

EFFECTIVE TREATMENT OF GLASS MANUFACTURING PROCESS WASTEWATER WITH CONFORMED EFFLUENT DISCHARGES

E. F. Sodiya¹, S. O. Olagbende² and N.Y Ilesanmi¹

¹Department of Chemical Sciences, Mountain Top University, Ibafo, Nigeria

²Department of Chemistry, Lagos State University, Ojo, Lagos, Nigeria

ABSTRACT

The constituents of wastewater and effluent discharges from the manufacturing operations was investigated as a representative of other soda lime silica glass manufacturing and other related processes in Nigeria. Samples were sourced from the Forming end, compressor, generator and furnace cooling waters. The samples collected were analysed in the laboratory by physicochemical analysis and Microbiological analysis. The results indicated that the physiochemical parameters such as odourless and clearer colour were observed from the influent. The pH was brought down from 9.0 to 7.8 with the heavy metal kept below maximum limit. The major contaminants in glass waste water are suspended solids which comes from both silica sand and cullet treatment plants, it was reduced from 50mg/L to 30mg/L. The organics and its derivatives have been treated to have moved conductivity from 64 to 100. However, the bacteriological related cocntaminants were eliminated

Keywords: Wastewater, Influent, Effluent, Chemical Oxygen Demand, Total suspended solid

INTRODUCTION

Wastes generated by human and animal activities on the earth exists in the three distinct states of matter. The liquid and solid wastes are visible but gaseous are diluted in to the atmosphere. However all are vastly contributing to environmental degradation in degrees of its pollution effect [1]. Liquids and solid wastes are noticeable in the immediate environment but pollution in the form of gaseous emission spread to over a long range of areas. It's concentrated form atimes moves to upper atmospheric layers to obstruct natural structures.

Glassy products are inorganic substance fused and cooled to rigidity without crystallization. [2]

The type of glass produced determines the mode of support services applied and the raw materials charged into the production process which however are functions of the types of bye products and wastes to be generated[3][4]

Wastes which are pollutants in glass factories come from (a) In plant treatment of water and raw materials (b) Discharging of raw materials into the Silo and decomposition of the batch in the furnace. (c) Cooling water and Oil from production lines and Power (Electricity and Compressed air) Services sections (d) non-conformed products and packaging materials at Cold (sorting and packaging) end.

Wastewater generated from various parts of operational units such as cooling water from the electric generator and gas compressor engines that contain oil, swabbing oil and shear blade lubricating and cooling oil at product forming end of glass containers, waste water from sand and foreign cullet treatment plants are channeled into wastewater treatment plant. Cooling water and oil from production lines and Power (Electricity and Compressed air) Services sections.

Influents are the wastewaters from various treatment operations (washing) of foreign cullet complemented with pipe leakages from process lines and domestics. This wastes are however characterized by high sand (Total dissolved solid). The degree of suspended matter in the wastewater is a function of the sandy component of the supplied cullet as well as the sludge level of the cullet recycle water pond [5]. The Chemical Oxygen Demand (COD) which is the oxygen volume required for complete oxidation of organic matter present in the waste water to carbon (IV) oxide and water. While the Biological Oxygen Demand (BOD) which measures of the concentration of organic matter present in that waste water[6] are not always adequate. The greater the decomposable matter present, the greater the oxygen demand and the greater the BOD Value. The Wastewater Treatment Plant put in place employs a coagulant (Alum solution) to precipitate undissolved matters especially fine and colloidal particles. Also pumping compressed air into constantly stirred influent to enrich it with oxygen. These will bring the Total Suspended Solids and the Chemical Oxygen Demand

of the influent under treatment into conformity with government standards. [7][8]

MATERIALS AND METHODS

Sampling

Samples of the wastewater were taken at both the influent and final discharge point from the effluent treatment plant. Samples were also taken from the sedimentation stage of wastewater treatment plant. The Physicochemical analysis was done using adequate equipment and instruments with the required reagents. [9].

Physicochemical Analysis

The, physicochemical analysis relies on a wide range of analysis techniques. There are various benefits of using instrumental analysis in addition to sensorial and chemo-metric analysis.

Determination of pH:

A pH buffer was used to calibrate the HANNA instrument pH meter before it was used to measure pH. With distilled water, the pH meter's electrode was cleaned. The electrode was put into the measured sample after 20 ml of each water sample that was to be examined had been measured into several graduated beakers. The pH meter's display of a stable value was used to take the reading.

Determination of Electrical Conductivity:

After the determination of the pH, the electrical conductivity was determined using the theme instrument above.

