**Charcoal- Reinforced Solid Refuse Versus Charcoal as Incinerating Material In Small Scale Electricity Production Using Prototype Steam Engine Process**

A Partial Fulfillment

In The Requirement of the Subject

Research II

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**INTRODUCTION**

**Background of the Study**

Incineration is a form of Garbage Disposals that is common to Filipino practice. The form of disposal (Incineration) is highly discouraged by Environmental laws (Nate Seltenrich, 2013) because of its hazardous impacts.

This type of disposal involves combustion of organic substances contained in waste materials (Bill Freedman,2008) and produces high level of carbon dioxide. On the other flip of the coin, Incineration, as studies shown (Profu, 2004) has also become a waste treatment system that is used in energy recovery.

Energy Recovery is one of the waste-to-energy technologies (**Department for Environment Food and Rural Affairs, 2014**). Examples are gasification and pyrolysis where incineration falls in the bracket. The Energy product from incineration is high-temperature heat and undergoes a process (pyrolysis) converting it to energy.

Charcoal Incineration, on the other hand is wildly used and accepted process of means to produce energy through the Steam Engine Process. Moreover, Coal Incineration is specifically practiced in the province of Sta. Cruz Davao del Sur as set by the Aboitiz Corp. (Coal Issues, 2011).

Incineration is the common thread in this research.

This study aims to put comparison among the types of medium (namely the common Solid Refuse –as a group: scraps of wood, paper/paperboard, leaves, bagasse, and biodegradable wrappers reinforced with charcoal VERSUS Charcoal alone) incinerated through a designed Prototype Steam Engine and by following the established Steam Engine Process derived from the Study of (**Environmental Sanitation Center Japan**,2012) on their capacity to produce energy to activate small scale batteries .

**Statement of the Problem**

Hundreds of researches, whether macro or micro type are manufactured and published to lessen the damaging effects of the undeniable waste stack up, come what place, plastics and other types of refuse are mounding. In a Micro scale in the province of Davao del Sur, Incineration is a common household practice to relieve waste mound up.

Thus in this study, the researchers will attempt to capture the feasibility of the Solid waste/refuse as material either as an alternate or reinforce to charcoal/coal in the Incineration process as energy producer.

The study will adapt the Steam Engine Process as established by the (**Environmental Sanitation Center Japan**,2012) but in prototype form as it is to be used to energized proto type batteries.

**General Objectives of the Study**

This study aims to:

1. To measure and tabulate the amount of energy (Volts) produced by Charcoal-Reinforced Solid wastes Versus Charcoal as incinerated using the Steam Engine Process
2. To establish the properties of the materials as Incineration material to energize small scale batteries
3. To design a prototype Steam Engine (Device)

**Hypotheses**

This studywhich aims to determine the measure and tabulate the amount of energy (Volts) produced by Charcoal-Reinforced Solid wastes Versus Charcoal as incinerated using the Steam Engine Process assumed derived to assume the following hypotheses:

Ha: There is a significant difference among the treatments applied to the device on the measured and tabulated amount of energy (Volts) produced as incinerated using the steam engine process.

Ha: Treatment (Tong 50:50) is the most effective treatment applied to the device with respect to the measured and tabulated amount of energy (Volts) produced as incinerated using the steam engine process.

Ho: There is no significant difference among the treatments applied to the device on the measured and tabulated amount of energy (Volts) produced as incinerated using the steam engine process.

Ho: Treatment 1 is the most effective treatment applied to the device with respect to the measured and tabulated amount of energy (Volts) produced as incinerated using the steam engine process.

**Significance of the Study**

The significance of the Study is focused on reduction of waste by reuse of waste/ solid refuse as alternative incineration material to produce energy. This study is more likely beneficial to the following:

A.) **Environment** – Garbage had become a major problem in the environment. Due to the increasing number of wastes hazards was generated on either to the health and the environment itself. If this study will be proven effective, the address of the study which is to give a substitute treatments on the use of coal as an incinerating material will help lessen, though in smaller amounts, Reuse of non-renewable energy fuel in the steam engine technologies. Moreover, if the garbage will be used as medium of incineration, it will be diminished on landfills and merely decrease the rate of health hazards to the people around the landfills areas. Therefore, if the study will be implemented then environmental concerns will barely be retorted.

