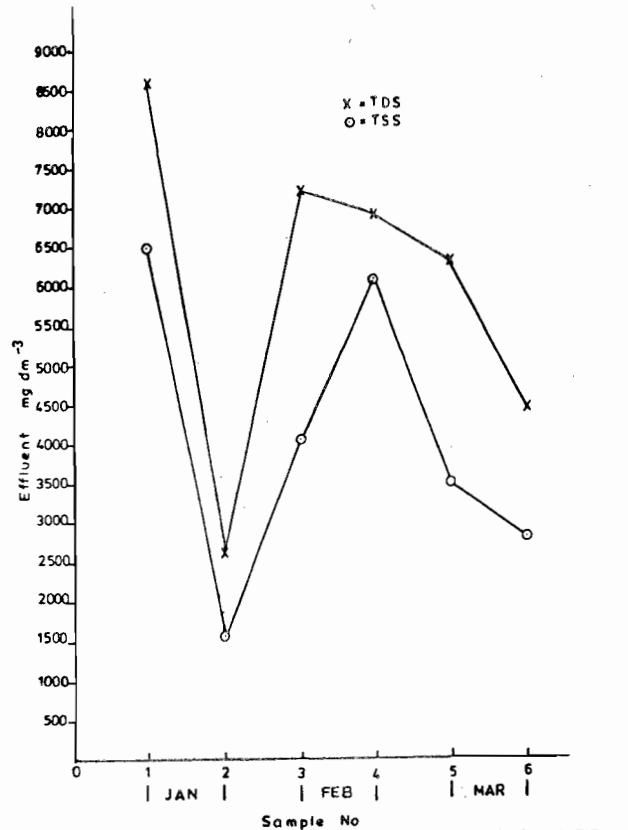


FIG.4: VARIATION OF TOTAL DISSOLVED SOLID(TDS) AND TOTAL SUSPENDED SOLID (TSS) BETWEEN JANUARY AND MARCH

61% between February and March. Both highest and lowest TDS values appeared in January with a Mean value of 6020 mgdm⁻³ and Standard Deviation of 2144 mgdm⁻³. The high TDS values were responsible for the high conductivity (5240 17260 µs/cm) values obtained during analyses.

The value of the Total Suspended Solids (TSS), Fig. 4, also decreased from 6513 mgdm⁻³ to 1560 mgdm⁻³ in January, it increased to 6100 mgdm⁻³ in February and thereafter decreased to 2810 mgdm⁻³ in March. The TSS decreased by over 300% of its original value in January, but increased by over 290% between January and February and decreased by 117% between February and March. TSS has Mean value of 4092 mgdm⁻³ and a Standard Deviation of 1913 mgdm⁻³. A thin layer of settled sludge is capable of forming a blanket that can deprive a section of a river or lake bed of oxygen and thus can adversely affect aquatic life (UNIDO, 2003). The values obtained for Total Suspended Solids were higher than the limits (40 mgdm⁻³) set for discharge of effluents by the FMEnv.

CONCLUSION

Most tannery factories are known to close for the year in December and resume activity in January. Factory production after the December break is usually high and this may be responsible for the high values of most of the physicochemical parameters recorded for January over the other months. Increased production as well as irregular discharges of sectional effluent by some of the big tanneries may be responsible for the high values of the physicochemical parameters obtained in the month of February. The decrease in values of the physicochemical parameters of the effluent in March implies a decrease in overall factories' production levels in March.

The concentrations of pollution parameters of discharged effluents from the Challawa Industrial Estate, Kano, are higher than the limits set by the Federal Ministry of Environment for discharge of effluents by the Tannery Sector. About 90% of the Tanneries in Challawa Industrial Estate have installed primary effluent treatment plants within their facilities. However, only 10% of these factories treat their effluents due to the high cost of operating the treatment plants. The tannery effluents from the Challawa Industrial Estate in Kano are polluted and hence pollute the Challawa river.

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