UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PERFORMANCE ANALYSIS ON THE EFFECTS OF FILLER MATERIAL ON HDPE PLASTIC

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Department of Manufacturing Process) (Hons.). The member of the supervisory is as follow:

…….

(Dr. Raja Izamshah Bin Raja Abdullah)

ABSTRACT

There are many products that are already created by human to provide comfort for users that comes in verity of uses. Plastics are inexpensive, lightweight and durable materials, which are moulded-ready into a variety of products that has a wide range of applications. As a consequence, the production of plastics has increased in market over the last 60 years. However, current levels of their usage and disposal generate several environmental problems. Recycling is one of the most important actions currently available to reduce impacts and represents one of the most dynamic areas in the plastics industry today. There are many products that already invented by using these plastic recycle. The one possible application was HDPE wall tiles. There are few limitations or defects on pure HDPE wall tile in terms of their properties. The ideas that the filler materials are mixed with recycled HDPE plastic are generated to increase performance and improve the properties such as hardness, water absorption and flammability. The blends were processed by an internal mixture machine or Haake machine at 180^{o}C processing temperature. Then, the materials which have been mixed will be placed inside the tiles mould of Hot Press Machine or Hot Isostatic Press Machine and melted at a nominal set temperature of 210^{o}C. The wall tile will be tested on flammability test according to method of ASTM handbook. The flammability test was important because the HDPE are flammable and to see if that when mixed with filler material, it will able to reduce the flammability of wall tiles. Other than that, the testing for hardness and water absorption was following the standard that provide by Malaysian Standards. The Statistical Analysis shows that by using filler material of Silica sand give more effects on the HDPE plastic.

ABSTRAK

Terdapat banyak produk yang telah dicipta oleh manusia untuk memberi keselesaan kepada pengguna yang datang dalam kejujuran kegunaan. Plastik adalah murah, ringan dan tahan lama bahan-bahan, yang dibentuk-siap ke dalam pelbagai produk yang mempunyai pelbagai aplikasi. Akibatnya, pengeluaran plastik telah meningkat di pasaran sejak 60 tahun yang lalu. Walau bagaimanapun, tahap semasa penggunaan dan pelupusan mereka menjana beberapa masalah alam sekitar. Kitar semula adalah salah satu tindakan yang paling penting pada masa ini untuk mengurangkan impak dan merupakan salah satu kawasan yang paling dinamik dalam industri plastik hari ini. Terdapat banyak produk yang telah dicipta dengan menggunakan ini kitar semula plastik. Satu aplikasi mungkin adalah jubin dinding HDPE. Terdapat beberapa batasan atau kecacatan pada HDPE tulen jubin dinding dari segi sifat-sifat mereka. Idea bahawa bahan-bahan pengisi dicampur dengan HDPE plastik kitar semula yang dihasilkan untuk meningkatkan prestasi dan memperbaiki sifat-sifat seperti kekerasan, penyerapan air dan terbakar. Campuran telah diproses oleh mesin campuran dalaman atau mesin Haake pada suhu 180^{o}C pemprosesan. Kemudian, bahan-bahan yang telah dicampurkan akan diletakkan di dalam acuan jubin yang Hot Mesin Tekan atau panas isostatic Press Mesin dan cair pada suhu set nominal 210^{o}C. Jubin dinding akan diuji pada ujian kemudahbakaran mengikut kaedah ASTM buku panduan. Ujian kemudahbakaran adalah penting kerana HDPE yang mudah terbakar dan untuk melihat apakah yang apabila dicampur dengan bahan pengisi, ia akan dapat mengurangkan terbakar jubin dinding. Selain daripada itu, ujian untuk kekerasan dan penyerapan air mematuhi standard yang disediakan oleh Standard Malaysia. Analisis statistik menunjukkan bahawa dengan menggunakan bahan pengisi pasir Silika memberi lebih kesan ke atas plastik HDPE itu.

DEDICATION

First and foremost, this dedication is for my father and mother, who always pray for my safety and health. Thanks to them because always be my side no matter what happen. Without blessing from them, maybe I'm not here. All guidance and advice given by them always I follow. For me, their prayer is key of my success. I am grateful because I have them as my mother and father. Thank you

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LIST OF ABBREVIATIONS, SYMBOLS AND SPECIALIZED NOMENCLATURE

HDPE	-	High Density Polyethylene
SIRIM	-	Standards and Industrial Research Institute of Malaysia
FKP	-	Fakulti Kejureteraan Pembuatan
LDPE	-	Low Density Polyethylene
NFPA	-	National Fire Protection Association
PS	-	Polystyrene
$CaCO_3$	-	Calcium Carbonate
ATH	-	Alumina Trihydrate
NIST	-	National institute of Standards and Technology
UTeM	-	University Technical of Malaysia
DWB	-	Digital Weighing Balance
WA%	-	Water Absorption %

CHAPTER 1
INTRODUCTION

1.1 Overview of study

This section will explain the problem statement, project background, objective and scope of the object. The title of this project is a performance analysis on the effects of filler material on HDPE plastic. The one possible application was wall tile. The goal of this project is to study of recycled plastic HDPE wall tile. High-density polyethylene (HDPE) was one of the most commonly used plastics in the world. The HDPE plastic marked as 2, typically found in milk bottle or jugs, plastic bags and refillable plastic bottles. Moreover, recycled HDPE plastic mostly it is used to manufacture lawn and garden products, and automobile parts.

