KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI, GHANA

COLLEGE OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

CENG 291 ENGINEERING IN SOCIETY

THE MENACE OF FISH SMOKING AND ITS EFFECTS ON THE INHABITANTS OF TEMA NEW TOWN.

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ENGINEERING IN SOCIETY

DECLARATION

I hereby declare that the project work entitled “THE MENACE OF FISH SMOKING AND ITS EFFECTS ON THE INHABITANTS OF TEMA NEW TOWN” submitted to the CHEMICAL ENGINEERING DEPARTMENT of KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLGY (KNUST), is a record of an original work done by me under the guidance of Mrs. Kwao-Boakye Emmmanuella, a lecturer at the Chemical Engineering Department of the College of Engineering, and this report is submitted in partial fulfillment of Engineering in Society project.

……

TETTEH LEBENE KWAME BRIGHT

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ACKNOWLEDGEMENT

First and foremost, I would like to thank the Almighty God for giving me the strength and ideas to undertake this wonderful project. I am also grateful to my supervisor Miss. Emmanuella Bosomtwi for her guidance and support throughout the entire period of undertaking this project. I am forever indebted to Mr. Kemavor Jonathan, Mr.Dzakpasu David and Mr.Agyemang Prince for their routine inspection on the progress of this report and also reading through the final report and effecting the needed corrections. Again, I am most grateful to the people of Tema New Town especially the fishmongers without whose support this report would not have been possible. Finally, to everybody who in one way or the other has contributed immensely to the writing of this report, I say; God richly bless you.

ENGINEERING IN SOCIETY

ABSTRACT

Fishing has been the major occupation of the indigenes of countries with water bodies or better still those countries along the coast of the African continent. Even though fishing and its preservation activities has provided people with sources of livelihood, it has also bedeviled our societies with one problem or the other. This report seeks to address the eminent and challenging problems associated with fish-smoking, one of most common ways of fish preservation of most countries in Africa with Ghana not being an exception. A fishing community, Tema New Town, a suburb of the Greater Accra region of Ghana is used as a case study for this project.

The main scope of this report seeks to establish the nature and characteristics of the effects of smoke on the inhabitants of communities that adopt smoking as a mode of preservation of fishes. The smoke is generated as a result of using firewood at the initial phase of smoking and bagasse (a dry pulpy fibrous matter that remains after sugarcane or sorghum stalks are crushed to extract their juice) is used at the second phase of smoking in order give the fishes a brown and shining appearance. The main methods of data acquisition were through the use of questionnaires, the internet and interviews (one on one chats) with the fishmongers in the community. Analysis of the gathered information proves the fact that, the prolong exposure to smoke by the fishmongers has been the prime factor for the adverse effect on their health. The inhabitants and the environment are also affected at large.

The proposed solution to this menace was to build chimneys over the ovens which will be connected to a plant in order to convert the carbon dioxide gas produced into electricity which will help decrease the release of carbon dioxide gas into the atmosphere which will go a long way to decrease global warming, change in rainfall patterns and rise in sea levels. Another proposed solution is shifting from the traditional method of fish smoking to mechanical method of fish smoking which is generated through smoke condensates, which is created by turning smoke into solid or liquid form.

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1 INTRODUCTION

1.1 Background to the Course

Science is the process of obtaining knowledge through observation and experimentation. The application of this scientific knowledge helps us to edify and design structures, devices and materials that make work easier, faster and also used in rectifying problems in our society.

Engineering in society is a course that seeks to inculcate in students the appreciation of the fact that the purpose of engineering is to solve societal problems. The course also aims at encouraging students early in their programs of study to draw a link between their chosen field of engineering and the application of their field of engineering to the issues that confront the day to day lives of people in the society.

1.2 Aims and Objectives of the Course

Mankind has always dreamt of making the world a better and safer place to live in by inventing devices and designing infrastructures. The invention of these devices and the design of these of these infrastructures are the major roles of engineers, thereby making them very important in today's world and very crucial to the development of any country.

