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Physico-chemical characterization and heavy metals of effluents from glass processing plant in Agbara Industrial Estate, Ogun, Nigeria

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Abstract

The physico-chemical analysis of effluents from glass processing plants in Ogun state, Nigeria was carried out to establish the pollutive nature of the effluents. The physic-chemical parameters were determined by Standard method while the metals were determined by Atomic absorption spectrophotometry following wet digestion. The mean pH values for all samples POD, P1 and P2 are 6.48±1.50, 6.92±1.26 and 7.16±0.92. The temperature ranged from 29.0±1.41 to 29.8±0.84 respectively and all were within the FMENV and that of W.H.O. standard of 6-9 and 20-33^{0}C. The mean concentration of the phosphate, nitrate, sulphate are all within the limit standard but the mean value of total suspended solids: a POD (74.00 ±57.89), P1 (73.20±57.85) and P2 (73.20±57.17)mg/L were above the FMENV of 30mg/l. The DO and BOD_5 are all within the limit while the COD for POD,P1 P2 were 181.00±85.07 mg/L, 187.20±86.33 mg/L and 187.40±85.10 mg/L respectively which exceeded the limit of 80mg/L for a glass industry effluent limit. The levels of Zn, Fe, Pb, Cu, Cr & Cd were all below the FMENV limit. The concentrations of both the cations and anions analysed were within stipulated limits.

Keywords: Glass industry, Estate, Effluent, wastewater parameters, heavy metals

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Introduction

Industrial pollution is one of the problems currently facing Nigeria and several efforts are being vigorously pursued to control it in various industries spanning length and breadth of the country to see that Nigerians live in a disease- free environment. Effluent generated by the industries is one of the sources of pollution. Contaminated air, soil, and water by effluents from the industries are associated with heavy disease burden [1] and this could be part of the reasons for the current shorter life expectancy in the country [2] when compared to the developed nations. Some heavy metals contained in these effluents (either in free form in the effluents or adsorbed in the suspended solids) from the industries have been found to be carcinogenic [3] while other chemicals equally present are poisonous depending on the dose and exposure duration [4-5]. These chemicals are not only poisonous to humans but also found toxic to aquatic life [1] and they may result in food contamination [6]. Water is used by industry in a myriad of ways: for cleaning, heating and cooling; for generating steam; for transporting dissolved substances or particulates; as a raw material; as a solvent; and as a constituent part of the product itself (glass industry). The water that evaporates in the process must also be considered in accurate assessments as well as the water that remains in the product, by-products, and the solid wastes generated along the way. The balance is discharged after use as wastewater or effluent. Water is the most valuable resource on earth, and untreated industrial effluent is the major cause of water pollution globally [7-9]. Glass has been in use for centuries; the Egyptians were the first to use glass containers in the fifteenth century BC. Modern use really started at the twentieth century when in 1903 the first fully automated bottle-making machine was developed in Ohio, USA. Glass is still widely used despite the introduction of substitute products, particularly plastics. Glass has wide range of applications and uses depending on its source of raw materials. The container glasses, tableware and flat glass are termed as soda lime glasses. The crystal tableware, TV screens and display screen equipment are lead glasses. The borosilicate glasses are for making glass fibers, wool insulation, and ovenware and thermo flasks. The alumino silicates (technical glasses) are for scientific and optical apparatus. Certain percentages of electronic and electrical equipment are made of glass. Glass constitutes about 2.9% of the materials in automobiles (by weight) usually inform of flat glass [10]. Various steps are involved in glass production and at each step there is possibility of waste generation. Production process involves series of steps; each step has its own input, out put and waste. Considering the huge amount of glass being produced annually, the possibilities, of waste generation from the outset of production of the glass to the product life-span, a lot of waste will be generated [11]. Large volumes of effluents partially treated and untreated are discharged on a daily basis into our environment [12,13].

The investigated company is located in Agbara industrial estate in Ogun state, Nigeria. It is the leading hollow glass container manufacturing companies in the country. The company manufactures bottles for beer, stout, malt drinks, soft drinks, pharmaceuticals, wine and spirit to mention a few. It generates an estimated volume of 20,000litres of wastewater daily. This Glass industry is one of the biggest industries on this estate. Therefore, the aim of this study was to determine the physico-chemical parameters and heavy metals (zinc, iron, lead, copper, chromium and cadmium) in the waste water generated by this Glass industry.

Materials and Methods

Sample collection and treatment

Effluent discharged from the glass industry was sampled during the month of May and June 2007 from the point of discharge(POD) and samples from two points P_1 and P_2(about 100m and 200m respectively) away from the point of discharge were also collected before the effluent emptied into the stream. The effluent was collected with pre-washed polyethene container (2L) for physico-chemical parameters analysis while sample for heavy metal was collected into a separate pre-washed polyethene container and was preserved on site with conc.HNO_3.The dissolved oxygen was determined in-situ with a water proof microprocessor controlled DO meter of (Hanna model DT330-10 H19145).