B.) **Vicinity.** If the device will be a effectually proven, the rise expansion of economy will take place, for the phenomena involved in the air such as air-borne disease will decrease because garbage will slightly robust the lives of the people in the community. Due to this, the vicinity will not suffer in various medical assessments and other forms of air –borne disease manipulation missions. Also, as garbage become lesser and lesser, the global phenomena on garbage pollution become lower as well that will merely result to a clean, safe and healthy surrounding.

C.) **Citizens of Digos City**. This study will be profitable to citizens of Digos City because aside from it promote environmental care and protection, it will also merely help them become ill-free due to the garbage pollutions, the support to environmental and waste management will be implemented and the wastes will decrease in number as to its solid, liquid, toxic and harmful gaseous phases after the process. This will help the citizens have clean areas of living as lessening the garbage mound-up observed in the surroundings.

**Scope and Delimitations**

This study was conducted to measure and tabulate the amount of energy (Volts) produced by Charcoal-Reinforced Solid wastes Versus Charcoal as incinerated using the Steam Engine Process. The study does not aim to reconcile such universal-environmental issues but to attempt on extending, albeit in a micro-scale, the ‘energy-recovery’ technologies as proven by other studies. On the other hand, the study only will be using five different solid refuses,namely; scraps of wood, paper/paperboard, leaves, bagasse, and wrappers, as incinerating material on either set as an alternate or as a reinforcement to charcoal itself. The main study will be conducted on May 2016 at Digos City Davao del Sur. However, the device will be constructed on April at Geyrozaga’s Residence.

**REVIEW OF RELATED LITERATURE**

**Waste as Fuel**

Waste for incineration must meet certain basic requirements. In particular, the energy content of the waste, the so-called lower calorific value (LCV), must be above a minimum level. The specific composition of the waste is also important. An extreme waste composition of only sand and plastics is not suitable for incineration, even though the average lower calorific value is relatively high. Furthermore, in order to operate the incineration plant continuously, waste generation must be fairly stable during the year.

Hence, the amount and composition of solid waste generated in the collection area for a potential incineration plant, and possible seasonal variations, must be well established before the project is launched. Waste composition depends on variables such as cultural differences, climate, and socio-economic conditions. Therefore, data usually cannot be transferred from one place to another.

All waste studies and forecasts must focus on the waste ultimately supplied to the waste incineration plant. Consequently, the effect of recycling activities (for example, scavengers) that change the composition of the waste must always be considered.

In many developing countries, the domestic waste has a high moisture or ash content (or both). Therefore, a comprehensive survey must be taken to establish whether it is feasible to incinerate year-round, as seasonal variations may significantly affect the combustibility of the waste.

Waste from industries and the commercial sector (except for market waste) generally have a much higher calorific value than domestic waste. However, collection of such wastes is often less organized or controlled, and delivery to an incineration plant can be difficult. Some types of waste, such as demolition waste and waste containing certain hazardous or explosive com- pounds are not suitable for incineration.

The waste composition may change in time because of either additional recycling or economic growth in the collection area. Both changes can significantly alter the amount of waste and its calorific value.

**Waste Classifications**

Domestic Waste from household activities, including food preparation, cleaning, fuel burning, old clothes and furniture, obsolete utensils and equipment, packaging, newsprint, and garden wastes.

In lower-income countries, domestic waste is dominated by food waste and ash. Middle- and higher-income countries have a larger proportion of paper, plastic, metal, glass, discarded items, and hazardous matter.

Commercial Waste from shops, offices, restaurants, hotels, and similar commercial establishments; typically consisting of packaging materials, office supplies, and food waste and bearing a close resemblance to domestic waste.

In lower-income countries, food markets may contribute a large proportion of the commercial waste. Commercial waste may include hazardous components such as contaminated packaging materials.

Institutional Waste from schools, hospitals, clinics, government offices, military bases, and so on. It is similar to both domestic and commercial waste, although there is generally more packaging materials than food waste. Hospital and clinical waste include potentially infectious and hazardous materials. It is important to separate the hazardous and non-hazardous components to reduce health risks.