Determination of Alkalinity:

The spectrophotometer was ON and afterwards scrolled down to select programmed tests. Again, scrolled down to select 1 on the machine. Alkalinity-UDV from the tasting menu. A clean vial [0156] was rinsed with sample water to be tested on and filled with 3ml of sample then the tube was inserted into the chamber, the lid was closed and SCAN BLANK was selected. Then the vial was taken out from the spectrophotometer, and 3ml of Alk UDV vial [4318] was added to it. The solution was left for maximum colour development. The mixture was inverted three times afterwards and positioned into the spectrophotometer to read the alkalinity in ppm. Then the result was recorded.

Determination of Iron Total:

The spectrophotometer was ON afterwards scrolled down to select programmed tests. Once again to choose 51 Iron Bipyr from the testing menu by scrolling down. After rinsing a clean tube [0290] with sample water for testing, the tube was filled with the sample to the 10 ml mark, placed inside the chamber, the lid was shut, and SCAN BLANK was chosen. After removing the tube from the

spectrophotometer, 0.5 ml of Iron Reagent #1 [V-4450] and 0.1 g of Iron Reagent #2 powder [V4451] were added and mixed. After capping the liquid, it was forcefully shaken for thirty seconds.

The solution was left for 3 minutes for maximum colour development. At the end of 3 minutes, the tube was inserted into the spectrophotometer to read the concentration of Iron in ppm present in the sample.

Determination of Manganese:

The spectrophotometer was ON afterwards scrolled down to select programmed tests. Again, scrolled down to select 55 Manganese L from the testing menu. After rinsing a clean tube [0290] with sample water for testing, the tube was filled with 10 ml of sample, placed inside the chamber, the lid was shut, and SCAN BLANK was chosen [4255]. After taking the tube out of the spectrophotometer, 2 milliliters of the hardness buffer reagent were added using a 1 milliliter pipet. Two drops of 10% sodium cyanide were added to the mixture and stirred [6565]. After capping the mixture, 0.5 milliliter of manganese indicator reagent [3956] was added and shaken. In order to determine the manganese content in parts per million, the mixture was placed into the spectrophotometer. The outcome was then noted.

Determination of Chloride:

The spectrophotometer was ON and afterwards scrolled down to select programmed tests. Again, scrolled down to select 21 Chloride – TesTab from the testing menu. A clean tube [0290] was rinsed with sample water to be tested on and filled with 10ml of sample then the tube was inserted into the chamber, the lid was closed and SCAN BLANK was selected. Then the tube was removed from the spectrophotometer, and one chloride spectrophotometric grade tablet was added to it. The solution was left for 2 minutes for maximum colour development. The mixture was inverted two times afterwards and inserted into the spectrophotometer to read the Chloride concentration in ppm. Then the result was recorded.

Determination of Chromium:

The spectrophotometer was ON and afterwards scrolled down to select programmed tests. Again, scrolled down to select 22 Chromium from the testing menu. A clean tube [0290] was rinsed with sample water to be tested on and filled with 10ml of sample. Then the tube was inserted into the chamber, the lid was closed and SCAN BLANK was selected. Then the tube was removed from the spectrophotometer, and one measure of chromium reagent was der [V-6276]. The mixture was capped and shaken vigorously

until the powder dissolved and was left for 3minutes for maximum colour development. A filter paper [0465] was folded into a cone and was used to push corners together to open and a funnel was inserted. The mixture was inserted into the spectrophotometer to read the chromium concentration. The result gotten was converted to chromate [CrO_4^{2-}] multiplied by 2.23. Then the result was recorded.

Determination of Lead:

The spectrophotometer was ON afterwards scrolled down to select programmed tests. Again, scrolled down to select 54 Lead from the testing menu. A clean tube [0290] was rinsed with sample water to be tested on and filled to the 10ml line with the sample then the tube was inserted into the chamber, the lid was closed and SCAN BLANK was selected. Then the tube was removed from the spectrophotometer, the tube was emptied and 5ml of the sample was added to the empty bottle. 5ml Ammonium Chloride Buffer [4032] was added to fill the tube to the 10ml line. The mixture was swirled and 3 drops of sodium cyanide, 10% [6565]. 0.5ml PAR indicator [4033] was added to the mixture with 0.5ml stabilizing reagent [4022]. After capping, the mixture was stirred. Three drops of DDC Reagent [4034] were added after the mixture was further placed into the spectrophotometer to read the lead content in parts per million.

The mixture was shaken to mix; the tube was inserted into the spectrophotometer to read the concentration of Lead in ppm present in the sample. Then the result was recorded as reading B, to get total ppm Lead reading B was deducted from reading A (reading A- reading B).

