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Research

Investigations into the Properties of Waste Water within and around Agbara Industrial Estate of Ogun State, Nigeria

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Abstract

Waste water within and around Agbara Industrial estate find their way into rivulets and streams which often times are sources of water supply both for domestic and agro-allied applications. Investigations reveal that the BOD values of seven waste water samples collected at different locations showed values between 1.30 and 7.60 except for sample G, all pH values ranged from 5.98 (acidic) to 8.30 (basic) with conductivity ranging from 475µs/cm to as high as 691µs/cm. The total hardness values range from 1.83 to as high as 6.50 whereas the calcium hardness range from 0.25 to 1.63 mg/100ml. Total Dissolved Solid (TDS) range from 1800 -3200mg/L and Total Suspended Solid (TSS) ranged from 6775 to 9860mg/L. Heavy metals ranged from 1.015 mg/100ml. to 1.421 mg/100ml. for Cu^{2+}; 12.01 to 17.56 mg/100ml. for Fe^{2+} and 0.414 to 1.419 mg/100ml. for Zn^{2+} respectively. Mn^{2+}, Pb^{2+} and As^{2+} had values ranging from; Mn^{2+} (1.720 to 2.53) mg/100ml, Pb^{2+} (2.052 to 3.421) mg/100ml.and As^{2+} (0.521 – 0.741) mg/100ml.

KEY WORDS: Conductivity, Waste Water, Contamination, Environment, Sludge.

Introduction

Since the second part of the 20th century, there has been growing concern over the diverse effects of heavy metals on human and aquatic ecosystems. Environmental impact of heavy metals was earlier mostly attributed to industrial sources but in recent years, metal production emissions have decreased in many countries due to strict legislation, improved cleaning/purification technology and altered industrial activities (European commission, 2002).

For most applications heavy metals, the applications are estimated to be the same in nearly all countries but the consumption pattern may be different. For some applications which during the last decades has been phased out in some countries, there may however, today be significant differences in uses (Hui, Chao and Kot, 2005; Karrelas, Katsoyiannis and Samara, 2003; Ahluwalia and Goyal, 2007).

Knowing however water is the store house for chemical pollution, sea water and waste water contaminants are of critical concern. Hardness in water, notably calcium and magnesium salts are primary causes of failure or loss of process efficiency due to clogging or loss of heat transfer or both. Though hardness is caused by these polyvalent cations but those other than these ions are seldom present than in trace amounts. Effluents from textile, leather, tannery, electroplating, pigment, galvanizing, dyeing, and metallurgical and paint industries at small and large-scale sectors contain considerable amounts of toxic metal ions (Ahluwalia et al 2007).

Heavy metals commonly used in industries re generically toxic to animals and to aerobic and anaerobic processes, but all of them are not dense or entirely metallic and includes As, Cd, Cr, Cu, Pb, Hg, Ni, Zn all of which pose a number of undesired properties that affect humans and environment (Dufus, 2002).

All heavy metals have effect in humans and environment in different ways (European commission, 2002; Karrelas et al, 2003; Dufus 2002). Lead for instance exists mainly in particulate nature. Of particular concern for the general population is the effect of lead on the nervous system. It has shown to interfere on heamoglobin synthesis and aneamic conditions have been observed in children at lead blood levels above 40ug/dl. Lead is also known to cause kidney damage. Even so some of the effects of lead are reversible, chronic exposure to high lead levels may result in continued decreased kidney function and possible renal failure.

