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Development of Biodegradable Composite using Banana fiber and High- density Polyethylene

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DECLARATION

The work described in this thesis was carried out by me under the supervision of Dr. Jagath Premachandra senior lecturer of the Department of Chemical Engineering and Processing at the University of Moratuwa and report on this has not been submitted in whole or in part of any University or any other institution for another degree/Diploma.

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SUPERVISOR RECOMMENDATION

I certify that the above statement made by the candidates is true and that this is suitable for submission to the University for the purpose of evaluation.

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DEVELOPMENT OF BIODEGRADABLE COMPOSITE USING BANANA FIBER AND HIGH DENSITY POLY ETHYLENE

By J.M.M.Jayasuriya

ABSTRACT

Accumulation of the Plastic waste is the one of major problem in our societytoday. Although several solutions have introduced to solve this problem such as recycling of plastics, incineration of plastics, reusing of plastics and introducing new biodegradable polymers (using chemical additives) it has not been given better solution to the Sri Lanken society. This attempt is to develop a new biodegradable polymer using renewable natural resources called banana fiber. Not only develop biodegradable polymer but also ensure the good economic return for the cultivation of natural fiber for the Sri Lanken Banana growers and examine the opportunity to developed new composite of using waste high- density polyethylene and banana fiber. In here, by changing the fiber size and percentage of the weight of the fibre , the properties of the composite were checked. Tensile strength, weatherability, stress and strain, moisture content, water absorption, and biodegradability were examined. Good results for biodegradability test and high tensile strength were shown by the samples. It can be proposed to application of flowerpots garbage bins and agriculture applications.

Supervised by Dr. Jagath Premachandra

1. INTRODUCTION

1.1 BACK GROUND

Plastic products in polymer family have invaded almost every share of human activity, during the last several decades. It has slowly and surely become a substitution for the conventional material such as wood, rubber, leather, and metals. It has contributed in some measure in conserving the fast depleting of forests and ore deposits. According to the sources 6000 tons of plastic furniture saves 14,000 cubic meters of timber. Although it has become a wonder material because of its durability and low fabrication cost, It is alarming plastic waste accumulation in environment as their non-biodegradability.

Since Stone age to space age we have been met the wonder material called polymer. Plastic is the dominant polymer of the space age while general-purpose plastic and the special-purpose plastics continuously benefit us in numerous ways. But the poor management of the plastic waste has begun to create a negative image of this versatile material i.e. polyolefin contribute largely to the environmental problem. Allthough plastic is only 6% out of the total solid waste, because of their non-biodegradability (inability of easily broken down to the elements by microorganisms) and high visibility factors cause it to remain in the mind of the people as a negative perception.

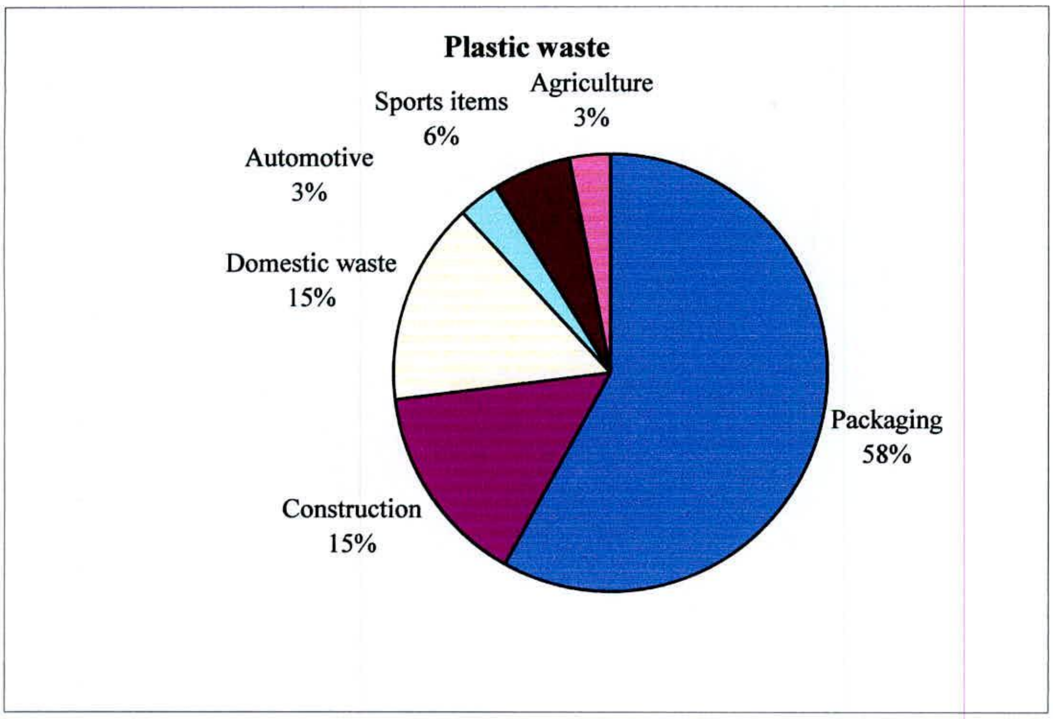

Figure 1.1.1 An analyzing the plastic waste stream application wise (Source The journal of Plastics and rubber- 2001)