Embarking on research and writing of reports is a vital tool engineers use to solve most societal problems. However, the solution generation process is highly dependent on the quality of research and the vital findings from the research, these findings are used to write reports to the appropriate headquarters for consideration and implementation.

In light of the above, engineering in society (CENG 291) project aims at tasking first year engineering students of the Kwame Nkrumah University of Science and Technology to identify problems and devise solutions to these problems in their various societies by applying knowledge based on their field of study in order to cause an improvement in the lives of the inhabitants of the society and to bring about development. The course also aims to improve the sense of innovation of students and the application of engineering to development.

The main aim of the study is to examine the effects of smoke from the smoking method of fish smoking on the fish smokers, the inhabitants of Tema New Town and the environment at large

and also suggest possible measures to tackle the problem. Specifically, the research aims at achieving the following objectives;

- To identify the health repercussions of the smoke on the fish smokers and the inhabitants of Tema New Town.
- To examine the effects of the smoke on the environment at large.
- To devise alternative means of fish smoking in order to help curb the present menace.
- To make recommendations for effective fish smoking in Tema New Town.

2 MATERIALS AND METHODS

2.1 Identification of the Problem

The problem was identified by the frequent complaints from the inhabitants of the community about the effects of smoke emanating from the smoking of fishes by the fishmongers. This led to an online research into the effects of smoke on the health of human and the environment. The results from the research were very alarming, which in effect is the reason for undertaking this project.

2.2 Preparation of the Map of the Community

The map of the community was obtained from Google maps on the internet.

2.3 The Data and Information Acquisition Process

Data and information were obtained about the proposed problem through three main processes;

1. The use of questionnaires.
2. Conducting interviews.
3. Research using the internet.

2.3.1 The Use of Questionnaires

Questionnaires were used to obtain information from the inhabitants and relevant authorities in the community. These questionnaires were administered to the youth of the community and the Environmental Protection Agency. Copies of questionnaires used can be found in the appendices.

2.3.2 Conducting Verbal Investigation

Verbal investigations were conducted with the fishmongers in the local language (ewe) due to the fact that almost all the women in the fish mongering business are not literates. During the interview, important points and major issues of concern were noted down from each interviewee.

2.3.3 Research Using the Internet

The internet was extensively used to research about the effects of prolong exposure to smoke on the fishmongers, the inhabitants and the environment at large. It was also used find similar problems faced by other communities and how they went about to solve the problem. Facts and findings from these researches were analyzed during the data analyses stage of problem solving.

3 RESULTS AND DISCUSSIONS

3.1 Description of the Community

Tema New Town is a fishing community located in the eastern part of Tema metropolis. It is 20.3 miles / 32.7 km W/SW from Accra- the capital of Ghana and regional capital of Greater Accra Region, 11.1 miles / 17.9 km W/SW from Nungua and 13.2 miles / 21.3 km W/SW from Teshie. [8] The population is about 71,711 which are made up of 34,639 males and 37,072 females according to the 2010 population and housing census. [7]

The town was chiefly inhabited by the indigenous Gas but due to employment and other reasons it is currently cosmopolitan in nature i.e. it is made up of people of different ethnic groups such as Ewes, Hausas and Akans. The predominant occupation of the males is fishing whiles that of the females is fish smoking and mongering due to the proximity of the Tema harbor. Homowo is the festival celebrated by the people of Tema New Town. Christianity, Islamic and traditional religions are the three major notable religions in the community**.** [8]

Although some areas of the community such as Zighe shore, Tooe and U-compound can be described as a slum settlement, the layout of the settlement is the dispersed type.

These slum areas have no proper drainage system and no waste storage and collection equipment, hence solid waste is dumped into gutters lagoon, dump sites and sea shore.