Industrial Waste The composition of industrial waste depends on the kind of industries involved. Basically, industrial waste includes components similar to domestic and commercial source waste, including food wastes from kitchens and canteens, packaging materials, plastics, paper, and metal items. Some production processes, however, utilize or generate hazardous (chemical or infectious) substances. Disposal routes for hazardous wastes are usually different from those for non-hazardous waste and depend on the composition of the actual waste type.

Street Sweepings This waste is dominated by dust and soil together with varying amounts of paper, metal, and other litter from the streets. In lower-income countries, street sweepings may also include drain cleanings and domestic waste dumped along the roads, plant remains, and animal manure.

Construction and Demolition Waste The composition of this waste depends on the type of building materials, but typically includes soil, stone, brick, concrete and ceramic materials, scraps of wood, packaging materials, and the like.

Generally, construction, demolition, and street sweeping wastes are not suited for incineration.

The International Bank for Reconstruction and Development / THE WORLD BANK(1999).Retrieved on March 16, 2016 retrieved from http://www.worldbank.org/urban/solid\_wm/erm/CWG%20folder/Waste%20Incineration.pdf

**Waste Incineration Effects**

Producers require taking back their products and packaging. This gives them the necessary incentive to redesign their products for end-of-life recycling, and without hazardous materials. However, EPR may not always be enforceable or practical, in which case bans of hazardous or incinerators. They cause a wide range of health problems, including cancer, immune system damage, reproductive and developmental problems. Dioxins biomagnified, meaning that they are passed up the food chain from prey to predator, concentrating in meat and dairy products, and, ultimately, in humans. Dioxins are of particular concern because they are ubiquitous in the environment (and in humans) at levels that have been shown to cause health problems, implying that entire populations are now suffering their ill effects. Worldwide, incinerators are the primary source of dioxins.

Incinerators are also a major source of mercury pollution. Mercury is a powerful neurotoxin, impairing motor, sensory and cognitive functions, and Dioxins are the most notorious pollutant associated with mercury contamination is widespread. Incinerators are also an significant source of other heavy metal pollutants such as lead, cadmium, arsenic, and chromium.

Other pollutants of concern from incinerators include other (non-dioxin) halogenated hydrocarbons; acid gases that are precursors of acid rain; particulates, which impair lung function; and greenhouse gases. However, characterization of incinerator pollutant releases is still incomplete, and many unidentified compounds are present in air emissions and ashes.

The greatest barrier to recycling, however, is that most products are not designed to be recycled at the end of their useful lives. This is because manufacturers currently have little economic incentive to do so. Extended Producer Responsibility is a policy approach that problematic materials and products may be appropriate.

Using product bans and EPR to force industrial redesign on the one hand, and waste stream disaggregation, composting and recycling on the other, alternative systems can divert the majority of municipal discards away from landfill or incineration. Many communities have reached 50 percent and higher diversion rates, and several have set their sights on Zero Waste.

Health care is the source of a significant amount of wastes, some of which can be quite expensive to manage. But not all health care waste is potentially infectious or hazardous. The vast majority of the waste produced in health care facilities is identical to municipal waste. A rigorous source separation system is essential to keep the small percentage of waste that is potentially infectious or chemically hazardous segregated from the general waste stream.

Potentially infectious wastes do need treatment and disposal, and several non- incineration technologies are available to disinfect the waste. These technologies are generally cheaper, less technically complicated, and less polluting than incinerators.

A wide range of chemically hazardous wastes, including pharmaceuticals, are produced in small quantities in health care facilities. These are not amenable to incineration. Some, such as mercury, should be eliminated through changes in purchasing; others can be recycled; the rest should be carefully collected and returned to the manufacturer. Case studies show how these principles work in widely varying environments, such as a small maternity clinic in India and a major urban hospital in the United States.

Neil Tangri, Essential Action for GAIA  
Global Anti-Incinerator Alliance/  
Global Alliance for Incinerator Alternatives

Published and released on 14 July 2003 on the occasion of the 2nd GAIA Global Day of Action on Waste and Incineration.

**BASIC STEAM GENERATION**

**A simple boiler**

In order to describe the principles of a steam boiler, consider a very simple case, where the boiler simply is a container, partially filled with water (Figure 1). Combustion of fuel produce heat, which is transferred to the container and makes the water evaporate. The vapor or steam can escape through a pipe that is connected to the container and be transported elsewhere. Another pipe brings water (called “feedwater”) to the container to replace the water that has evaporated and escaped.

