

ENGINEERING IN SOCIETY

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY



**COLLEGE OF ENGINEERING
DEPARTMENT OF CHEMICAL ENGINEERING**

CENG 291

CHEMICAL WASTE MANAGEMENT IN SCHOOLS

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ABSTRACT

When it comes to the topic of environmental pollution of the environment the main concerns of people are mostly on illegal mining activities, noise from factories etc. We fail to acknowledge the fact that in pursuing scientific knowledge we contribute to polluting the environment. Especially in secondary schools where most of the practical work for those pursuing science begins. A variety of chemicals are used in the chemistry laboratory and after each exercise they discharged into sinks without any treatment. These effluents eventually flow through the drains and join water bodies and the underground.

This report seeks to help solve this and treat waste from laboratory instead of disposing them into sinks.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Course

The course Engineering in Society (CENG 291) also known as the Provost's Special Initiative was introduced by the College of Education, Kwame Nkrumah University of Science and Technology, Kumasi. The course is geared towards equipping students with the required skills needed to identify problems in the surrounding and how to approach and help fix these problems.

1.2 Objectives

This course aims at encouraging students early in their program of study to draw a link between their chosen field of Engineering and the application to the issues that confront the day to day lives of the people in the society. This will hopefully address our problems and ease our shoulders of the burdens we face each day.

The main purpose of the report is to examine waste generated from chemistry laboratories in schools typically secondary schools. The project is aimed at achieving the following:

- The effects of the chemical waste from the laboratory on the environment.
- The field of chemical engineering and various branches of it.
- Find a different method of disposing chemicals other than through the drains.

CHAPTER TWO

2.0 METHODOLOGY

2.1 Problem Identification

In identifying the problem many students of Asanteman and Adventist were spoken to and through their suggestions and also once being a student pursuing science as a program in the secondary level agreed on the problem. Disposal of waste from chemistry laboratories was chosen as the problem to be studied.

2.2 Preparation of the Map

Three things were employed in the preparation of map. These are the Wi-Fi, GPS and Google Map where the map was downloaded from via mobile phone to obtain a satellite view of the study area. The map shows both schools and their surrounding communities.

2.3 Collection of Data

The chemistry laboratory of Asanteman Senior High school was visited and some of the commonly used chemicals were taken into account. Different chemistry teachers and science students were interviewed and asked various questions relating to the problem and how their effect on the environment and how best to curb it. Information was also gathered from the internet and Chemistry text books on the various chemicals used in the laboratory during these practical lessons and how these chemicals react different when introduced into the atmosphere.

Questionnaires were given out to various students whilst others were interviewed on their views towards the proposed problem.

CHAPTER THREE

3.0 DISCUSSION OF RESULTS

3.1 Description of Study Area

Asanteman Secondary School is a school located at Bantama in the Ashanti region of Ghana. It currently has a population of about two thousand five hundred (2,500) students of which offer the program of General arts, General Science, Visual Arts, Home Economics. They have moderately equipped laboratories for pursuing knowledge in the 3 field of science. The school is located at 6°42'0 North, 1°38'0 West. It is surrounded by a market to the right, with mechanic shops and a police station to the north.