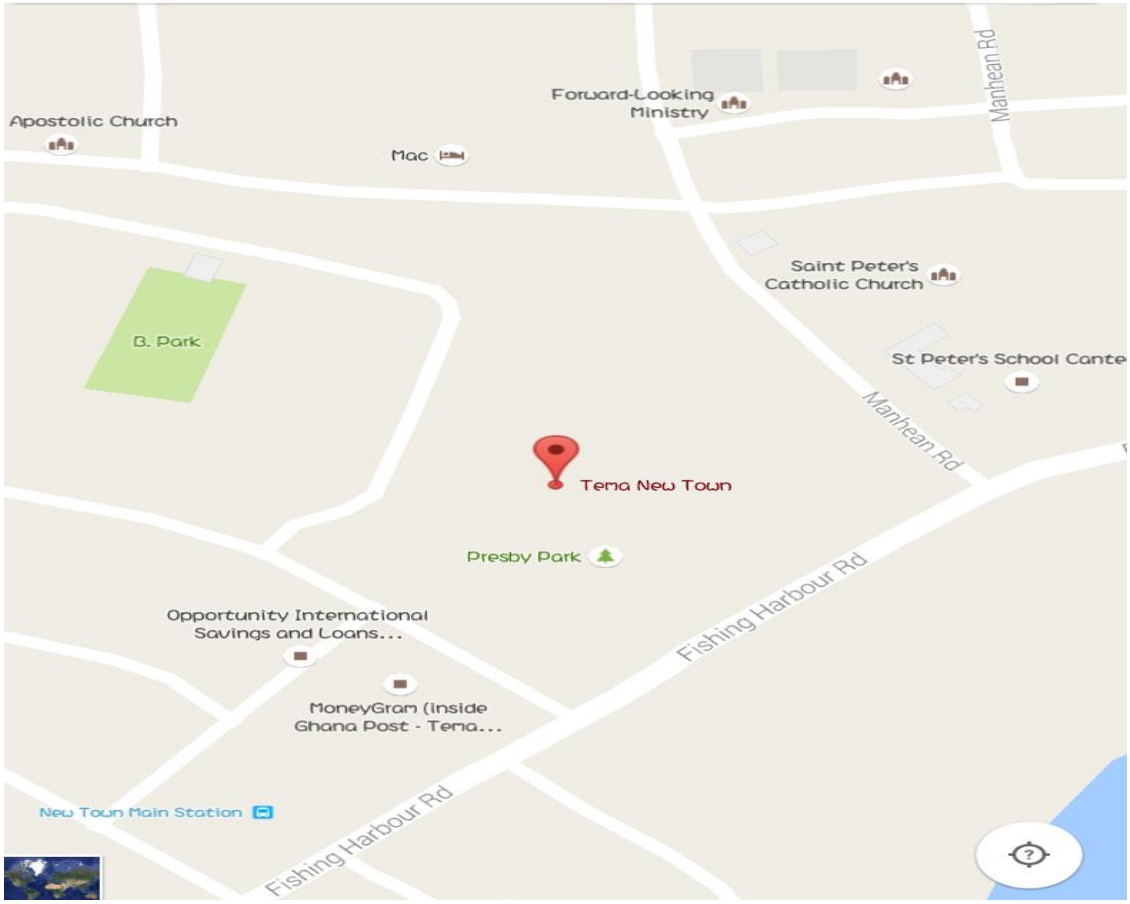

Figure 1: The Map of Tema New Town

3.2 Description of Nature and Characteristics of the Problem

Tema New Town has been a fishing community ever since it was discovered. Due to this, the predominant occupation of most men in the in the community is fishing whiles that of the women is fish mongering. Various traditional methods are employed to preserve and process fish for consumption and storage. These include smoking, drying, salting, frying and fermenting and various combinations of these. In Ghana-Tema New Town, smoking is the most widely practiced method: practically all species of fish available in the country can be smoked and it has been estimated that 70-80 percent of the domestic marine and freshwater catch is consumed in smoked form. The advantages of smoking fish are manifold. Fish smoking prolongs shelf life, enhances flavor and increases utilization in soups and sauces. It reduces waste at times of bumper catches and permits storage for the lean season. It provides protein availability to people throughout the year and makes fish easier to pack, transport and market**.** [6]

