Characterizing Automobile Industrial Wastewater and its Impacts on Surrounding Water Quality

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ABSTRACT

The wastewater from industries varies so greatly in both flow and pollution strength. So, it is impossible to assign fixed values to their constituents. It is necessary to pretreat the wastes prior to release to the municipal system since lack of adequate treatment of the effluent can cause deterioration of the ecosystem, die off and contamination of the aquatic environment. These adverse effects necessitated the study of wastewater effect on surface water body at Emene Industrial Layout, Enugu State, Nigeria. Wastewater samples were collected, analyzed and compared with the plot of treatment means. The results obtained from the study were compared with WHO and NIS 554 water standards. The wastewater analysis suggested that contaminant at the untreated stage was very high. The results of the treated and river sample were within the WHO and NIS 554 allowable water ranges. Samples at discharge point recorded increased values which suggest high re-contamination along the open channel (from non-point sources) before discharge. This calls for proper monitoring and treatment of the industrial effluent prior to ground water recharge or discharge to surface water.

Keywords-- Water Quality, Wastewater, Automobile Industry

I. INTRODUCTION

Discharge of wastewater causes percolation of wastes to the ground water or flushing into the surface water. Most industries in Nigeria discharge their wastewater into open drain/channel. According to the report of the UN Department of Technical Cooperation for Development. (1985), about $2.15 \times 10^5$ million gallons of industrial wastewater is being produced daily from industrial sectors in most countries. World Bank (1993) asserts that very few industries employ primary treatment and chemical neutralization. Therefore it is expected that soil, surface and even groundwater may be contaminated in industrial areas due to high organic load which affects the dissolved oxygen levels, thus impacting water quality and aquatic organisms. Additionally, the nitrogen or phosphorous washed into water bodies will lead to eutrophication and subsequent oxygen depletion and will facilitate the growth of toxin-producing algae (Metcalfe and Eddy, 1991). Nitrogen can contaminate ground water and surface water bodies by infiltration and agricultural runoff. High concentrations of biodegradable organic matter in agricultural runoff water can lead to the consumption of dissolved oxygen in lakes and rivers (WHO, 2006; Choukr-Allah and Hamdy, 2003).

Figure 1: Typical Discharge of industrial wastewater to a river (Abdulrzeza, 2006)
The discharge of the wastewater in a non-treated form into watercourses and rivers as shown in fig.1, leads to the degeneration of surface of the water quality to the point where it became unsuitable for direct use for drinking purposes. According to (Abdulrzzak, 2006), most important results of this noticeable pollution of rivers and other water bodies are the disappearance of living organisms because of the lack of oxygen, nutrient enrichment, high diurnal variation, depletion of dissolved oxygen level, the appearance of undesirable plants and weeds that clog water canals in certain regions, hateful odor of organic materials and the abundance of insects and rodents. This work is targeted at characterizing the untreated (raw), treated wastewater at various points of discharge as well as water from the river.

II. MATERIALS AND METHODS

2.1 Study Sites Description

The study carried out in a river located at Nkpologu area within the Industrial zone of Emene located in Enugu State, South Eastern Nigeria on the coordinate of 6°27’9.60″N, 7°30’37.20″E at an altitude of 218 above sea level, having population of above 100,000 persons, is within a tropical rain forest with an annual rainfall range of 152cm to 203cm that spans the range of 4 to 6 months. The dry season lasts for about 5-7 months with temperature between 32°C and 37°C and relative humidity of around 71% (Ministry of Works, Land and Transport Enugu, 2005). This area is where major Automobile industries are found, such as Mercedes-Benz Anambra Motor Manufacturing Company (MB-ANAMMCO), Peace Automobile workshop, Innoson Plastic Manufacturing Company, amongst other industries. The Nkpologu River is where MB-ANAMMCO discharges its waste water, hence the study site.

2.2 Sample Collection and Analysis

The primary data captured is based on the site collection of wastewater samples, physical observations, and personal interviews around the sites of study. While supporting information to were gotten from the internet, textbooks, journals, survey reports from ministries and relevant institutions.

Using conventional (World Health Organization, 2004) automobile industrial wastewater sample, which flows through the open channel samples, were collected at four different points: an untreated wastewater sample from the biological tank (point A), just outside the industry at the outlet effluent point (before falling into the surface drain point B), Just at the point where the wastewater is being used for agricultural irrigation purpose (point C) and water sample from the river (D).

All wastewater samples using the analytical methods from Australian laboratory handbook of Soil and Water chemical methods (Rayment and Higginson, 1992) and American Public Health Association (1992) were...
analyzed for total soluble salts, pH, soluble Ca$^{2+}$, Mg$^{2+}$, CO$_3^{2-}$, HCO$_3^{-}$ and heavy metals such as Cu, Zn, Mn and Fe. The samples were also analyzed for the concentrations of 

$$SAR = \frac{Na^+}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

The data obtained were subjected to using the plot of treatment means for sample compared.