Determination of Copper:

The spectrophotometer was ON and afterwards scrolled down to select programmed tests. once again to choose 32 Copper DDC from the testing menu by scrolling down. After filling a clean tube [0290] with 10 milliliters of sample and rinsing it with test water, the tube was placed inside the chamber, the lid was shut, and SCAN BLANK was chosen. Next, the spectrophotometer's tube was taken out. and 5 drops of copper 1 [6446] were added to it. The mixture was capped and shaken vigorously. The solution turned yellow to indicate the presence of copper. The mixture was inserted into the spectrophotometer to read the copper concentration in ppm. Then the result was recorded.

Determination of Total Solids, Total Dissolved Solids, Total Suspended Solids:

Total Dissolved Solids (TDS) is a measure of the total amount of organic and inorganic compounds that have been suspended or dissolved as molecular ionized, or micro granular

particles in a liquid. By deducting the suspended solids values from the corresponding total solids of the samples, the total dissolved solids were calculated. The high value of TS and TSS can affect the organisms living in water bodies and can influence the dissolved oxygen level. In 100ml dry beakers which were initially weighed (W_1) each sample of water was measured and allowed to evaporate totally on a hot plate leaving behind both the suspended and dissolved solids in the beaker denoting the total solid. Using this calculation given below the initial is deducted from the final weight(W_2) divided by the volume of sample water used, multiplied by 1000mg/l. Then the same process is repeated but here the water samples are filtered, then the residue is discarded leaving behind the dissolved solids.

$$\frac{(W_2 - W_1) \times 1000\text{mg/l}}{100\text{ml}}$$

Total Hardness:

The spectrophotometer was ON and afterwards scrolled down to select programmed tests. Again, scrolled down to select 13 Ca & mg Hard-UDV from the tasting menu. After filling a clean vial [0156] with three milliliters of sample and rinsing it with sample water for testing, the vial was placed inside the chamber, the lid was shut, and SCAN BLANK was chosen. The vial was then taken out of the spectrophotometer, and 3ml of the sample was added to a calcium Hardness

UDV vial [4309]. After that, the mixture was placed into the spectrophotometer three times

invertedly to determine the total hardness in parts per million. The outcome was then noted.

RESULTS AND DISCUSSION

Table 1.0 Physicochemical Analysis of Results of Influent and Effluent Wastewater

S/N	PARAMETERS	Influent	Effluent	FMENV LIMIT
1	Appearance (in situ)	Brownish	Light Brownish	Clear & Colourless
2	Colour (Hazen Units)	52	22	25
3	pH at 25 °C (in situ)	9.0	7.8	6.5-8.5
4	Temperature °C (in situ)	27.0	27.1	35 - 40
5	Conductivity (µs/cm)	64.0	100	NS
6	Odour (in situ)	Unpleasant	odourless	Odourless
7	Total Suspended Solids (mg/L)	50	30	30 max
8	Total Dissolved Solids (mg/L)	120	52	2000
9	Alkalinity (CaCO ₃ mg/L)	27	100	NS
10	Acidity (CaCO ₃ mg/L)	4.5	3.0	NS
11	Total Hardness (CaCO ₃ mg/L)	30	70.	NS
12	Zinc (mg/L)	0.58	0.03	<1
13	Iron (mg/L)	0.28	0.03	20
14	Calcium (as Ca ²⁺ mg/L)	3.0	20	200
15	Magnesium (as Mg ²⁺ mg/L)	5.4	6.0	200
16	Lead, (mg/L)	<0.05	ND	<1
17	Copper, (mg/L)	0.02	0.02	<1
18	Nickel (mg/L)	0.05	0.02	<1
19	Manganese, (mg/L)	0.02	0.02	5

21	Chromium (Tri/ Hexavalent mg/L)	<0.005	ND	<1
22	Cadmium (mg/l)	<0.001	ND	<1
23	Nitrate (NO ₃ ⁻) (mg/L)	7.1	3.8	20
24	Chloride (mg/L)	11.3	12.0	600
25	Sulphate(as SO ₄ ⁻ mg/L)	34.0	15.2	500
26	Phosphate (as PO ₄ ⁻ mg/L)	0.6	0.8	3.5
27	Biochemical Oxygen Demand at 20 °C, (mg/L)	2.0	25	30
28	Chemical Oxygen Demand (mg/L)	210	130	80
29	Dissolved Oxygen (DO) (mg/L) (in situ)	6.8	3.2	Not <2
30	Phenolic compounds (as phenol) (mg/L)	<0.005	<0.1	<0.5
31	Oil and Grease (mg/L)	<0.5	<0.5	10
32	TotalPlate count (cfu/100ml)	56	605	5000
33	Total coliforms (cfu/100ml)	0	10	200
34	E.Coli (cfu/100ml)	0	0	0

ND = Not Determined

It is expected that all manufacturing companies that generate wastewater during their operations should engage in wastewater treatments before discharging it to the water bodies. The effectiveness of the treatment will determine the quality of the water discharged from the system. The results indicated odourless and

clearer colour were observed from the influent. The pH was brought down from 9.0 to 7.8 with the heavy metal kept below maximum limit.