According to Jeffrey J. Rozum "The process of smoking fish occurs through the use of fire. Wood contains three major components that are broken down in the burning process to form smoke. The burning process is called **pyrolysis**, which is simply defined as the chemical decomposition by heat. The major wood components are **cellulose, hemicellulose and lignin**." [2] The art of fish smoking, said to be as old as civilization, combines three main processes: **cooking**- since the smoking is done at temperatures above 80°C, the flesh of the fish is cooked, the heat destroys bacteria resting on and inside the fish and enzymes in the guts and flesh are de-activated; **drying**- the fire which produces the smoke also generates heat, which dries the fish; **smoking** - the smoke is produced by burning wood containing a number of compounds, some of which kill bacteria; the process has a preservative value**.** [6]

The fish mongers employ the traditional method of fish smoking to smoke their fishes. The traditional method involves the fishes being arranged uniformly in wooden-wire trays , the fishes in the wooden-wire trays are left to dry under the sun for about two hours after which it is placed over a locally manufactured oven (called "**gbado"** in ewe**)** from refractive bricks obtained from cinders of the Volta Aluminum Company(VALCO) bauxite furnace. [6] The ovens are rectangular in shape and are further divided into squares. Fire woods are placed in both squared parts of the rectangular oven; the fire woods are lit up to produce fire. As the woods heat up, it start to smoke, the smoke is a cloud of combustible **gases** and **tar** droplets. [1] The fire produces a lot of smoke which also generates heat used to process the fishes. After the fishes are smoked by the fire woods, they have whitish looks which make the smoked fishes unappealing to customers. Due to this reason, the fish mongers have employed the use of **bagasse** (a fibrous matter that remains after sugarcane or sorghum stalks are crushed to extract their juice or a dry pulpy residue left after the extraction of juice from sugar cane) in addition to the fire woods to smoke the fishes. [3] During the process, large amounts of dense smoke is produced as a result of combining the fire woods and bagasse. After this process, the smoked fishes look more attractive to customers.

Figure 2: Fishes arranged in wooden-wire trays

Figure 3: Initial stage of fire setting in the oven used for smoking

Figure 4: Wooden-Wire Trays on the Oven

Figure 5: Bagasse

Figure 6: Whitish Appearance of Fishes after being Smoked with Firewood

Figure 7: Dark-brown Appearance of Fishes after being Smoked with Bagasse

But this method of smoking is very alarming because of its adverse effects on the fish mongers, the inhabitants and the environment.

3.2.1 Effects on the Fish Mongers

During the interview with the fish mongers, it was revealed that, most of them suffered minor health problems such as; eyes, nose and throat irritations and also nauseous feelings due to the nauseating odor from the smoke as a result of prolong exposure to the smoke. Some too complained about headaches, shortness of breath, respiratory irritation, aggravated asthma and heart conditions. [4] A few of them also reported minor burns in cases of accidents in the process of undertaking the smoking. In lieu of the above, these women spend their hard earned money on medicines to rectify some of the above mentioned illness, which when neglected can lead to major health conditions that cause their fortunes to dwindle eventually leading to reduction in capital which affects the productivity of the women.

Figure 8: Fish Smoker Inhaling the Smoke

3.2.2 Effects on Inhabitants of the Community

Analysis from the questionnaires and interviews with the inhabitants of the community unveiled the fact that, most of them also suffered minor health problems such as; eyes, nose and throat irritations and nauseous feelings due to the nauseating odor from the smoke. Notable amongst these problems is the issues of eye problems: squirting eyes in the attempt to sleep after an exposure to the smoke and other eye related problems that affect vision and reading. Others too

complained about the foul smoke odor in their clothes whenever they dry them on the drying line and also the black color (soot) the smoke leaves on their buildings which make them spend a lot of money on painting of their houses.

