



# Chemical liquid waste management in Senior High Schools and educational research institutions in the Accra Metropolis

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**Abstract:**

Chemical liquid wastes are generated as a result of teaching and research activities in science educational and science research institutions. It is however not immediately clear how these chemical liquid wastes are treated by schools and educational research institutions before they are discharged into drains. The study explored to what extent, chemical liquid waste was managed in the senior high schools and some research institutions in the Accra Metropolis. Again, the study sought to establish the means of disposal of chemical liquid waste in educational and research institutions in the Metropolis, and also ascertained the policy guidelines of the GES and GAST on the management of chemical liquid wastes in senior high schools in the Metropolis. The study which involved thirteen (13) Senior High Schools and five (5) educational research institutions employed a descriptive research design with questionnaires as instrument for data collection. The study revealed that chemical liquid waste was not properly managed from the institutions and recommends development of Educational Chemical Waste Management Guidelines by the GES and GAST and the monitoring of liquid chemical wastes generated by universities and research institutions by EPA.

**Keywords:**

Chemical Wastes; Educational Institutions; Environmental Protection Agency (EPA); Ghana Association of Science Teachers (GAST); Ghana Education Service (GES); Research Institutions.

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## 1. Introduction

Science and technology are the backbone for the development of a country. Consequently, Ghana places a lot of emphasis on the study of science with Chemistry as one of its components. The teaching of chemistry includes theory and demonstration classes. In the demonstration classes which are carried out in the laboratory, chemical liquid wastes are generated and are discharged into sinks. These wastes are washed away into gutters and eventually enter streams affecting water quality. Key contaminants that could result from the educational institutions and research institutions are chlorides, phosphates and sulphates of copper because of their extensive use in chemical analysis. Some people use water from these water bodies especially in urban areas for irrigation of vegetable and fruits and other food crops, producing chemically contaminated food which could create all sorts of diseases including some cancers (Bahri, 2009; Keraita et al., 2002; Keraita, 2003; Mosley et al., 2004). Chemical liquid wastes discharge from educational and research institutions in the Accra Metropolis could therefore be a source of water pollution. It is however not immediately clear how these institutions manage their chemical liquid wastes before discharging them into the drains. The study therefore aimed at finding out how schools, colleges, universities, and other research institutions manage chemical liquid wastes generated during the course of their laboratory activities.

The study specifically was set: to explore to what extent, chemical liquid waste was managed in the senior high schools, universities and some research institutions in the Accra Metropolis, to establish the means of disposal of chemical liquid waste in some educational and research institutions in the Accra Metropolis, to ascertain the Ghana Education Service (GES) and Ghana Association of Science Teachers (GAST) Policy guidelines on the management of chemical liquid waste in senior high schools in the Accra Metropolis and ascertain the EPA Environmental Quality Policy Guidelines on effluent discharge for educational and research institutions.

## 2. Review of related literature

High chloride concentration in water and wastewater can inhibit the growth of plants, bacteria and fish in surface waters; high levels can lead to breakdowns in cell structure (APHA, 1992; Bosnic et al., 2000). High chloride content may indicate pollution by sewage or industrial wastes. A high chloride content has a corrosive effect on metal pipes and structures which makes it harmful to most trees and plants (UNEP/WHO, 1996). Chlorides are relatively harmless to organism except when converted to  $Cl_2$  and  $ClO_3^-$  which are toxic (Ampofo-Nuako, 2012). In Ghana, Ampofo-Nuako, (2012) reported that the levels of chloride in all the effluents were greater than the EPA, Ghana maximum permissible level which is 250.00 mg/l in senior high schools in the Kumasi metropolis. Ampofo-Nuako et al (2012), however did not establish how the schools managed their chemical liquid wastes before discharging into the environment.