### III. RESULTS AND DISCUSSION

The result of wastewater analysis at four different points is shown in Table 1. The water analysis result could not be analyzed with any standard statistical analysis means, the comparison of mean value was used in the analysis. The pH values of the four tested samples were not within WHO (2004) and NIS (2007) recommended range which is 6.5-8.5 and 6.5-9.0 respectively. It was also observed that from the plot of means, that the treated wastewater at the discharge point had tolerable value Mg$^{2+}$, Ca$^{2+}$ and Na$^+$ for all samples tested as can be seen in Table 1. Fe$^{2+}$, Mn, Ba, fecal coliform, BOD$_5$ and Cl$^-$ showed the highest values at the reuse point, at water body and at the untreated stage than the point before exist and above the tolerable range for standards. The odour level was objectionable for all samples but Hardness was within NIS (2007) standard of 150mg/l. The relative high value of SO$_4^{2-}$ and K at the reuse point was above the others tested points suggest high re-contamination along the open channel before discharge to the river.

| Treatments | Untreated wastewater (A) | After treatment before exit (B) | Point before reuse (C) | Sample from the River (D) | WHO Standard | NIS Standard |
|------------|--------------------------|--------------------------------|------------------------|--------------------------|--------------|--------------|
| pH         | 5.9                      | 4.6                            | 4.9                    | 7.10                     | 6.5-8.5      | 6-9          |
| Mg$^{2+}$  | 1.6                      | 2.2                            | 1.4                    | 0.9                      | NS           | 0.20         |
| Na$^+$ mg/l | 0.29                    | 0.29                           | 0.27                   | 41.3                     | 75           | NS           |
| Ca$^{2+}$  | 5.5                      | 9.2                            | 4.0                    | NS                       | 200-600      | 200          |
| N (%)      | 0.238                    | 0.266                          | 0.264                  | 0.48                     | 4-4.5        | 2.0          |
| K$^+$ mg/l | 22.29                    | 12.95                          | 6.3                    | 6.0                      | NS           | NS           |
| Cl mg/l    | 207                      | 124.2                          | 138                    | 120                      | 75           | 250          |
| SO$_4^{2-}$/mg/l | 0.004          | 0.0026                         | 0.0026                 | 0.003                    | -            | 100          |
| Fe$^{2+}$/ppm | 0.84                    | 2.52                           | 0.84                   | 1.82                     | 0.3          | 0.3          |
| Mn mg/l    | 35.11                    | 27.47                          | 32.96                  | 15                       | 0.2          | 0.2          |
| Ba mg/l    | 2.38                     | 3.56                           | 2.38                   | 1.8                      | 0.7          | 0.7          |
| EC (dS/m)  | 26                       | 27                             | 22                     | 20                       | NS           | NS           |
| NO$_3^{-}$/ | 0.7583                   | 4.2286                         | 0.4764                 | 0.5                      | NS           | 50           |
| NH$_3^{+}$/ | 510.9                    | 340.6                          | 85.15                  | 80.5                     | NS           | NS           |
| Cu$^{2+}$/ | 0                       | 0.0089                         | 0.0178                 | 0.02                     | 1.0          | 1.0          |
| HCO$_3^{-}$/ | 275                      | 50                             | 35.2                   | 27                       | NS           | NS           |
| CO$_2^{-}$/ | 0                       | 0                              | 0                      | 0                        | NS           | 0            |
| Coliform MPN/100ml | >24,000         | 1100                           | 120                    | 110                      | NS           | 10           |
| BOD$_5$/ | 44                       | 12                             | 43                     | 32                       | NS           | 30           |
| SAR        | 17.10                    | 14.84                          | 13                     | 10                       | NS           | NS           |
| Odour      | Objectionable            | Objectionable                   | Objectionable          | unobjectionable           | Odourless    | Odourless    |
| Hardness   | 50                       | 15                             | 13.5                   | 14                       | NS           | 150          |

All units are in mg/l except stated otherwise.

**NS-Not stated; WHO- World Health Organization; NIS- NIGERIAN INDUSTRIAL STANDARD**
IV. CONCLUSIONS AND RECOMMENDATIONS

The study found wide variation in chemical status of automobile industrial wastewater given primary treatment and discharged to the Nkpologu surface water body. High values and intolerable limits for Fe²⁺, Mn, Ba, Fecal Coliform, BOD₅ and Cl⁻ as well as objectionable odour level of wastewater at the discharge point call for proper monitoring and treatment of the industrial effluent prior to discharge. This situation may affect the water ecosystem in ways such as; creating salinity hazards and water deficiency, eutrophication, causing toxicity and other problems to aquatic habitat as well as the environment.

Although these levels may not be high enough to result in short-term aquatic environmental deterioration, but long term chemical accumulation may result, these chemical changes may in part contribute to stress symptoms and die off in some water lives. It is therefore recommended that automobile industrial wastewater from industries at Emene industrial zone be subjected to more treatment before discharge to surface water in the area.

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