HDPE plastic has few properties that make it suitable as a packaging and manufacturing product. It is extremely stronger than existing polyethylene, serves as a very effectively against humidity and then remains solid at room temperature. It resists against rot and other chemicals corrosion. It was easily recyclable and can be used for making a new product again. Recycled HDPE creates no harmful extrication during its production or during its usage by the user or consumer. Also, HDPE puncture no toxic chemicals into the ground or water.

The existing wall tile is 100% pure HDPE. The HDPE plastics are flammable. So that, many of product that made by HDPE cannot have longer life. This context actually will happen when the product made by HDPE was burnt. Apart from that, the testing for the wall tiles includes the water absorption and hardness. So that, to ensure that the wall tile can be improved by using mixing method. The Figure 1.1 shows that the pure HDPE wall tile.

Figure 1.1: Pure HDPE Wall tile

The type of input such as filler or additional material contains fire retardant element was most important aspects to be considered in process of making HDPE product. The parameter will be investigated during the process it will consider the filler material used the ratio of mixed composition used and other.

1.2 Background of study

The idea of this project is actually come from the concept of tiles. In the modern era, mostly houses are usually uses a used tile either in bathroom, hall room, kitchen and other places. There are few types and characteristics of tiles that commonly used such as ceramic tiles, homogeneous tile, glazed tiles, and rectified tile. The most tiles that used by the people are ceramic tile or glazed ceramic. A existing tile could be a factory made piece of hard and brittle material like ceramic, cement, stone, metal, or perhaps glass, usually used for floors, covering roofs, walls, or alternative objects like tabletops (Malaysian Standard, 1983). Ceramic tile was a mixture of clay and quartz ferrous sand materials along with water. The special clays are mined from the earth, shaped, colored and then fired in kilns. They can be colored and the surfaces can be glazed either in a high gloss or matte finish. The ceramic tiles also have their disadvantage which is the hardness. Hardness also can be measured by instrument. The hardness of ceramic tile are lowest, if the high force is apply it will cracked (Malaysian Standard, 1981). The idea

that used by recycled plastic HDPE are generated. The recycle plastic HDPE wall tiles are eco-friendly option. Other than that, plastic also have a defect such as flammable.

According to D.McEvoy (2008), producing plastic has a world environmental impact because it uses many fossil fuels. There are about 3 million tons of plastic waste each year that create by people in the world. The Government agency reports that around 80% of plastic waste is reaching landfill sites. This is a primary problem cause for land fill sites increasing and environmental impact. The possible solution is to reuse or recycle the plastic that has already been produced. In fact, recycling plastic has many benefits such as reducing consumption of energy and nonrenewable fossil fuels use.

Figure 1.2: Plastic waste (Masni, 2009)

According to Fletcher and Mackay (2002), proposes a new method of plastics recycling for reduce the amount of plastic waste. They prove that recycling plastic can lessen the quantity of waste to landfill. From that, the new plastics are produce by calling it as thermoplastic polymers. Figure 1.2 shows that the plastic waste found in landfill.

Callister (2003), stated that thermoplastic become soft and easily formed when heating. There a few common examples of thermoplastic such as polypropylene, polyethylene, polyvinyl chloride, polycarbonate and many others. All these particular plastic have their own properties such as fabric, films and packaging materials

A recycled plastic manufacturer produces various product plastic tiles for use in construction or houses. They create a new product from recycled high density polyethylene (HDPE) for improve quality of product and also reduce in terms of cost. Certainly, HDPE is a thermoplastic that is easily reused or recycled and easily being formed. Some primary properties of these thermoplastics are can use in highly temperature range and it is also stronger, impact and temperature resistance and has an optical properties. Unfortunately, these thermoplastics are one of the expensive plastic in the world. That is why it needs to be recycled. A main issue is that mixture of different type of material has giving high effect on HDPE plastic properties such as hardness, water absorption, flammability, etc.

Shriver *et al*, (2010) stated that the amount of plastics recycled was mixed excessively for making a products, it can improve and increase mechanical properties such as impact and tensile strength. The amounts of mixture materials or components to produce recycled plastic products must also be considered.

Gou *et al*, (2001) stated that the number amounts of mixture material or components to produce plastic recycled products can be defined or determined. Mixing experimental method is one of the most accurate and possible techniques for studying the effect of mixture components on overall characteristics. This method is applied to any kind of materials such as silica sand, clay powder and shell powder ($CaCO_3$ calcium carbonate). To determine the number amounts of mixture material or components to produce HDPE plastic wall tiles, response surface methodology with mixture experiment was employed. This research will apply or used the experiment of mixture method.