Phosphorus present in domestic wastewater is an important macro-nutrient for plant and microorganisms' growth. The discharge of large quantities of this nutrient, into natural receiving sources, raises the growth of algae and results in eutrophication of lakes and streams (Mervat and Logan, 1996) as cited by Ampofo-Nuako et al, (2012). Ampofo-Nuako et al, (2012), observed that in Kumasi Metropolis, all schools exceeded the EPA permissible level of phosphate discharge into river bodies, which is 2.00 mg/l. The knowledge of the management of these chemical liquid wastes by the schools and educational research institutions will go a long way in recommending effective methods of managing chemical liquid wastes to keep the chloride and phosphorus levels within permissible levels

Usually, water-soluble copper compounds occur in the environment after release through application in agriculture (ATSDR, 1990). In surface water copper can travel great distances, either suspended on sludge particles or as free ions (Skipton et al., 2008). High levels of copper can be harmful. Very-high doses of copper

can cause damage to the liver and kidneys, and can even cause death (Wong, 1988; ATSDR, 2004.). Its release into water bodies has been found to have a high chronic toxic effect on aquatic life even as low as a level of 0.3 mg/L total copper (Bosnic et al., 2000). The level of copper in some schools in the Kumasi Metropolis were observed to be above the EPA Ghana permissible limit of 5 mg/l for copper (Ampofo-Nuako et al, 2012). This level recorded by Ampofo-Nuako et al (2012), may be due to the fact that copper sulphate is used a lot in chemistry demonstration lessons in the schools and therefore if the chemical liquid wastes are not treated before discharging into streams, can be a source of pollution to affect aquatic life.

### **3. Methodology**

Descriptive design was used in this research work as it relies on observation by the means of collecting data. Questionnaires were used to collect data for this research. Thirteen senior high schools were purposively selected for this research. The schools selected all offered the general science program with the option of teaching chemistry and the presence of science laboratories. The chemistry department of the public university and the science laboratory technology department of the polytechnic were also selected since they offered courses which demanded the demonstration classes and the subsequent generation of chemical liquid waste in their laboratories. Two educational research institutions which carry out research work using a lot of chemicals in their laboratories were also selected for this work. The government agency responsible for environmental protection but also having a laboratory for environmental quality was also selected for this work.

#### **3.1 Instrument, Data collection and analysis technique**

The questionnaire was used as an instrument for data collection. The questionnaires were structured into three (3) sections. The first section covered the demography of the school or the institution. The second section was on the chemicals frequently used in chemistry laboratories for practical classes and the third section covered the treatment and disposal of chemical liquid waste in the various chemistry laboratories in the senior high schools and educational research institutions.

The questionnaire was administered in each senior high school and the educational research institutions. The questionnaire was pretested in two (2) senior high schools and was modified to suit the objectives of this research. The Chemistry teachers in the senior high schools whilst the heads of Chemistry Departments formed the respondents in the research institutions.

The data collected were analysed using SPSS and statistical descriptive were used in expressing the results.

### **4. Data analysis**

The analysis of the data collected from the field is presented in this section. The analysis is followed by a discussion which is presented in relation to literature.

#### **4.1 Management of chemical liquid waste in schools, universities and some research institutions in the Accra Metropolis**

