DESIGN AND DEVELOPMENT OF HOME BASED SOLID WASTE INCINERATOR

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This report is submitted
in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled “Design And Development of Home Based Solid Waste Incinerator” is the result of my own work except as cited in the references

Signature : .....

Name : Muhammad Izamudin Bin Johari

Date : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation).

Signature :. .....

Name of Supervisor : Dr.Mohd Nizam Bin Sudin

Date : .....

Dedication to:

<u>My beloved Family</u>

Johari bin Yamin
Zainon bte Hj Abd Samad
Muhammad Izuddin bin Johari
Nurizuana binti Johari
Nurul Izyani binti Johari

<u>My lovely</u>:

Fatin Irfah binti Iskandar
My Classmate & friend
My Family Theater TOPART

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ABSTRACT

Incinerator is a machine that is used for burning various types of waste. It is also known as a heat treatment system that using a high temperature to burn a solid waste such as discarded materials, including paper, plastics, metals and food scraps and convert it into bottom ash, fly ash, combustion gases and heat Typically, the incinerator is available in large industries, municipalities and so on. In addition, the incinerator is used to reduce waste disposed in landfills. The purpose of this project is to design and develop a small scale incinerator for burning the solid waste at home. In this project, several concepts and design principles have been applied to select and produce a quality product and meet the customers need with the final aim to help in the solid waste problem growing in our country. The methods that had been used are Quality function deployment, House of Quality and Concept Scoring. After that, the selected design is drawn in detail dimension using CATIA V5. In addition, the best material that is suitable to apply to this product design was selected using the CES Selector 2013. Later, the incinerator was analyzed by using ANSYS software to ensure that the product produced is safe, durable, have a high heat-resistant and not corrosion. In addition, the discussion was also made in the project for the purpose of improvement of product designs that have been selected based on material selection and also a process that includes the calculations to prove the ability of the product.

ABSTRAK

Insinerator adalah sebuah mesin yang digunakan untuk membakar pelbagai jenis sisa. Ianya juga dikenali sebagai sistem rawatan haba menggunakan suhu yang tinggi untuk membakar sisa pepejal seperti bahan-bahan yang dibuang, termasuk kertas, plastik, logam dan makanan dan menukar menjadi Abu, Abu Terbang, pembakaran gas dan haba . Biasanya, insinerator hanya terdapat di industri-industri besar, Majlis Perbandaran dan sebagainya. Di samping itu, insinerator digunakan untuk mengurangkan sisa yang dilupuskan di tapak pelupusan sampah. Projek ini dilaksanakan bertujuan untuk merekabentuk dan membangunkan sebuah perniagaan kecil-kecilan untuk membakar sisa pepejal di rumah. Dalam projek ini, beberapa konsep dan reka bentuk prinsip-prinsip yang telah digunakan untuk memilih dan menghasilkan produk yang berkualiti dan memenuhi kehendak pelanggan dengan tujuan akhir untuk membantu dalam masalah sisa pepejal semakin meningkat di negara kita. Kaedah-kaedah yang telah digunakan adalah penggunaan fungsi kualiti, rumah kualiti dan konsep pemarkahan. Selepas itu, rekabentuk terpilih diambil butiran dimensi menggunakan CATIA V5. Di samping itu, bahan terbaik yang sesuai untuk digunakan untuk rekabentuk produk ini dipilih menggunakan CES Selector 2013 . Kemudian, insinerator dianalisis dengan menggunakan perisian ANSYS untuk memastikan bahawa produk yang dihasilkan adalah memenuhi keselamatan, tahan lasak, mempunyai tinggi tahan haba dan daya tahan. Di samping itu, perbincangan juga telah dibuat dalam projek ini untuk tujuan penambahbaikan reka bentuk produk yang telah dipilih berdasarkan pemilihan bahan dan proses yang melibatkan pengiraan untuk membuktikan keupayaan produk ini.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Waste is a unwanted or unusable material as a result of waste disposal activities, whether in residential or housing, industry and trade in certain areas. There are various types of waste that can be categorized according to its origin as domestic waste, industrial waste, commercial waste, construction waste, residual institution agricultural, waste water treatment, and so on.