Figure 9: Soot Formed on Roofs and Building

3.2.3 Effect on the Environment

The smoke released by burning of firewood and bagasse is a mixture of particles and chemicals produced by incomplete combustion of carbon-containing materials. The smoke produced from the burning of the firewood and bagasse contains carbon monoxide (CO), carbon dioxide (CO_2) and particulate matter (PM or soot). [5] Carbon dioxide being a major component of greenhouse gases is released into the atmosphere during the burning. The continuous release of this greenhouse gas has dire consequences such as global warming due to the depletion of the ozone layer, the rise in sea level and different rainfall patterns. [5]

Figure 10: Smoke Released into the Environment

3.3 Description of Program of Study

Chemical engineering is the detailed study of systems involved in the transformation of materials and energy from one form to another. It has developed from its initial base around the reaction and processing of liquids and gases to that of biological materials and solid or solid-like materials of all kinds. Chemical Engineers provide and improve chemical processes and devices, which are more environmental friendly sound.

It is a branch of engineering that applies physical sciences (e.g. chemistry and physics) and life sciences (e.g. biology, microbiology and biochemistry) together with mathematics and economics to produce, transform, transport, and properly use chemicals, materials and energy. It essentially

deals with the engineering of chemicals, energy and the processes that create and/or convert them. Modern chemical engineers are concerned with processes that convert raw materials or chemicals into more useful or valuable forms. They are also concerned with pioneering valuable materials and related techniques – which are often essential to related fields such as nanotechnology, fuel cells and bioengineering.

Chemical engineering is a discipline influencing numerous areas. It covers a wide scope which includes the following: **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, water and its treatment, recycling metals, food processing, paper, oil and gas, fuel combustion technology, healthcare, design and construction, pulp and paper, specialty chemicals, microelectronics, electronic and advanced materials, polymers, business services, biotechnology, environmental health and safety industries.**

Within these industries, chemical engineers rely on their knowledge of mathematics and science—particularly chemistry— to overcome technical problems safely and economically. And, of course, they draw upon and apply their engineering knowledge to solve any technical challenges they encounter. Their expertise is also applied in the areas of law, education, publishing, finance and medicine specifically; chemical engineers improve food processing techniques, and methods of producing fertilizers, to increase the quantity and quality of available food. They also construct the synthetic fibers that make our clothes more comfortable and water resistant; they develop methods to mass-produce drugs, making them more affordable; and they create safer, more efficient methods of refining petroleum products, making energy and chemical sources more productive and cost effective.

3.4 Solving Problem Using Knowledge from Chemical Engineering

The problem solving process involves two ways, which are;

- Trapping the smoke and converting the carbon dioxide in it into electricity.
- Exploiting other methods of smoking, i.e. switching from the traditional method to the mechanical method of smoking.

3.4.1 Trapping the Smoke and Converting the Carbon Dioxide in it into Electricity

This process involves building a chimney over the locally manufactured ovens which will be connected to a carbon dioxide-electricity conversion geothermal power plant. The purpose of building the chimney over the ovens is to trap the smoke emanating from the burning of the firewood and the bagasse which will be channeled to the plant for the conversion. This involves the use of membranes and water to pull current out of the carbon dioxide (CO_2). The conversion is as follows; tanks filled with water are set up, on one side of the tank, a membrane is placed there which allows only positively charged ions to pass through and on the other side, another membrane is placed there which only allows negatively charged ions to pass through. Beyond the membrane is an electrode. When the carbon dioxide is pumped through the water, it separates into positive hydrogen ions (H^+) and negatively charged bicarbonates (HCO_3^-). Since the membranes only allow one kind of ion through, a net flow of electrons – or current – move from one side to the other, thus electricity is produced! It is estimated that, harvesting all the carbon dioxide from homes and power plants could produce about 1,570 terawatts of additional electricity annually. This process will go a long way to address the current load shedding faced by the country. [9]