Standard methods of America Public Health Association [14] were used for the physico-chemical parameters analyse. Heavy metals were determined through acid digestion. 200ml effluent sample was digested with 3ml conc. HNO_3 on a water bath till the volume was reduced to about 20ml and was filtered using 42mm Whatman filter paper into a standard flask and made up to mark with de-ionised water. The resulting solution was analysed for Zn, Fe, Pb, Cu, Cr & Cd by flame atomic absorption spectrophotometer Buck Scientific VGS model. A blank determination was also carried out. The reagents used were of Analar grade.

Results and Discussion

Table 1 shows the mean result of the physico-chemical parameters while Table 2 shows the mean results of the heavy metals.

The pH values of the points (POD, P1 and P2) are 6.48±1.50, 6.92±1.26 and 7.16±0.92, while the temperature are 29.6± 1.14, 29.0±1.41and 29.8±0.84 respectively are all within the FMENV and that of WHO standard of 6-9 and 20-33^{0}C. The total suspended solid mean results of the POD, P1and P2 are 74.0±57.89, 73.2±57.85 and 77.80±63.44 respectively were found to exceed the FMENV [15]of 30mg/L and 50 mg/L WHO standard. The result is more than two folds of the limits, this could be attributed to sand which is one of the major raw materials use in the making of glass and may be major sources of heavy metals.

The nitrate, sulphate and phosphate were found within the normal specification. The nitrate level ranged from 11.0 to 11.3 mg/L, the sulphate ranged from 26.0-26.5 mg/L and the phosphate range from 3.1to 3.5 mg/L. High levels of these parameters especially nitrate and phosphate in a receiving body of water environment leads to nutrient build-up (eutrophication) which posses a serious problem in lakes and slow moving waters.

The BOD value is within the FMENV limit (Table 1). On the other hand, the high COD levels of the sampled effluent 181.00±85.07 mg/L for the POD, P1 with value 187.20±86.33 mg/L and that of P2 with value of 187.40±85.10 mg/L imply would toxic conditions and the presence of biologically resistant organic substances [16].The DO is an important measure of water quality [17].The low level of DO from Table 1 obtained could result in the non maintenance of conditions favorable to the anaerobic organism. This could lead to anaerobic organisms taking over with the resultant creation of conditions making the water body uninhabitable to gill-breathing aquatic organism [1]. There were negative correlation between TDS and TH (0.756), on one hand and between TDS and Conductivity (0.960) on the other.

The levels of heavy metals were generally low and within the FMENV limit (Table 2). The level of Pb in the POD (0.12±0.22) mg/L exceeded the limit of 0.1mg/L. Heavy metals in the waste water could impact negatively to the environment [118]. The result of the Cu, and Pb level in the effluent obtained is comparable to the one reported by Adebiso et al [19] while the Zn, Fe and Cr level is lower than that reported by Adebiso et al [19]. This could be attributed to the type of glass manufactured by the company. There is a general decrease in the concentration of heavy metals from the point of discharge to the other points which could be as a result of fast flowing of the effluent along the drainage. Increased heavy metals concentration in river sediments could increase suspended solids concentration [20]. From the correlation coefficient table, there is a negative correlation between Zn and Fe also between Zn and Cu.

Table 1 Shows the mean ±Standard deviation result of the physico-chemical parameters

Parameter	**FMENV. Limit**	**POD**	**Point 1**	**Point 2**
Appearance	Clear & Colourless	Brownish	Brownish	Brownish
Colour (True colour Unit)	25	23.8±8.93	23.8 ± 9.65	23.8± 9.58
pH	6-9	6.48±1.50	6.92±1.26	7.17±0.92
Temp.^{o}C	20-33	29.60±1.14	29.00±1.41	29.80±0.84
Conductivity (µm/cm)	---	161.6±82.23	161.8±82.64	162.0±82.92
TSS	30	74.0±57.89	73.2± 57.85	73.2± 57.17
TDS	2000	78.6±64.33	78.4±63.78	77.8±63.44
Total Hardness	------	95.48 ±49.49	95.28± 49.32	95.72±49.10
Alkalinity	-----	51.24±32.03	51.1±31.20	51.68±32.08
Ca^{2+}	200	23.6±0.29	23.5 ± 0.10	23.6±0.21
Mg^{2+}	200	10.2±0.14	10.3±0.30	10. 3±0.09
Nitrate	20	11.2±0.00	11.1±0.01	11.2±0.07
Sulphate	500	26.3 ±0.17	26.2 ±0.18	26.3±0.22
Phosphate	5	3.2 ±0.07	3.3 ±0.16	3.2±0.1
DO	2	2.5±0.54	2.5 ±0.55	2.5±0.52
BOD_5	30	24.0±7.07	24.20±6.61	24.00±7.48
COD	80	181.00± 85.07	187.20±86.33	187.40±85.10

Units in mg/L unless otherwise stated.