The waste will be collected and taken to the landfill in the space provided. Furthermore, the solid waste that is disposed in a garbage disposer is features danger and it can land a human and enviroment. Various examples of solid waste that we can see such organic materials, glass, metal, paper, plastic and other hazardous or solid waste such as toxic, non-toxic, flammable, radioactive, and other diseases. Furthermore, if waste is not handled properly, it will give a bad impression to the sanitary conditions in urban areas, housing, and factories, rural and pollute the air with odors, polluted groundwater, as well as poor soil. Developing countries face an urgent need for a solution that is affordable, safe and convenient for treating infectious waste. For examples, without a proper treatment of waste such as needles and syringes can cause infection and injury to patients. Infectious medical waste management in developing countries has become an increasingly complex issue. Global standard for acceptable performance of health care waste management (CWM) do not exist. “Combined, the large number of small-scale industries has a substantial environmental impact. As most small-scale industries are situated within or in close proximity to residential areas, their impact on the environment is all the worse. They cause local pollution and nuisance from the release of smoke, foul smells, and toxic

contaminants to the air, soil, surface and ground-water, such as chrome from tanneries and oil from car garages" (Frijns and Van Vliet, 1999).

Moreover, technological progress is limited in order to deal with dangers, products, requirements, and environments. This result in many countries waste management is uncontrolled and disorganized. The World Health Organization (WHO) advocates for the relative risk approach to waste treatment- ie, the weight of health risks from environmental exposure to the risks posed by the deliberate infection of infectious waste is not managed well (especially sharp). Same with another country India, 23 metro cities in India generates about 30,000 tonnes of such municipal wastes per day while about 50,000 tonnes are generated daily from the Class I cities. This makes it very difficult to control the informal collection, segregation and recycling of MSW & improper waste handling because scarcity of land for landfill.

Besides, to solve the problem of disposing of waste, there are various actions that have made governments and non-governmental organizations such as conducting campaigns to tackle the problem of waste disposal in every place, especially in residential areas. In addition, the public was introduced with the Reduce, Reuse, and Recycle. These methods of waste reduction, waste reuse and recycling are the preferred options when managing waste. There are many environmental benefits that can be derived from the use of these methods. They prevent or reduce greenhouse gas emissions, reduce the release of pollutants, conserve resources, save energy and reduce the demand for waste treatment technology and landfill space.

Furthermore, one of effective methods to solve this problem is by using an incinerator. Incineratior is the most common waste thermal treatment process that involves the combustion of organic substances contained in solid waste materials. After incineration, the wastes are converted to carbon dioxide, water vapor and ash. This method may be used as a means of recovering energy to be used in heating or the supply of electricity. This is because in some cases, the heat generated by incineration can be used to generate electric power. In addition to supplying energy incineration technologies have the advantage of reducing the volume of the waste, rendering it harmless, reducing transportation costs and reducing the production of the greenhouse.

1.2 PROBLEM STATEMENT

Solid waste disposal is increasing in our country nowadays. This is because areas such cities that continue grow exposed to uncontrolled waste disposal. Also, these things happen because of rising of human population, housing and factories. As a result of the uncontrolled disposal of waste, is environmental pollution such as air pollution, ground pollution and water pollution, as well as crops destroyed.

1.3 OBJECTIVE

To research, design, analysis and develop a simple incinerator that can be constructed at low cost to encourage clean burning and complete combustion for solid wastes at a house to reduce the waste that cannot be recycled, reused, or disposed of in a landfill.

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. The incinerator is only designed and constructs to remove a solid waste by using a fire to burn the waste disposed. Further acts of the heat generated by incineration can be used to generate electric power will not be done in this research.

2. The research of this project is based on solid waste incinerator for home based with the amount of waste that removed daily.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Nowadays, regardless people in urban, rural, residential or factory area are having a same problem which is limited access for collection services, not enough landfill place and processing facilities. As a result, their behaviors of disposing waste in ineffective manners such as dumping and burning causes a variety of environmental impacts such as global warming, land pollution and more. In addition, the people dwelling in these areas are often unaware of the health risks when they throw trash everywhere. This is because with the uncontrolled disposal of waste, it can cause smells unpleasant and makes the place dirty. Other than that, animals that are dirty such as rats, worms, and flies also like to come to places that are dirty and it will make the surrounding place not clean and uncomfortable.