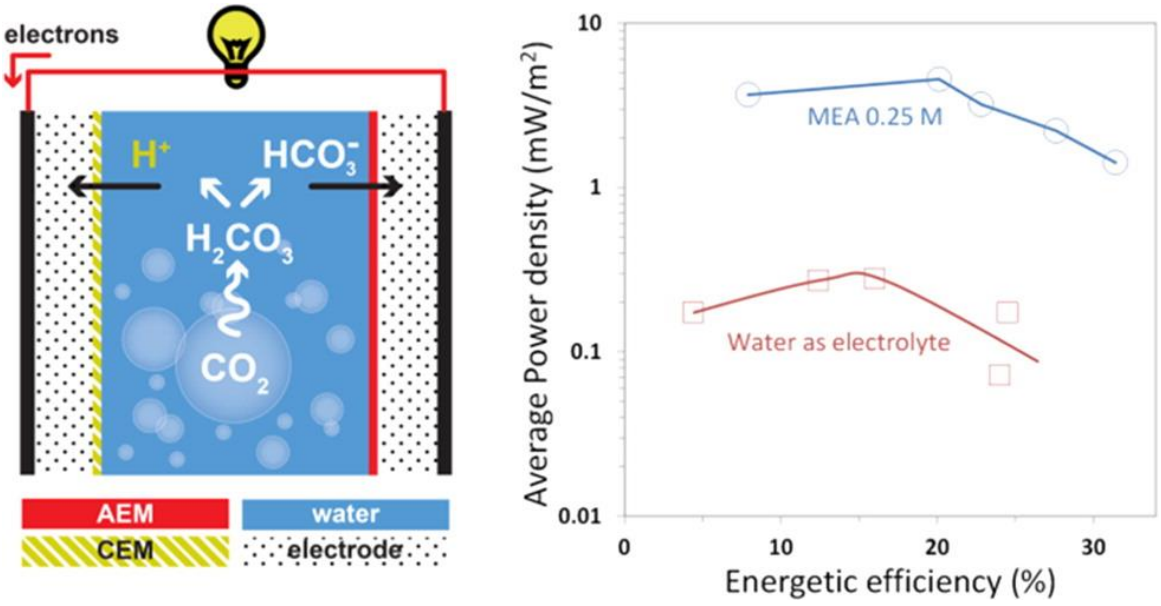

Figure 11: The Smoke (CO_2) to Electricity Conversion Process

3.4.2 Moving from the traditional to the Mechanical Method of Smoking

In the mechanical method smoking, the smoke is generated through the use of smoke condensates, which are created by the industrial process of turning smoke into a solid or liquid form. The flow

of smoke in the mechanical kiln is computer controlled and the fish generally spend less time being smoked than in a traditional kiln**.** [2] This will go a long way to reduce the time used to smoke the fish from 2 hours to 1 hour 30 minutes which is a 25% reduction in the smoking time. Laminar air-flow technology allows mechanical kilns to achieve a higher production rate, while the use of micro-processors has allowed mechanical kiln smokers increased sensor coverage within the kiln. [2]

4 CONCLUSION AND RECOMMENDATIONS

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 smoke on the fishmongers, the inhabitants of the community and the environment, 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 the various ways of alleviating the menace by adopting different method of smoking and effective utilization of the carbon dioxide from the smoke. Taking into consideration the health effects and generating economic benefits solutions to the problem, it was realized that, modernized method of fish smoking should be adopted by the fish mongers. The appropriate bodies should undertake regular health screening; educate the fishmongers on the effects of smoke on the environment and also relocating the fishmongers to a different settlement along with their ovens in order to create a smoke free environment for the inhabitants of the community. The appropriate body should be well resourced to carry out these functions. Another suggestion was that public education should be conducted to school the fishmongers on proper fish smoking activities in order to address the menace.

Therefore, all the objectives set for the study have been achieved and are obviously the key factors affecting smoking activities in Tema New Town. It is therefore important that the above recommendations are implemented to ensure effective and efficient fish smoking activities in the town.