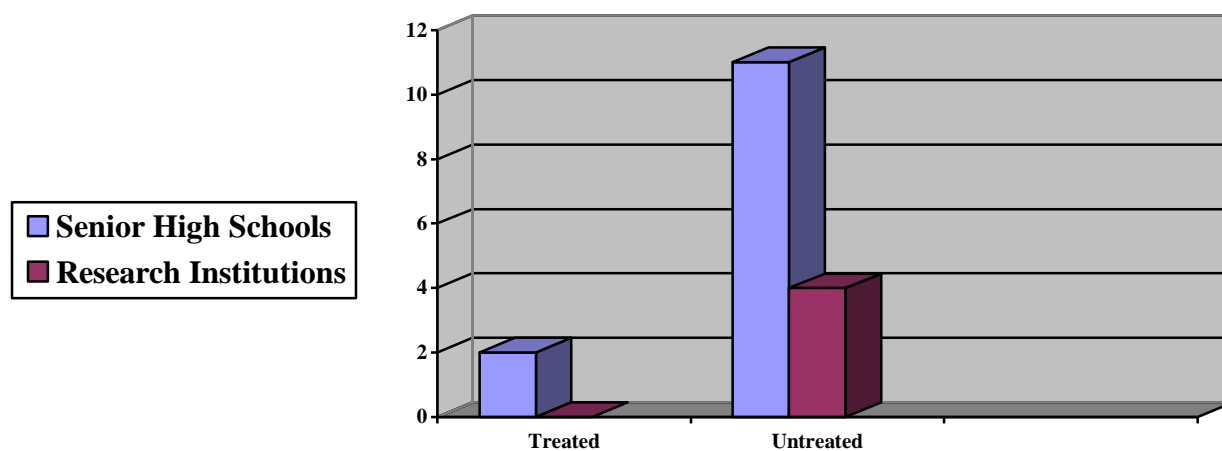


Figure 1: Treatment of chemical waste in senior high schools and educational research institutions

Concerning management of chemical liquid wastes, figure 1 indicates that in some senior high schools in the Metropolis, majority of respondents (84.62%) indicated that chemical liquid wastes from their laboratories was not treated before discharged into the sinks in the laboratories. Fifteen percent (15.38%), however responded that chemical liquid wastes from their laboratories were treated before disposal. The latter response may probably have come from some of the well-endowed schools with well-trained Laboratory Assistants and environmentally conscious Headmasters or Headmistresses. In the educational research institutions, all four (4) institutions reported the absence of facilities for the treatment of chemical liquid waste. These responses seemed to suggest that liquid chemical wastes were not treated by the schools and educational institutions before they were discharged into the environment. This may be due to the fact that, most laboratories were built without treatment facilities and these institutions might have taken for granted the impact of these chemical liquid wastes on water quality due to the amount discharged into the environment. This however could be problematic bearing in mind that small amounts of these chemicals in the liquid waste could affect water quality.

#### 4.2 Methods of disposal of chemical liquid waste

Table 1: Where chemical waste finally ends from the laboratories of senior high schools and educational research institutions

Location	Frequency (SHS)	Percentage	Frequency (Research Institutions)	Percentage
Open drain	10	76.93	3	75
Septic tank	1	7.69	1	25
No idea	2	15.38	-	-

Concerning disposal of chemical liquid waste in senior high schools and educational research institutions, most of the respondents (76.93%) in senior high schools indicated that chemical waste from practical activities is disposed of in open drains, a few (7.69%), however indicated that the sinks in their schools were connected to septic tanks where these chemical liquid wastes finally end. The effects of these chemicals on the chemical reactions in the septic tank was beyond the scope of this paper and thus no attempt was made to that effect. The rest 15.38% of respondents however had no idea where the chemical liquid waste generated leads to after their demonstration classes. In the educational research

institutions, 75% of respondents as in the senior high schools indicated the chemical liquid waste generated ended in the open drains after their demonstration classes whereas 25% of respondents indicated the chemical liquid waste ended up in septic tanks.

The disposal of untreated chemical liquid waste into the environment, results in bioaccumulation and biomagnification of some persistent organic compounds in the tissues of some organism. These persistent organic compounds could consequently be found throughout the food chain in the ecosystem. The presence of chlorides in the chemical liquid wastes could inhibit the growth of plants, bacteria and fishes in the surface waters (APHA, 1992, Bosnic et al, 2000). The presence of high nitrates in the chemical liquid wastes disposed into the environment untreated could result into eutrophication when phosphates are also present. The high nitrates in drinking water are of immense health risk to babies leading to methemoglobinemia and also interrupt with the normal body processes in some infants. (UNEP/WHO, 1996).