Toxic metals existing in high concentrations (>500mg/ml) must be effectively treated/ removed from waste water because if they are discharged directly into the sewage system, it may affect negatively subsequent biological waste water treatment (Wan, Ngah and Hanafiah, 2008). Among the many methods available to reduce heavy metal concentration from waste water include chemical precipitation, ion exchange, adsorption, coagulation, concentration, electro-dialysis, electro-mining, electro-coagulation and reverse osmosis (Ahluwalia et al, 2007; Demirbas, 2008; Bailey, Olin, Bricka and Adrian, 1999; Sekhar, Kamala, Chary and Anjaneyulu, 2003). Some of the reported low-cost sorbents of heavy metals in waste water such as bark/ tannin-rich materials, lignin, chitin/chitosan, dead biomass, seaweed/algae/alginate, xanthate, zeolite, clay, fish ash, peat moss, bone gelation beads etc have shown high efficacy in removal of heavy metals from waste water. Important parameters for the sorbent effectiveness were affected by pH, metal concentration, ligand concentration competing ions and particular size (Ahluwalia, et al, 2007; Wan et al, 2008; Demirbas, 2008; Gaily et al, 1999).

Another type of sorbent is plant waste (Bailey et al, 1999). However, plants wastes are often expensive as they have little or no economic value. Recently, most of the adsorption studies have been centered on untreated plant wastes like papaya wood, maize leaf, rubber (Hevea brasiliensis) leaf powder, corundum Sativum, Peeanut hull pellets etc. some of the advantage of using plant wastes for waste water treatment are that the techniques are simple, requires little processing, good adsorption capacity, selective adsorption of heavy metal ions, low cost, free availability and easy regeneration.

However the application of untreated plant wastes as adsorbents can also cause several problems such as low adsorption capacity, high chemical oxygen demand (COD) and biological oxygen demand (BOD) as well as total organic carbon (TOC) due to the release of soluble organic compounds contained in water and can threaten aquatic life. Plant waste therefore need modification or treatment before they are used to remove heavy metals. A clear comparison of adsorption efficiency between chemically modified and unmodified adsorbents has been reported (Demirbas, 2008).

Another option is the use of biological materials (Ahluwali et al, 2007; Wan et al, 2008; Demirbas, 2008; Baily, Olin and Bricka, 1999; Sag and Kutsal, 2001; Volesky, 2007). Biomaterials of microbial and plant origin interact effectively with heavy metals.

Dead biomasses which are metabolically inactive, due to their unique chemical composition are able to sequester metal ions and metal complexes from solution which obviates the necessity to maintain special growth supporting conditions. Seaweed, mold, bacteria, crab shells and yeast are among the different kinds of biomass which have been subjected to tests for removal of metal ions (Demirbas, 2008; Ahalya, Ramachandra and Kanamad, 2003; Sag et al, 2001; Volesky, 2007).

Experimental

During the survey, all points where waste waters are discharged into the river were noted and sampling stations designated as station A to G were established. Sample A was collected at a point before the effluents get to the upstream. Sample B to D represents the various points of entry of waste water into Agbara River. Sample E was obtained upstream from Agbara River while F represents the water going into Lagos lagoon after confluence with effluent form the industries. Sample G was obtained from a point after the industrial effluent discharge point confluence with a rivulet along Badagry.

To ensure that samples were representative, all samples were taken at the centre of the stream and below the surface at a distance away from the mixing point. The sampling program was divided into two; one in the morning and the other in the afternoon in order to account for the variation in waste water discharge from the industries. A composite sample was formed by mixing the two in equal proportions after preservation. A total of seven samples were collected for each test and the tests were performed in accordance with APHA, AWWA, WPEF, (1995). The samples were also collected in the months of April and May when the river flow is lowest, the level of dilution is little and pollutants concentration in the river is critical. Portions of the waste water samples for heavy metal analysis were allowed initially to sediment after initial filtration with filter paper. The sediments were treated separately by re-boiling with dilute tetraoxosulphate (VI) acid to recover the metal contaminants which were ordinarily not soluble in the waste water. Preliminary analyses were carried out for total dissolved solids, total suspended solids, alkalinity, conductivity, biochemical oxygen demand (BOD), total hardness and calcium hardness. Total dissolved solids were recovered after 100ml of each sample was evaporated to dryness after consecutive filtration using Whatman filter paper. Total dissolved solids were obtained when 100ml of the samples were filtered and the filtrated dried to constant weight. BOD was carried out according to APHA- 51210B while alkalinity was estimated by titration with standard sulphuric acid at room temperature using phenolphthalein indicator. Conductivity was determined using conductimeter measured in us/cm while hardness (Total and calcium) were determined by EDTA titration. Iron was complexed with o-phenanthrolein to form an orange-red colour complex of Fe $(o\text{-phen})_3^{+2}$ and the absorbance measured at 510nm. Lead, Zinc, Copper, Manganese and Arsenic were determined using Thermo-Unicam (SOLAAR) atomic absorption spectrophotometer having a double beam system with a unique facility that the reference optics are completely removed throughout the period of measurement.