4.2 Recommendations

The following measures have been recommended to ensure safe and effective fish smoking in Tema New Town. If these recommendations are taken into considerations, there will a great deal of improvement in the lives of the fishmongers, the inhabitants and the environment.

4.2.1 Relocating the Fish Smokers

The Tema Metropolitan Assembly should undertake projects to totally relocate the fishmongers to a different settlement along with their ovens in order to create a smoke free environment for the other residents of the community**.**

4.2.2 Consistent Health Screening

Regular health screening should be organized in order to rectify the present ailments the women suffer from and also advise them to be going for checkups regularly.

4.2.3 Education on the Health Effects of the Smoke

The fishmongers should be constantly educated on the ramifications of the prolong exposure to the smoke on their health and the need why they should avoid the inhaling of the smoke.

4.2.4 Organizing Workshops

The Environmental Protection Agency (EPA), the fisheries department and other educational institutions responsible for sensitizing the people should ensure regular, timely and scheduled educational programs for the people on the ways to undertake the fish smoking

4.2.5 Improved Methods of Fish Smoking

Improved methods such as the mechanical method and the capturing of the smoke by a chimney and converting it into electricity should be introduced to the women so as to aid them in going about their fish smoking activities swiftly.

4.2.6 Education on the Effects of Smoke on the Environment

The women should be educated by the Environmental Protection Agency (EPA) about the adverse effects of smoke on the environment, such as, global warming, different rainfall patterns and rise in sea levels and the reasons why the aforementioned effects should be avoided.

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6 APPENDICES

QUESTIONNAIRES

QUESTIONNAIRE FOR THE YOUTH IN THE COMMUNITY

1. How long have you been in the community?

   …….

2. Do you help your parent/guardian in her fish smoking business?

   YES ☐ NO ☐

3. Do you think the smoke from the fish smoking activities affects;

YOU	YES	☐	NO	☐
PARENT/GUARDIAN	YES	☐	NO	☐
EMPLOYEES	YES	☐	NO	☐

4. If **YES**, then which of the health conditions below have you, your parent/guardian and her employees been suffering from? (Tick from the following)

i. Irritating eyes, nose and throats
ii. Feeling nauseous due to the nauseating odor from the smoke
iii. Headaches
iv. Reduced alertness
v. Aggravated heart condition (Angina)
vi. Respiratory irritation
vii. Shortness of breath
viii. Worsened asthma
ix. Worsened heart condition
x. Burnt fingers

5. If the effects of smoke on you, your parent/guardian and employees is not stated in (4) above, then state them below.

   ……
   ……
   ……

……
……

6. Do you think the smoke have any effects on the environment? If YES, then list them below;

……
……
……

7. Why do you think bagasse is used in addition to the firewood to smoke the fishes? Explain briefly.

……
……
……

8. Do you think your parent/guardian would accept an improved method of fish smoking procedure and do away with the present one?

YES ☐ NO ☐

9. If YES, then describe how you think the improved method of fish smoking should be like?

……
……
……

<u>QUESTIONNAIRE FOR THE ENVIRONMENTAL PROTECTION AGENCY (EPA)</u>

Please indicate the following below;

NAME: ……

POSITION: ……

1. What is the quantity of smoke released due to the fish smoking in Tema New Town? ……

2. Is the smoke environmental friendly**? .....**

3. Have you been receiving complaints about the smoke been released into the environment as a result of the fish smoking?

YES ☐ **NO** ☐

4. What are the repercussions of the smoke released into the environment due to the fish smoking? Indicate them below.

……

……

……

……

……

5. What education is the agency giving to the fish smokers about the use of the fire wood and the bagasse in smoking of the fishes?