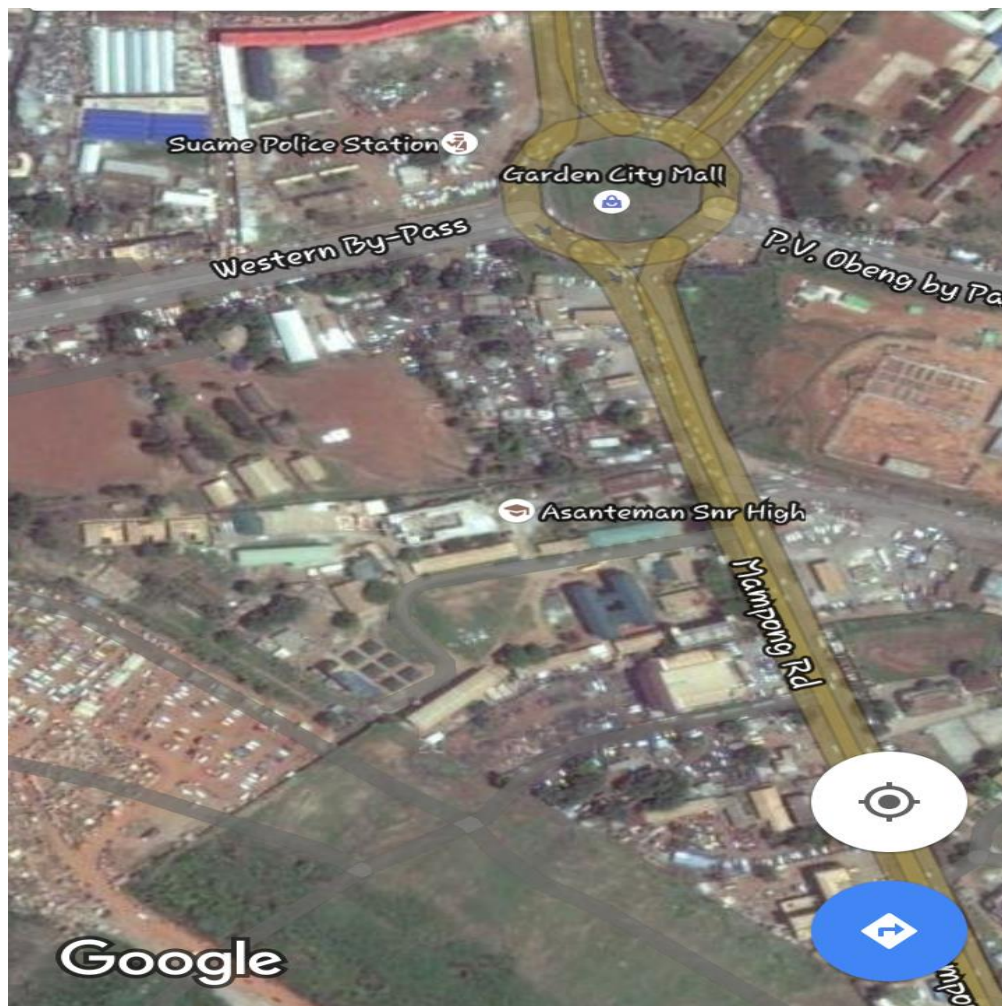


FIGURE 1: The map of Asanteman SHS and neighbouring community

3.2 Nature and Characteristics of the Problem

3.2.1 What is Chemical Waste?

Chemical waste is generally referred to any kind of waste that is made from harmful chemicals. These waste are mostly generated from large factories but can also be produced outside these factories but in small amounts. According to a research headed by the Boston University Research department, laboratories which use chemicals generate chemical waste in small or large quantity as a result. Federal and State regulations have put in place strict regulations regarding how chemical waste must be classified, accumulated and disposed of.

3.2.2 Classification of Chemical Waste

Chemicals are classified as being hazardous or not. Chemical wastes are classified as hazardous if it is specifically listed by the Environmental Protection Agency (EPA) as hazardous, that is if it meets the four hazardous characteristics that is **ignitable, corrosive, reactive** and **toxic**. If a chemical is not in the EPA list of hazardous waste and does not meet any of the hazardous characteristics it is a non-hazardous waste. Though care must still be taken in disposing them of and should not be poured into sinks. The list contains many chemicals of which fluorine, hydrogen, cyanide, methane, nitric oxide form part and are used in the various chemistry laboratories in Ghana.

3.2.3 The Problem

The study of science is very practical and so entails a lot of practical activities. Due to this reason it has become compulsory for any secondary school in Ghana that pursues science as one of its course of studies to have laboratories dedicated to the study of science. The various senior high schools in Ghana perform various practical exercises with chemicals such as CN^- (in Potassium hexacyanoferrate (II) and Potassium hexacyanoferrate (III)), Zinc, Ammonia, Sodium hydroxide (NaOH) etc. These chemicals if exposed to the environment through disposal into the drains can harm both aquatic and human lives when allowed into water bodies (Bahri, A., *et al*, 2008).

According to interviews and data collected from the internet it was determined that chemicals even before reaching into the drains may or may not react and cause chemicals which are not harmful to become harmful. A survey was carried out to determine how these react by determining the

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components of each of the sink and matching them with some of the chemicals used in the laboratory to determine if they react or not and how these reactions contribute to polluting the environment.

An interview with the lab technician at Asanteman SHS revealed that chemicals which are very reactive and corrosive are disposed of by her personally but in some cases the students neglect warning and still dispose them into sinks. According to her chemicals are collected in a bowl of water to further prevent them from reacting and at the end of the laboratory exercise it is poured into sinks and washed off with a lot of water. With regards to solids, they are disposed by covering them properly and burying it or keeping it in dustbins.