In the United States in 1996, nearly 210 million tons—about 4.3 lb. (2 kg) per person daily (up from 2.7 lb. /1.2 kg in 1960) —were collected and disposed of by municipalities. In that year, municipal garbage included 12.4 million tons of glass and about 80 million tons of paper and paperboard (by far the largest constituent); in addition enormous tonnages of food residues, yard trimmings, textiles, plastics, and sludge formed in sewage treatment were produced. Although the amount of the increase has been slowed somewhat by recycling and composting programs and improvements in packaging, the amount of solid waste continues to increase annually. Moreover, the most common disposal methods pollute land, water, or air to some degree (see pollution). Management of solid waste therefore presents an increasingly acute problem.

As a conclusion to solve this problem, various methods have been carried out by government and non-government organizations. Among them is by making a Recycle Campaign from home to home, establish a waste recovery and many others. In this way it does help in reducing the uncontrolled discharge of waste. However, for future periods of research and investigations should be made to solve this problem with larger scale and ensure its effectiveness so that this problem can be solved in a short time and easily.

2.2 TYPE OF WASTE

In our country, garbage or waste is a problem that is increasingly growing day and become a burden to mankind and the environment. This is true because as a result of economic development and the development of the rapid increase in population in the country. Every day, large quantities of waste are produced throughout the world. In order to treat this waste, it must be classified so that it can be directed toward the appropriate treatment facility. Often, waste is discarded will be brought to the landfill and this is also a problem for the management, namely the lack of landfill areas. As we know, there are various types of waste disposed of in landfill areas. They come from various places such as factories, hospitals, farms, shops and many more. Among the types of waste that there is:

2.2.1 Institutional waste

Institutional waste is waste from places such as schools, hospitals, clinics, government offices, military bases and so on. This waste is similar to the domestic and commercial waste, although generally more packaging materials from food waste. Furthermore, hospital and clinical waste including potentially infectious and hazardous material such as needles, syringes, tablets, medicines and various more. It is important to separate hazardous and harmful components in order to reduce health risks and dangers to humans and the environment.

2.2.2 Construction and Demolition waste

The composition of this waste depends on the type of building materials, but usually covers the ground, stone, brick, concrete materials, wood and ceramics, packaging materials, etc. Moreover, it is also a building material waste and rubble due to the operation of the construction, reconstruction, repair and demolition of houses, commercial buildings, and other structures. In addition plaster and wallboard, roofing materials, metal hands on type and nonferrous, glass (Windows and doors); and others are also a construction waste.

2.2.3 Hazardous waste

Hazardous waste is waste that contains a variety of toxic elements such as organic materials or dangerous (solvents and hydrocarbons), acid or gas that may have an impact on human health or the environment. In addition, this waste also has one or more of the following characteristics: explosive, flammable, irritant, easily spread, poisonous, toxic, and mutagenic or erode carcinogenic. Normally, 2/3 of hazardous waste comes from industry and the construction sector. More exactly, production and industrial waste treatment resulted in the highest percentage of hazardous waste, followed by construction (produced using tar contaminated soil and stone), service industry and Chemical Industry. According to Eurostat, the volume of hazardous waste produced stood at 94.5 million tons in the European Union in 2010, or less than 4% of all waste produced.

2.2.4 Industrial Waste

Industrial waste is a waste material generated by industrial activities which include anything organized materials depends on the type of industry involved. Some examples of the rest of the industry is a chemical solvent, paint, sand paper, paper products, an industrial by product, metals and residual radioactive. Basically, the rest of the industry to contain components that are similar to the rest of the domestic and commercial sources, including food scraps from the kitchen and cafeteria, Encasement, plastic, paper, and metal goods. Other than that, there are several irresponsible refineries that use oil will discard the

remaining oil that had used to place that not suitable to disposal. As a result, environment pollution happens and it will bring harm to human beings.

2.2.5 Solid Waste

Solid waste is the unwanted or useless solid materials generated from human activities such as domestic, commercial, agricultural, waste water treatment and so on. The domestic waste comes 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. On the other hand, for commercial waste, it comes from place like 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. The solid waste must properly handle and treated, if not it will give a negative impact on the hygienic conditions in urban areas and pollute the air and surface and ground water, as well as the soil and crops. Also, with rising urbanization and change in lifestyle and food habits, the amount of solid waste has been increasing rapidly and its composition changing. This can give an impact of decreasing a disposal landfill.

In this project, one of the wastes will be studied and used as a guideline according to the objectives and scope that had been made. The objective of this project is to research, design, analysis, and develop a simple incinerator that can be constructed at low cost to encourage cleaner burning and more complete combustion of solid wastes at a house with a view to reduce the waste that cannot be recycled, reused, or disposed of in a landfill. Therefore, the solid waste from the home based was chosen as a guide to this project.