The pH of the influent was brought down from 9 to 7.8. This is in accordance with the regulatory standard limit of (6.5 - 8.5). It was also observed that the

microbial load of the influent was very low because of the nature of the operation which uses water majorly as a coolant for their machine and therefore it is expected that the microbial load of the wastewater should be minimal. There was an increase in conductivity of the treated wastewater compared to the influent and this can be attributed to the elimination of organic contaminants in the influent and the inorganic compound and other anion charged into the treatment process.

. . The Biochemical Oxygen Demand (BOD), and the Chemical oxygen demand (COD), nitrates, oil and grease, and phenolic compounds, also the colour and the odour of the effluent was also fell within the regulatory limit which shows the effectiveness of the treatment employed by the system. Metals such as lead, zinc, , copper, nickel, chromium, and iron were within the acceptable range of the standard which showed that the effluent is environmentally friendly.

CONCLUSION

Effective quality control are of great importance in sustaining the discharge of waste water⁵ treated to conform to regulatory standards. The maintenance of constant high efficiency of waste water deliveries from the wastewater treatment plant will also assure the quality of the effluent discharge to the environment. Based on these, it is expected that all companies should fulfil their statutory function of treating their wastewater before discharge because it makes the world a safer place for us to live in.

The result obtained from the influent of the company compared with the regulatory bodies showed that pH

, colour and the total suspended solids is within the acceptable standard limits.

The major contaminants in glass wastewater are suspended solids which comes from both silica sand and cullet treatment plants, it was reduced from 50mg/L to 30mg/L. The organics and it's related compounds have been treated to have moved conductivity from 64 to 100 . However, the bacteriological related pollutants were almost removed as the wastewater were not organically contaminated. With most of the wastewater components treated to unarmful concentrations level. It can thus be concluded that the quality of effluent treated released to the immediate environment was evaluated and ascertained to be in compliance with government statutory regulations requirements. The result of the effluent showed conformity with the standard, this showed the effectiveness of the factory wastewater treatment operation. Comparative analysis of the influent and effluent results showed that the company's wastewater treatment facilities are top-notch because it was efficient in converting polluted wastewater to environmentally friendly effluent.

REFERENCES

1. D. Purushotham, Narsing Rao, A., M. Ravi. Prakash,. (2011). Environmental Impact on groundwater of Maheshwaram Watershed, Ranga Reddy district, Andhra Pradesh. J Geol Soci India 77(6): 539-548
2. D. Fahrion. (2019). Waste Control is your waste and cost reduction expert

- <https://wastecontrolinc.com/2019/07/11/the-different-types-of-industrial-waste>
3. S. Srinivasa, Gowd., B. Kotaiah. (1994) Groundwater pollution by Cystine manufacturing industrial effluent around the factory. *Environ Geol* 39(6): 679-682.
 4. V. Werner,. 1994. *Glass Chemistry* Springer-Verlag Berlin and Heidelberg GmbH & Co. K. 2nd Revised edition ISBN 3-540-57572-3.
 5. American Public Health Association (APHA), American Water APHA In: Standard Methods for the Examination of Water and Wastewater. Works Association (AWWA) & Water Environment Federation (WEF), 21st Edition, Washington, DC. 1368.
 6. H. Hassan & P Amadi,. (2013). Industrial waste management with application of RIAM environmental assessment: A case study on tools of industrial wastes. *Iranica J. Energy and Environ*, 4 (2), 142-149.
 7. I. Kannj, and O. Achi, (2011). Industrial Effluents and their impact on water quality of receiving rivers in Nigeria. *Journal of Applied Technology in Environmental Sanitation*, 1, 75-86.
 8. R. S Lokhande,., P. U Singare.,and , D. S. Pimple (2011.). Pollution in Water of Kasardi River Flowing alongTaloja Industrial Area of Mumbai, India. *World Environment* , 1(1), 6-13.
 9. S. Patel, A Mehta,. and H. Solanki, (2017). Physiochemical Analysis of Treated Industrial Effluent Collected from Ahmedabad Mega Pipeline. *J Environ Anal Toxicol*, 7(5), 16. doi:doi: 10.4172/2161-0525.1000497