FIGURE 2: Picture showing condition of sink after long period



FIGURE 3: A picture of some chemicals used in the laboratory

Some common ways a person may be exposed to these chemicals if they make their way into the environment include the following:

Water: this occurs when chemicals from the lab through the drains joins underground water. Though at early stages it may be non-harmful over a long period of time if available in large quantities can be introduced into the human body through contaminated groundwater or surface water. Direct skin contact also is an exposure pathway that occurs during activities like swimming and showering.

Air: Exposure occurs when people breathe in chemical vapours during these practicals in the secondary schools. According to interview held at Asanteman SHS it was discovered that students do not use protective clothing during practical exercise and are also not provided by the school. So in cases where gas is evolved they are exposed directly to the chemical evolved.

Soil: People can be exposed to hazardous chemicals in the soil if they incidentally ingest it or breathe it in, or have direct skin contact. Children are highly susceptible to these exposure

pathways. In their daily activities children have a tendency to have frequent hand- to- mouth contact and introduce non- food items into their mouth.

Food: When underground water body becomes contaminated by the chemical. People stand a high risk of exposure since most of mankind's food is planted in this same soil. The plant absorbs the water along with these chemical substances and hence can be transferred to people. Aquatic life also have a high probability of being affected and also pose a threat to people who consume it

3.2.4 Effects of Chemical Waste on the Community

Various chemicals have different effects on the environment when exposed into the environment. Below are some common chemicals used in secondary schools and their effects.

Chlorine ions (Cl^-): high concentration of Cl^- in the environment inhibits growth of plants, bacteria and fish in surface waters. High level lead to breakdown in cell structure. Has corrosive effect on metal pipes and structures.

Nitrate ions (NO_3^-): soluble in water. It is a strong oxidising agent. Low levels of it occur naturally in water but sometimes higher levels are dangerous to infants i.e., high concentration is fatal to infants

Sulphate ions (SO_4^{2-}): one of the least toxic anions containing compound but its presence in drinking water in high concentration causes a laxative effect when combined with calcium (Ca) and magnesium (Mg). Can also lead to dehydration, catharsis and gastrointestinal irritation in other cases.

Chemical pollutants include heavy metals and anions like NO_2^- , NO , Cl^- , SO_4^{2-} , PO_4^{3-} long term exposure to these chemicals such as arsenic, fluoride, boron and nitrate may cause chronic illness, disability and death (Mosley et al, 2004).

3.3 Programme of Study and Branches

3.3.1 Chemical Engineering as a programme of study

Chemical engineering is a field of engineering that deals with the study and practise of transforming substances at large scale for tangible improvement of the human condition, such transformations are executed to produce other useful substances or energy, and lie at the heart of vast segments of the chemical, petroleum, pharmaceutical and electronic industries. This field of engineering apply the principles of the three branches of pure science i.e. physics, chemistry, biology and also mathematics to solve problems that involve the production or use of chemicals, fuel, drugs, and many other products. They design processes and equipment for large- scale manufacturing, plan and test production methods and byproducts treatment, and directly facility operations.

3.3.2 Scope of Chemical Engineering

Chemical engineering as a discipline influences many areas. It covers a wide scope including

- Mineral based industries
- Petrochemical plants
- Synthetic fiber units
- Petroleum refining plants
- Synthetic fiber units
- Chemical industries
- Refineries
- Pharmaceuticals
- Paint and dyes
- Fertilizers
- Textiles
- Plastics
- Nuclear energy

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- Water and its treatment
- Environmental and ecofriendly industries
- Recycling metals
- Food processing
- Paper
- Oil and Gas
- Fuel Combustion Technology

3.4 Suggested solution to the problem of chemical waste disposal

Chemical waste generated in the various schools though cannot be eliminated can be managed. The scale of laboratory experiments can also be reduced to reduce the volume of waste produced.

Hazardous waste containers can be provided at the various laboratories and labelled to help identify the kind or type of chemicals that must be disposed into each container. These containers may be stored in the lab for up to 12 months from the day waste was first placed into the container as long as the accumulation limits is not exceeded.

Waste containers stored in the lab must be:

- In good condition always.
- Kept closed at all times except when filling
- Carefully labelled.
- Waste must always remain in the lab



FIGURE 4: Example of hazardous waste container.