Since the pressure level in the boiler should be kept constant (in order to have stable process values), the mass of the steam that escapes has to be equal to the mass of the water that is added. If steam leaves the boiler faster than water is added, the pressure in the boiler falls. If water is added faster than it is evaporated, the pressure rises.

If more fuel is combusted, more heat is generated and transferred to the water. Thus, more steam is generated and pressure rises inside the boiler. If less fuel is combusted, less steam is generated and the pressure sinks.

**A simple power plant cycle**

The steam boiler provides steam to a heat consumer, usually to power an engine. In a steam power plant a steam turbine is used for extracting the heat from the steam and turning it into work. The turbine usually drives a generator that turns the work from the turbine into electricity. The steam, used by the turbine, can be recycled by cooling it until it condensates into water and then return it as feedwater to the boiler. The condenser, where the steam is condensed, is a heat exchanger that typically uses water from a nearby sea or a river to cool the steam. In a typical power plant the pressure, at which the steam is produced, is high. But when the steam has been used to drive the turbine, the pressure has dropped drastically. A pump is therefore needed to get the pressure back up. Since the work needed to compress a fluid is about a hundred times less than the work needed to compress a gas, the pump is located after the condenser. The cycle that the described process forms, is called a Rankine cycle and is the basis of most modern steam power plant processes.

**Basics of combustion Principles**

The process of combustion is a high speed, high temperature chemical reaction. It is the rapid union of an element or a compound with oxygen that results in the production of heat - essentially, it is a controlled explosion. Combustion occurs when the elements in a fuel combine with oxygen and produce heat. All fuels, whether they are solid, liquid or in gaseous form, consist primarily of compounds of carbon and hydrogen called hydrocarbons. Sulphur is also present in these fuels.

**Combustion of solid fuels**

Solid fuels can be divided into high grade; coal and low grade; peat and bark. The most typical firing methods are grate firing, cyclone firing, pulverized firing and fluidized bed firing, as described below. Pulverized firing has been used in industrial and utility boilers from 60 MWt to 6000 MWt. Grate firing (Figure 9) has been used to fire biofuels from 5 MWt to 600 MWt and cyclone firing has been used in small scale 3-6 MWt.

**Combustion of coal**

Oil and gas are always combusted with a burner, but there are three different ways to combust coal: The Basics of Steam Generation - 8

* Fluidized bed combustion
* Fixed bed combustion (grate boilers)
* Entrained bed combustion (pulverized coal combustion)

In fixed bed combustion, larger-sized coal is combusted in the bottom part of the combustor with low-velocity air. Stoker boilers also employ this type of combustion. Large-capacity pulverized coal fired boilers for power plants usually employ entrained bed combustion. In fluidized bed combustion, fuel is introduced into the fluidized bed and combusted.

Helsinki University of Technology Department of Mechanical Engineering Energy Engineering and Environmental Protection Publications

Steam Boiler Technology eBook Espoo 2002

**Garbage Mound-up**

Of the estimated 6,700 tons generated per day, approximately 720 tons per day is recycled or composted. The balance—some 6,000 tons daily—is either hauled to the city’s dump sites, dumped illegally on private land, in rivers, creeks, Manila Bay, or openly burned, adding to the heavily polluted air shed. Thousands of scavengers and waste pickers live and survive on this waste, eking out a harsh existence on mountains of smoldering waste. Some are children as young as 5 years old. Taking into account their families, the hundreds of junk shops and their workers, the thousands of eco-aides, the thousands of garbage trucks and their crews, and the tens of thousands of slum dwellers living on, around, and near the dump sites, an estimated 150,000 residents of Metro Manila know the sight and smell of garbage as an integral part of their daily lives.

The severity of Metro Manila’s garbage crisis is illustrated by the Payatas dump site tragedy. In July 2000, after a weekend of heavy rain, a mountain of garbage collapsed, burying hundreds of homes. Later, due to a dangerous mix of methane gas and downed electrical utility poles, fires spread across the dump site. The bodies of 205 people were recovered and, reportedly, hundreds more remain missing. In December 2000, the site was “permanently closed,” with plans to fast-track a new sanitary landfill project. A crisis in collection ensued, with mountains of garbage left uncollected throughout the metropolis. Over time, without any alternatives in place, dumping at Payatas has resumed.