Table 2 Shows the mean ±Standard deviation result of the heavy metals

Parameter	FMENV. Limit	POD	Point 1	Point 2
Arsenic	0.1	0.04±0.05	0.04 ±0.05	0.04±0.05
Zinc	< 1	0.15±0.02	0.17 ±0.24	0.15±0.20
Iron	20	0.48±0.19	0.44 ±0.25	0.46±0.23
Lead	<1	0.12± 0.22	0.02±0.04	0.02±0.04
Copper	<1	0.02±0.04	0.03±0.04	0.05±0.08
Chromium	<1	0.06±0.08	0.05±0.04	0.03±0.04
Cadmium	< 1	0.04±0.04	0.03±0.04	0.03±0.04

Units in mg/L

Table 3 Correlation coefficient result between trace metals in the effluent

	Zn	Fe	Pb	Cu	Cr	Cd
Zn	1.00					
Fe	-0.87	1.00				
Pb	0.50	-0.87	1.00			
Cu	-0.50	0.00	0.50	1.00		
Cr	0.11	0.40	-0.80	-0.92	1.00	
Cd	0.50	0.00	-0.50	-1.00	0.92	1.00

Conclusion

The pH, temperature and TDS were all within the regulatory limits. The nitrate, sulphate and phosphate were all within the regulatory limits. The TSS is above the regulatory limits. The DO and BOD are within the limit except for COD which is two folds greater than the regulatory limits. Finally, the metals concentrations of the effluent from all the sampling points were generally within the regulatory limits (FMEV).

The high TSS will affect the aquatic life in the receiving ecosystem causing low penetration of light. The high COD implies toxic conditions and the presence of biologically resistant organic substances. The effluent from the Glass industry is still much within the limit for most of the parameters analyzed except for the colour, TSS and the COD.

References

[1] WHO, Water Pollutants: Biological Agents, Dissolved Chemicals, Non-dissolved Chemicals, Sediments, Heat, WHO CEHA, Amman, Jordan, **2002**.
[2] WHO .The World Health Report 2003: Shaping the Future, World Health Organization, Geneva 27, Switzerland, **2003**, 1211
[3] G .Tamburlini; O.V. Ehrenstein ; R. Bertollini. Children's Health and Environment: A Review of Evidence, In: Environmental Issue Report *No. 129*, WHO/European Environment Agency, WHO Geneva, **2002** pp 223.
[4] C.E. Kupechella; M.C Hyland. *Environmental Science*, Allyn and Baron, London. **1989**
[5] R.Lae; S.Williams; M.A.Mallam; P.Morand ; Mikolasek O.Review of the Present State of Knowledge of Environment, Fish Stocks, and Fisheries of the River Niger (West Africa),In: Second International Symposium on the Management of Large Rivers for Fisheries:Sustaining Livelihoods and Biodiversity in the New Millennium, Phnom Penh, Kingdom of Cambodia, 11th–14th Feb. **2003**, pp 45.
[6] R.Novick. Overview and the Health in Europe in the 1990s, World Health Organization, Europe Regional Office, Copenhagen, EUR/ICP/EH/CO 02 02 05/6, **1999** pp 20.
[7] F. Gagne; C.Blaise.. *Environ.Toxicol.& Water Qual*. **1997,**12, 315-320
[8] B.J. Alloway; D.C. Ayres, Chemical principles of environmental pollution,Chapman and Hall,Melbourne,16-42pp.
[9] V.Novotony; H Olem, Prevention,identification and management of diffuse pollution Van Nostrano Reinhold,New York, **1994**,18-25pp,
[10] British Glass , The UK Manufacturing Sector, **2001**
[11] David Workman. *International Glass review* **2004**.
[12] E.I Adeyeye; O.O Ayejuyo, *Pak.J.Sci.Ind.Res*. **2002**,45, 10-16.
[13] FEPA(Federal Environmental Protection Agency, Guidelines to Standards for Environmental Pollution Control in Nigeria. FEPA, Lagos, (**1991**) 13-94pp.
[14] American Public Health Association. Standard methods for the examination of water and wastewater. APHA,AWWA and WPCE, 18th Am.Public Health Assoc., Byrd progress, Sprinfield, New York ,**1998**
[15] Federal Ministry of Environment (FMENV). Industrial Pollution Inventory Study in Nigeria, **1998**

[16] C.N Sawyer; P.L Mc Carty, Chemical for Environmental Engineering (3rd Edition). Ma Graw-Hill Book Company, NY **1973**.
[17] J.J.Peirce; R.F Weiner; P.A Vesilind, Environmental Pollution and Control, Butterworth-Heinemann, Woburn, MA, 4th Edition USA, **1997** pp 57–74
[18] K.C Sekhar; N.S Chary; C.T Kamala; J.V Rao; V Balaram; Y. Anjaneyuly, *Environmental International*, **2003**,29, 601–611.
[19] S.A. Adebiso; K.O. Ipinmorott; I.A. Amoo, *Research Journal of Applied Sciences*, **2007**,2 (4): 3.
[20] M.S. Kambole, Managing the Water Quality of the Kafue River, In: Physics and Chemistry of the Earth, Parts A/B/C, 28 (20-27), **2003**, pp 1105 – 1109.