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Facilities where the waste accumulated can be treated and recycled. Most of the products of these experiments which are discharged into sinks can be useful.

For example,

sodium chloride which is generated from most of the neutralisation reactions in secondary schools can be used for:

- Food preservative and flavour enhancer in food industries.
- Glass production.
- It is a major raw material for manufacturing of various chemicals such as sodium carbonate.

Sodium carbonate can also be used:

- in glass making.
- as cleaning agent and is a water softener thus helps detergents to lather more effectively.

Calcium chloride can also be used in the production of calcium salts, food industries and soil solidification.

CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Having gone through the various stages of this study, it is important at this concluding stage to examine whether the objectives for the study have been achieved. First, it was our objective to find the effects of waste generated by the chemistry practical exercises in secondary schools, outline the areas of Chemical Engineering and the different branches of it, describe how the problem may be solved using knowledge from Chemical Engineering, find a way of managing the waste generated rather than disposing them through sinks in the various labs. Taking into consideration the effects of this practise on the environment, generate alternative solution to the problem. Therefore, all the objectives set for the study have been achieved and It is therefore important that the following recommendations are implemented to ensure effective and efficient waste management of the chemicals.

4.2Recommendation

In general chemicals are harmful to human health, hence, care and importance should be given to how they are handled, managed and disposed. The following measures are therefore recommended to reduce the danger to students and the community as a whole:

1. The Ministry of Education, Ghana Education Service should put forward policies and come out with an alternative as to how to discard waste generate from the various chemistry laboratories.
2. Protective clothing should be provided in secondary schools to better protect students during practical exercises.

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APPENDIX

Questionnaire

This questionnaire is meant to obtain information from the students of Asanteman SHS precisely science students to enable Brobbey Mensah Sarpong, a first year Chemical engineering student in Kwame Nkrumah University of Science Technology to complete a course named “Engineering in society”. It is designed for purely academic purposes and I therefore humbly appeal to you to be sincere in filling them.

Instructions

It is in two parts; section A and section B. With the section A, options are being provided and one is kindly requested to tick the one in his/ her candid opinion. For the section B where options are not provided one is kindly requested to write his/her opinion.

Section A

Background Information

1. Age group:

10-15 ☐ 16- 20 ☐ 21 and above ☐

2. Gender: Male ☐ Female ☐

3. Which year are you in currently?

1st year ☐ 2nd year ☐ 3rd year ☐

Section B

1. How often have you been to the chemistry laboratory?

2. How often do you perform practical exercises?

3. Are you always under the supervision of a technician or teacher?

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4. Do you wear protective gears during practical exercise?
5. What happens to the chemical waste after the exercise?
6. Are you satisfied with the way the waste is being managed?

Yes ☐ No ☐

7. If Yes, why and if No, why?
8. What effects does the chemicals disposed have on the people?
9. What is wrong with the way the waste is being managed?
10. What do you recommend to be done to solve this problem?

Thanks for your cooperation.



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Our Ref: Coe-PO/CENG 291/

Date: May 17, 2016

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION

The bearer of this note is a first year engineering student of the College of Engineering conducting a project in a course titled "Engineering in Society".

The overall aim of the course is to inculcate in students an appreciation of the fact that the purpose of engineering is to solve societal problems. This course is aimed at encouraging students early in their programmes of study to draw a link between their chosen field of engineering and the application of this field to the issues that confront the day to day lives of people.

We should therefore be most grateful if you could facilitate his data collection and provide any other assistance that he may need.

Counting on your usual cooperation in such matters.

Yours sincerely,

ING. PROF. S.I.K. AMPADU, FGHIE
Provost, CoE

PROGRAMMES: Agricultural Engineering ■ BSc. Chemical Engineering ■ BSc. Petrochemical Engineering ■ BSc. Materials Engineering
BSc Metallurgical Engineering ■ BSc. Mechanical Engineering ■ BSc Aerospace Engineering ■ BSc. Geological Engineering ■ BSc. Geomatic Engineering
■ BSc. Petroleum Engineering ■ BSc. Civil Engineering ■ BSc Computer Engineering ■ BSc. Biomedical Engineering
■ BSc. Electrical/Electronic Engineering ■ BSc. Telecommunication Engineering
RESEARCH CENTRES: The Energy Centre Technology Consultancy Centre.