Metro Manila’s dump sites are dangerous, exposed, and generate potentially toxic liquids called “leachate.” As these toxins flow along the surface and seep into the earth, they risk poisoning the surface and groundwater that are used for drinking, aquatic life, and the environment. Waste fires at these sites are common, which send plumes of toxic emissions into the air. Other sites are critically unstable, presenting the possibility of another deadly garbage slide. The majority of Metro Manila’s dump sites will reach capacity during 2004. The likely result may be another visible crisis in collection and the hurried expansion of remaining sites. In this haste, longer-term, more sustainable solutions may be ignored. Despite the promotion of waste segregation and collection at source, adoption has been at a very slow pace. Efforts must be dramatically scaled up to have any effect on the unceasing wave of garbage generated by Metro Manila. The not-in-my-backyard (NIMBY) phenomenon is hard at work in Metro Manila. Despite numerous efforts, no community has been willing to take Metro Manila’s garbage. A survey found that while 67% of residents believed that Metro Manila has a serious garbage problem, 73% did not want to see a sanitary landfill in their community. Notably, 78% of surveyed house-holds had no idea where their collected garbage was taken for final disposal.

Medical waste management presents another challenge. Nearly 3,700 health care facilities in Metro Manila generate an estimated 47 tons of medical waste per day, with 56% of this waste, or 26 tons, considered potentially infectious. A significant proportion of this dangerous waste finds its way into the municipal waste stream, and is handled by people who are poorly equipped and trained, exposing them to infections and other health hazards. The problem of medical waste disposal is further exacerbated by the mandated closure of medical waste incinerators in hospitals in Metro Manila, as required by the Clean Air Act. No alternative is in place. Against this grim context, a major accomplishment has been the passage of Republic Act 9003—the Ecological Solid Waste Management Act of 2000. While a good beginning, much work remains to be done.

Despite the simplicity of its prescription—reduce, reuse, and recycle at the local level—the law awaits serious implementation. RA 9003 is an enlightened piece of legislation, yet few local governments are familiar with it. The timetable is behind schedule, source reduction and segregation efforts at the local level are sporadic and uneven, and there is little active public participation, understanding, or interest. Significantly, the required Solid Waste Management Fund has not been set aside as mandated by law, limiting the level of investment.

**Aboitiz Power Plant (DAVAO)**

Aboitiz Power, industry groups and the government have argued that a new coal-fired power station is required to meet growing demand for power and as a diversification strategy to help drought proof a grid heavily reliant on hydropower. The 982.1-megawatt Agus-Pulangi hydropower station currently supplies 55 percent of Mindanao's power but, the Sun-Star Manila reports, the project's generating capacity drops in summer due to lower water levels in Lanao Lake. Compounding this is the risk of drought. In 2010, a prolonged drought resulted in little generating capacity and half-day blackouts in some areas.

The forecast supply gap may reach 480 megawatts by 2014, according to the government. Aboitiz Power is already scheduled to commence work on a series of small hydro schemes for completion in late 2012. (The Tudaya 1 and Tudaya 2 projects will have a combined output of 13.6 megawatts. Two other hydro projects, the Sita project and the Simod project will have a combined output of 30 megawatts.

In March 2011, residents of Binugao village in the Toril district asked the city government to reject the proposal of Aboitiz Corp. to put a coal-fired power plant in the village. In early March, the city council approved on first reading the proposed project and forwarded it to the committee on energy, the committee on environment, the committee on health, and the committee on trade and commerce. The four committees were tasked to conduct public consultations on the proposal. Vice Mayor Rodrigo Duterte has been very vocal about his endorsement of the proposed 300-megawatt coal-fired power plant, even before the conduct of any study. His daughter, Mayor Sara Duterte, said she was personally opposed to the project although she would go with the decision of the people.