As figure (1.1.1) it clearly indicates that the packing industry contributes a major share of the plastic waste stream. They are responsible for block of drainage systems, death of animals through ingestion and also create an environmental eyesore.

1.2 REDUCING OF PLASTIC WASTE ACCUMULATION

For the purpose of controlling environmental pollution by plastic waste, several methods have implemented to reduce accumulation of plastic waste.

I. Recycling of plastic waste

Recycling means converting waste plastic materials into usable row materials for replace the virgin materials in manufacturing of new products. Some recyclable materials can be used over and over again without significant loss in quality and quantity. It would be the added advantage of saving valuable foreign exchange. The plastics recycling process can divide in to three main categories as Mechanical recycling, Co-mingled/mixed waste recycling, Chemical recycling. The main steps of the recycling process are collecting, sorting, cleaning, and drying. The most critical stage of this process is separated into categories based on type of resin, grade, color etc; Most of us have seen the tri angle symbol with three arrows, generally used as identifying codes for plastics (figure.1.2.1). But some manufactures in Sri Lanka haven't been concerned about indicating that symbols on their products. Then consumers are unable to identify the plastics separately. That has become a major problem in sorting process of recycling of plastics. It is important to introduce an automated sorting system for sustainable plastic recycling program to solve this problem.

- PET (Polyethylene terepthylate)
- HDPE (high density polyethylene)
- PVC (Polyvinyl Chloride)
- LDPE (Low density poly ethylene)
- PP (Poly propylene)
- PS (Polystyrene)
- Others

Figure (1.2.1) the symbols of plastic recycling codes

II. Introducing Biodegradable plastic

Degradation process is induced by micro flora and finally plastics are added to biomass. It has minimized the accumulation of plastics. But few disadvantages are accompanied with this process. Manufacture couldn't predict the lifetime of the Products and approximate weight; it should carry since the usage conditions. We should have assurance that the products do not start degrading, before the contents of the products are disposed off. The silly-silly bags should degrade only after it reaches the drain or garbage dump, because of sun light, heat, mechanical stress are beyond of our control. During the process of degradation that could take several weeks, the harmful effect on animals drain blockage and flooding could still occur. Releasing of green house gases such as Methane and carbon dioxide, during the degradation of polyethylene may cause to global warming. If degradable plastics were used in large scales that will give the bad effect to the rapidly growing plastic recycling industry. On the contrary degradable plastic ideal for specific applications such as garbage disposal bags, Agriculture films and pots. On the other hands the degradation step of the bottle lids, plastic hangers, crates, and cans should be arrested, it's way to recycling plant. It is very important to control time and condition for degradation when introducing the biodegradable plastics.

III. Incineration of plastics

Wastes to energy incineration plants are an environmentally safe option for disposing off solid waste, when using available emission control technologies and high combustion temperatures. Because of their high energy content, plastics can help to the entire waste-to-energy incineration. In United States, Western Europe, Germany, Sweden, Netherlands and Switzerland are now operating the waste to energy facilities.

Energy from plastic incineration is substituted for a specific mixture of electric base load power, district heating and for steam generation. The additional energy from waste incineration will replace, in the long-term, mainly natural gases, rather than coal.

Comparing the incineration of plastic and feedstock recycling method in different ways, the incineration of plastics leads to an increase of CO_2 emissions compared to landfill. The feedstock recycling reduces CO_2 emissions and saves energy resources. The cost for conserving energy for feedstock recycling is 50% higher relative to incineration. But this gap can close if automatic sorting and processing are implemented.

IV. Usage of Plant origin items

The Coconut leaves, Palm leaves, "Pan", *Pandanus* leaves, Banana leaves and some plant fiber (Jute, Flax, "akunda", Pineapple) made items and papers are widely used as bags, wrappers, codes, etc. But some problems arise with them such as less durability, low strength, more susceptible for microbes and high permeability to moisture and air. Then it can't use a better alternation for plastics.

1.3 OBJECTIVES

It is important to introduce new biodegradable polymers, considering above-mentioned facts. This attempt is to develop such a biodegradable composite material using high-density polyethylene (The highest consumption type of the polythene family see figure 2.5.1.1.) and banana fiber.