The Hot Press machine is used to make a recycled HDPE plastic wall tiles. In a hot press machine, a die is mounted and then be heated, with the products pressed by using the prescribed pressure. The molten material with temperature and time set in the mold used and the specific pressure control The Hot Press process itself was uncontaminated because the materials that used are in dry conditions. In this case, the recycle HDPE plastic mixed with other material and melt into mould by heating element using Haake internal mixture machine.

1.3 Problem Statement

On 16th century, the tile was used for decorative building and most of wall tile made by ceramic (Malaysian Standard, 1981). To develop the ceramic tile requires very high costs and it is brittle (Malaysian Standard, 1983). The solutions purposed was change the materials and replace with recycled HDPE plastic. The problem faced by many thermoplastics such as polyethylene, polypropylene, polyvinyl chloride and polycarbonate products was the material are often flammable (Hilado, 1998). The material need mixed by a fire retardant agent to resist heat (Frank Pitts, 2000). For this research, the recycled high density polyethylene (HDPE) plastics are being chosen for make a wall tiles. Thus, it also will become main research for doing flammability, hardness and water absorption test. The flammability test will be performed as followed by standards provide by ASTM Handbook and Malaysian Standard. The problem also needs to identify the best filler material such as natural fiber material like clay powder for mixed with the recycle HDPE plastic. It will be tough because it must be ensured that the filler material are matched and can produce the wall tiles after be compressed with hot press machine. Last but not least, the research also needs to suggest the suitable ratio for combining both materials that used. The research also needs to know their hardness and water absorption result for develop a good quality of wall tiles. The hardness test and water absorption is tests that provide by Malaysian Standard and also established by SIRIM.

1.4 Objective of study

The objectives of this study are:

1. To investigate the performances namely hardness, water absorption and flammability of filler material on HDPE plastic.
2. To analyze the performances on different filler material composition ratio.
3. To choose the best filler material type and composition ratio for specific application.

1.5 Scope of Study

The project studies for this final year project only cover one station in FKP laboratory. In this study mostly used the hot press machine at laboratory. Other than that, the machine that used for mixed both materials is Internal Mixture or Haake machine. Meanwhile, for crushing the filler material and recycled HDPE plastic bottle it will use the crushing machine available at FKP laboratory. Apart from that, the machine that used for crush a filler material into tiny particle or powder is Ball Mill Machine. The studies also need to find out the best filler material involve for producing a recycle HDPE plastic wall tiles. The factor involves the ratio of composition of filler material with HDPE plastic recycle. The project also needs to find out the result of flammability, water absorption and hardness of product.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter describe about the source and the history of the research that had been done by other that related to my research. The project study will highlight the detail about the process and quality tool that might be used to identify and problem solving in order to carry out an efficient improvement product of recycled plastic HDPE wall tiles. The explanation is aided with the literature concept and improvement method implemented by past researcher. The knowledge applied from other expertise literature is significant to produce a valid support for the project study to be referenced for other people in the future. The research carried out in the past has been fully approved by professional organization and the knowledge is valid to become a reference for preliminary stage for student to come out with their own article and journal in the future.

The chapter will outline some aspect need to consider in producing a fire resistance of recycled plastic HDPE wall tiles. The literature concept also needs to know about the characteristics and properties of HDPE plastic. It also summarized a several type of fire retardant material selected that will be a major parameter need to consider. Apart from that, the processes of mixing the material need to describe properly that include the ratio of combination material.

2.2 High Density Polyethylene (HDPE)

Muller (2007), stated HDPE is a discovery began in 1951 by J. Paul Hogan and Robert L Banks. Both researchers are exploring ways to convert the properties of ethylene and propylene, a hydrocarbon produced when burning natural gas. In the process, they discovered a catalyst that can convert these products into a solid polymer, plastic produced is crystalline polypropylene and high-density.

Plastic revenue impact extends to the use of plastic products. At present, most of the sectors that have been used plastic for producing a product. Among these is the use of plastic like bottles, containers of liquid filling materials and items of daily use.

Koerner (1992), stated thermal plastic material is viscoelastic, that means the properties such as mechanical properties is reflect on the viscous liquid and an stretchy solid at once. But when elastic stresses are imposed, it shows the action of dissipate energy means that the materials are viscous flow and the elastic displacement (ie stored energy). The properties of elastic materials depend on the temperature, time and rate of deformation. However, stress and strain testing usually be used as to determine mechanical properties of plastics.

2.2.1 Characteristics of HDPE plastic

Muller (2007), stated that HDPE plastic made by petroleum. To make one kilogram of HDPE, the petroleum need have around 1.75 kilograms. It has tensile strength and intermolecular forces higher than low density polyethylene (LDPE). In addition, the HDPE is also more robust and can withstand temperatures of at the point (120^{o}C / 248^{o}F in the short term and, 110^{o}C / 230^{o}F for prolonged. the density that produce by HDPE is around range between 0.935-0.965 g/cm3 and also highly crystalline compared to LDPE. HDPE slightly quite expensive but in terms of properties, it more stiffer and stronger.