2.3 SOLID WASTE MANAGEMENT

In our country nowadays, solid waste management is decreasing among human. This can cause adverse effects on the environment, human health and economic development and public life in urban areas or rural areas. Therefore, several methods and activities in managing waste by municipalities, including the monitoring, collection, transport, processing, recycling and disposal.

Methods of waste reduction, reuse and recycling of waste are a suitable method for managing and controlling waste disposal. There are many environmental benefits that can be obtained from the use of this method. This is because with the use of these methods, it can reduce or prevent the occurrence of environmental pollution, such as greenhouse gas emissions, reduce pollutant emissions, and conserve resources. In addition, it also saves energy and reduces the demand for waste treatment and reducing the dumping of solid waste at landfills.

2.3.1 Waste Reduction and Reuse

Waste reduction method to give benefits to humans because it can reduce the use of packaging and promoting the use of goods that can be reused for example, encouraging customers to bring their own bags for use as packaging in buying goods in stores. This can reduce the use of plastic. Another benefit from the use of this method is that it can encourage people to select the used goods such as cloth towels and plastic and glass containers that can be reused. In addition, unwanted goods can also be donated or shared in others than get rid of it. Therefore, all methods of waste prevention require public participation mentioned. Waste prevention will also succeed and have a significant impact on MSW reduction when consumers change both their consumption habits as well as their manner of disposing of what they purchase. (Thomas R. Mounteer, Oct 1992)

In addition, in order to get people's attention, participation, training and education programs should be established to educate the public about their role in managing and controlling waste disposal problems. Furthermore, the Government should also control the types and amount of packaging used by manufacturers and make reusing shopping bags are mandatory.

2.3.2 Recycling

Recycling is one of the methods for the Elimination of the goods does not apply from waste flows to be used as raw materials in making and producing new products. According to (T. E. & N. R. Council, 1989), Recycling efforts are on the rise in the United States. The use of recycled glass, known as "cullet" in the glass manufacturing industry, increased from 24,000 tons a year in 1970 to more than one million tons in 1987. Therefore, this method of recycling occurs in three phases, first the rest of the collected recyclables and distance, recyclables which will be used to produce raw materials.

This is because raw materials produced from recycled treatment are used in the production of new products. Furthermore, for recyclables process, it can be done at a place around us which are not within households, offices, store and more. For example, collections of old items and an item that still can be use can be sent to the recycling centres. In addition, at each residential and shops there should be Colour coded recycling bins for waste separation at the source of production. This is because, with this recycling bin product, people can dispose of waste according to the resources that have in the front of recycling bin such as paper, glass, plastic and many others.

Other than that, another option is to mix the recyclables with the general waste stream for collection and then sorting and recovery of the recyclable materials can be performed by the municipality at a suitable site. The sorting by the municipality has the advantage of eliminating the dependence on the public and ensuring that the recycling does occur. Wastes can also be separated at Materials Recovery Facilities (MRFs). Other advantages in the use of recycling are that it can reduce pollution of the environment and human health. Figure 2.1 shows the colour coded recycling bins for waste separation at the source of production.

Figure 2.1 (Colour coded recycling bins for waste separation at the source of production)

2.3.3 Landfills Disposal

Historically, landfilling has been the most common disposal method in the United States, with an estimated eighty percent about 130 million tons of the MSW disposed in approximately 10,000 landfills in 1986.(OTA Report, July 1987). Landfills have been created in order to reduce or eliminate waste that may pose a risk and a danger to public health and environmental quality. This landfill is usually placed in areas where the characteristics of the soil act as a natural buffer between the environment and the landfill. For example the area may be comprised of clay soil which is fairly impermeable due to its tightly packed particles, or the area may be characterized by a low water table and an absence of surface water bodies thus preventing the threat of water contamination. As we know, the placement of landfills should be suitable and strategic. This is because, in the bottom and sides of the landfill must be filled with a layer of clay or plastic to store liquid waste, known as leachate, escape into the ground. On the other hand, Landfill is divided into several individual cells and only a few cell sites are filled with garbage at any time. This can reduce exposure to wind and rain. In addition, the daily waste must be compacted to decrease the volume, and then the cover is used to reduce the smell and keep out pests.

When the landfill had reached capacity is limited with one impermeable seal that usually consists of clay. Some landfills are used to recover energy. Natural anaerobic