Results

The waste water samples were analyzed and the following results were obtained.

Table 1: Result of chemical analysis on waste water samples.

Sample	A	B	C	D	E	F	G	FEPA *Max.	WHO *Max.
TDS mg/L	2470	2450	2400	2010	1800	3200	2680	2000	-
TSS mg/L	8670	7650	6890	9860	8995	7665	6775	30	-
Conductivity μs/cm	475	509	631	464	560	691	693	600	500
Alkalinity mg/100ml	0.657	0.708	0.739	0.853	0.710	0.645	0.60		
pH	7.63	8.00	8.13	7.05	8.11	8.30	5.98	6 - 9	-
Total Hardness mg/100ml	2.67	2.50	6.50	3.00	2.66	1.83	3.67	-	-
Calcium hardness mg/100ml	1.00	1.63	0.88	0.63	0.75	1.38	0.25	-	-
BOD	1.304	7.599	1.304	1.648	1.491	1.437	1.481		

*FEPA and WHO maximum permissible standards

Table 2: Results of heavy metal analysis on waste water samples.

Parameter	A	B	C	D	E	F	G	FEPA Max.*	WHO Max.*
Iron mg/L	12.01	12.10	12.63	12.18	14.18	16.07	17.56	20	15
Zinc mg/L	1.419	0.414	0.425	0.437	0.844	0.434	0.425	1.00	1.00
Copper mg/L	1.421	1.104	1.101	1.205	1.321	1.015	1.025	1.00	0.50
Manganese mg/L	1.810	1.720	2.030	2.110	2.31	2.140	2.530	5.00	-
Lead mg/L	2.105	2.104	2.052	2.142	2.435	2.551	3.421	1.00	1.00
Arsenic mg/L	0.635	0.521	0.515	0.652	0.705	0.712	0.741	-	-

*FEPA and WHO maximum permissible standards

Deductions and Conclusions

Contamination of soil and water bodies from effluent of industries has over the past years been a major concern to the environmental scientist even though as it were, then, industrial development was yet rudimentary. Waste water carries along with it, potent inorganic matters which are harmful to aquatic, terrestrial and even human life. Efforts are being made by the environment as well as the regulatory bodies to control the content of industrial effluent.

Results obtained for iron (Fe) ranged from 12.01ppm to 17.56ppm but whereas sample A to E were within the WHO tolerance limit of Fe in waste water (15.0mg/l). F and G samples were above the tolerance limit. Except for sample A, all other waste water samples were below the tolerance limit for zinc - Zn (1.0mg/ml), whereas all samples showed high values for copper above the tolerance limit. Cu (1.0mg/L). All samples showed low levels of manganese well below the tolerance limit - Mn (5.0mg/L) but all values for lead were above the limit for sewage water (1.0mg/L)

The pH values for all the samples were still within the action limit for sewage water 6.0 - 9.0 though they are all in the alkaline range except for sample G. Samples B, C, E and F showed exceedingly high pH values reflecting the result of total and calcium hardness. Conductivity values were relatively high as well as the BOD values.

The total dissolved solid and suspended solids were found to be on the high side far beyond the tolerance limit.

These results are indicative of the need to monitor this environment over some time for the possible build-up of heavy metals possible. Chromium, titanium, lead or arsenic and it is expected that overtime, the BOD, TDS and TSS may impact on the water bodies nearby negatively.

It is suggested that further analysis be carried out to ascertain the extent to which the aquatic and plant life has been affected by the waste water in the industrial area.

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