The high percentage of open drain disposal of chemical liquid waste in the senior high schools and educational research institutions could partly be attributed to the poor design of most educational laboratories in the country before the promulgation of the Environmental Assessment Regulation (LI 1652, 1999) which enjoins all undertakings to be environmentally permitted. The Environmental Assessment Regulations (LI 1652, 1999) as amended (2002) requires that all activities likely to have an adverse effect on the environment must be subjected to environmental assessment and issuance of a permit before commencement of the activity. Even though the LI make provisions for undertakings that existed before the enactment of this law to be permitted ex post facto, the authors are not sure whether this was done by the authorities.

#### 4.3 Awareness of Policy Guidelines on Chemical waste management for educational and research institutions

Table 2: Knowledge of GES/GAST policy guideline on treatment and disposal of chemical waste

Option	Frequency (SHS)	Percentage	Frequency (Research Institutions)	Percentage
Yes	4	30.77	2	40
No	5	38.46	2	40
No idea	4	30.77	1	20

Schools operate under the Ghana Education Service (GES) whiles educational research institutions operate under the Ministry of Education. The science teachers teaching in the senior high schools belong to a professional Association, Ghana Association of Science Teachers. As part of this study, the researcher sought to find out the existence of policy guidelines regulating the management of chemical liquid wastes and the means of its disposal for senior high schools and educational research institutions from the GES, GAST, MoE and EPA and the awareness of its existence by the respondents. It was established that apart from the EPA, the MoE, GES and GAST did not have any policy to that effect.

## 5. Summary of findings

The study established that chemical liquid waste from the laboratories of senior high schools and educational research institutions undergo little treatment or none at all before they are discharged into the environment. Again, the GES and GAST do not seem to have any policy guidelines on the management of chemical liquid wastes for educational institutions. The schools themselves do not have any except some guidelines on handling of chemicals and safety precautions on the preparation of some gases like chlorine.

The EPA has guidelines for the management of health care and veterinary waste which are deemed to be using almost similar chemicals as used in the senior high schools and educational research institutions. The Environmental Quality laboratory of EPA also has guidelines for effluent discharge for industries that make use of chemicals that can pose danger to public health. But there is no policy guideline on the effluent discharge from senior high schools and educational research institutions that use chemicals of the same composition and characteristics.

## 6. Recommendations

Chemicals are generally poisonous to life depending on the quantity taken into the body over a period of time. It is very important and as a matter of urgency that the treatment and disposal methods of chemical liquid wastes be taken seriously through the country.

Based on the findings of this research, the following recommendations are made:

- The EPA must develop environmental quality standards guidelines of effluent (Chemical Liquid Waste) discharge for educational and research institutions in the country.
- The MoE, GES and GAST using the EPA Ghana standards develop safety guidelines for the treatment and disposal of chemicals and chemical liquid waste from the laboratories of research institutions and senior high schools.
- The proper management of chemical liquid waste must be included in any training programme of science teachers and researcher scientist in chemistry.
- The Ghana Education Service and Ghana Association of Science Teachers should organize periodic training workshops for chemistry teachers, laboratory assistants and laboratory technologists on the best practices of treatment and disposal of chemicals and chemical liquid waste.

## Conflict of Interest Statement

The authors declare no conflict of interest in the conduct of this study.

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## Biographical notes



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He possesses an MSc. in Environmental Management and Sustainability, NEBOSH (IGC) in Occupational Health and Safety (UK). PGDE and BSc. Biological Sciences. He is also a member of the Ghana Institute of Safety and Environmental Professionals (GhiSEP). Daniel is currently a Biology and Integrated Science tutor at Our Lady of Mercy Senior High School, Tema-Ghana. He is currently the Head of Department of the Biology Unit in the School. He also lectures Anatomy and Physiology on part-time basis to Nursing and Dispensary students. He has always had a passion for issues related to Environment, Health and Safety and his career objective is to impart and contribute to knowledge in this field.