Dr. Jean Lindo, one of the convenors of the No to Coal Davao, said the Aboitiz’s statement that the project would not pollute the environment was “a total statement of fallacy and deception” and “There is no such thing as clean coal." A petition submitted to the city council by those opposing the project states that 10 coal-fired power plants have been set up all over the country. They said "We, as Filipinos and energy consumers, have a right to demand for clean, renewable and affordable sources of energy without compromising our right to a healthful environment and genuine development,” the petition said.

**Technology in Disposing Urban Garbage by Incineration**

From about 1960, Japan began disposing urban garbage by incineration, and today, Japan possesses the world's leading garbage incineration facilities. In the fiscal year 2009, there were 1243 incineration facilities in Japan, incinerating garbage using several methods - stoker furnaces, fluidized bed furnaces, and gasification fusion resource furnaces with the objective of ash recycling. Stoker furnaces account for 70% of all furnaces, and improvement of this type of furnace is progressing rapidly. Today, while high level environmental conservation technologies are being introduced, technologies related to high-efficiency power generation and technologies related to safe operation, such as automatic incineration devices and automatic cranes are also being developed. We are now accumulating know-how on handling diverse types of garbage of today, ranging from the low-calorie garbage, which was generated when incineration facilities were first being built, to the high-calorie garbage. Such technology can be utilized for the type of garbage generated in the Asian region. The newest stoker furnace technology is low air incineration that aims for high-efficiency power generation, which is already under construction in Japan. The figure below shows one example of the latest technology: a facility exhibiting high pollution prevention and high-efficiency power generation capacity.

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**METHODOLOGY**

**Preparation of Materials**

The incinerating material used in the study will serve as a treatments as indicated in the conceptual framework. The fuels which are the treatments will be prepared for mere combustion. The controlled variable will be also managed to obtain consistency in the results.

**Device**

A hired technical consultant will guide in the establishment of this electricity producing device. This device is chiefly comprise of the following:

* Combustion Chamber- measuring reinforce covered by 1 meter by 1 meter by meter where charcoals are burned
* Boiling Box- made out of aluminum sheets constructed on the top of the burning where a 0.40 meter deep water is placed
* Supply Pipe- A 0.10 diameter aluminum pipe carrying the steam pressure towards the turbine box.
* Turbine Box- A housing where a propeller attach in the connecting shaft is being rotated by the pressured steam coming from the boiling box
* Electric and Copper Windings- This are the devices attached in the rotating disk that will generate electricity.

This device will be built with the technical assistance of the hired consultants to assured the technical appropriateness. Likewise, the proportion in the amount of charcoal used versus the amount of electricity generated will be graded to the help of electrical gadgets such as volt meter/Current meter.

**The Conduct of the Experiment**

The treatments such as will be combusted consecutively but separately in the designed device as it will be used as a fuel to generate steam. The Steam Engine process will then occur. The steam will flow to the turbine that is, a medium that will be used to obtain the acquired Mechanical to Electrical Energy Conversion. Then the generated electrical energy by the device will be measuring the electrical energy as the by product to be used as data to analyze the results of the experimentation.

**Analysis**

Analysis on the cost of the establishment of the device against the volume of energy generated or electricity will be quantified and qualified by the help of the technical consultants to assure technical feasibility.

**Statistical Tools**

The data gathered will be tallied, treated and interpreted. The following statistical tools will be used in the analysis of data.

* **ANOVA( Analysis of Variance ).** Statistical Comparison of at least two population means can be performed by conducting an analysis of variance. This method partition the total variance of the variable into interest into several components source. The most basic analysis of variance petitions the total variation into two namely variation due to different in the parents population and the variation due to the differences within the parents population. This type of analysis of variance is known as One Analysis of Variance. This will be used to determine the significant differences among the treatments applied to the device.
* **Regression Analysis.** It is a statistical technique used for the determining the functional form of the relationship between two or more variable where one variable is called the dependent or response variable and the rest are called independent or the explanatory variable. The ultimate objective is usually to be usually to be able to predict of estimate the value of the response variable given the values of the independent variables. This will be used to determine the domain that predicts the relationship between the number of the treatments applied to device and the mass of the electrical current produced by the combusted wastes.

1. **PRESENTATION OF DATA**
2. **INTERPRETATION OF DATA**
3. **CONCLUSIONS**
4. **APENDICES**