……

……

……

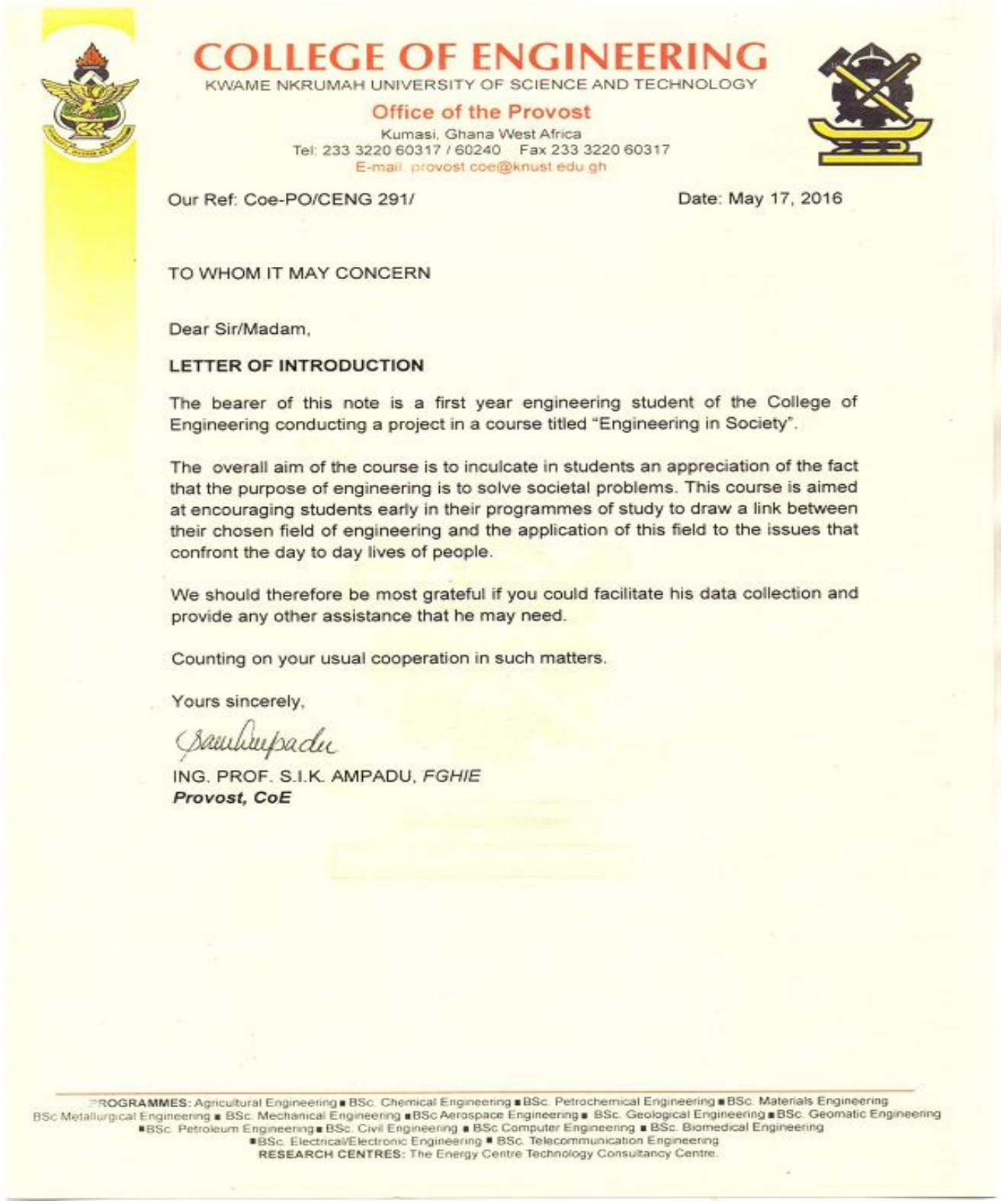
……

6. What measures are been put in place to curb the release of the smoke into the environment?

……

……

……



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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.

INTRODUCTORY LETTER

ENGINEERING IN SOCIETY

GALLERY