CHAPTER ONE

INTRODUCTION

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Recently, the role of plastic reduction campaign to reduce the volume of municipal solid waste was widely highlighted. Petrochemical based plastics which are commonly used in packaging in the whole wide world have become the largest culprit in the pollution of the environment. In order to achieve good waste management practice, the use of petrochemical based plastics should be reduced. These slowly-degrading materials could be replaced with something which is more readily degradable and therefore more environmentally friendly.

Chief Minister of Pulau Pinang, Malaysia, Tan Sri Dr. Koh Tsu Koon said that the usage of plastic bags and containers made from non-biodegradable items should be reduced since they had been identified as the major source of pollution and flash floods and people should start using alternatives packaging such as paper bags and perhaps biodegradable plastic containers and wrappings (Baharuddin N.A, 1996). Plastics manufacturers should consider this matter and should try producing biodegradable plastic bags which would help preserve the environment.

The U.S plastics industry fumbled at the beginning by introducing starch filled polyolefins as "biodegradable polymer" (Narayan *et al* 1990). In the end, it was found that only the surface starch has biodegraded ,

leaving behind a recalcitrant polyethylene material (Narayan, 1994). In addition starch entrapped within the polyethylene matrix did not appear to be degraded. This material could be best described as biodisintegrable and not completely biodegradable. Due to this matter, industrial interest has been focussed on polyhydroxyalkanoates, the polyesters of bacteria possess interesting characteristics similar to certain conventional plastics such as polypropylene.

Polyhydroxyalkanoates or PHA was firstly discovered by Lemoigne in 1925 in the form of polyhydroxybutyrate or PHB which is the most commonly known member of the PHA family. PHA can be described as a polyester produced intracellularly by a diverse genera of bacteria. The PHA serves as a carbon and energy storage material in the bacterial cell. PHA has been commercialized as BIOPOL®(ICI Biological Products, Billingham,UK). PHA can be divided into two main classes : the short chain variety whereby the monomers are 4 to 5 carbon length and the medium chain variety whereby the monomers are 6 to 14 carbon length. These two classes are synthesised by different groups of bacteria due to different biosynthetic pathways. The short chain length PHA are usually crystalline in structure while the medium chain length are more amorphous and elastic. The molecular weight of PHA ranges from $2x10^5$ to $3x10^6$.

Since PHA can be used to substitute certain petrochemical based plastics, it has caught the global interest in many aspects of life. PHA exhibit thermoplastic properties and can be synthesised from renewable resources thus showing positive future of recycling and conservation of natural resources. PHA is also biocompatible meaning that it is well tolerated when implanted in the human body. Therefore it can have medical applications. The most important factor is that PHA is biodegradable which reason out why it is attracting so much attention as a substitute for the non biodegradable plastics.

Various investigations have been directed to the study of environmental factors that influence biodegradation, the enzymology of the process and the changes to the polymer material. Some of these studies have shown that PHA can be degraded by depolymerase enzyme which is secreted by many bacteria and fungi present in soils and by hydrolysis in aquatic environment. The polymer is broken down into hydroxyalkanoic acids and later metabolized by microorganisms to carbon dioxide and water which is then recycled back to the environment.

Besides that we can also compost our biodegradable plastic and paper waste along with other "organic" compostable materials like yard, food and agricultural wastes. We can generate the much needed carbon-rich compost (humic material). Compost amended soil has beneficial

effects by increasing soil organic carbon, increasing water and nutrient retention, reducing chemical inputs and suppressing plant disease. Composting infrastructures, so important for the use and disposal of biodegradable plastics are growing widely in the U.S .

It is very important for researchers to actually define the exact meaning of "biodegradable plastics" before conducting any relevant studies. American Society of Testing and Materials (ASTM) and International Standards Organization (ISO) defined biodegradable plastic as a degradable plastic in which the degradation results from the action of naturally-occurring microorganisms such as bacteria, fungi and algae. Three major requirements have to be established in order to get general acceptance of biodegradable polymers in the environment (Swift, 1992):

1) justification for their use
2) a definition which clearly indicates that what they do in the environment is acceptable to everyone
3) test protocols which confirm that they do as expected in the environment

There are many ways of testing the biodegradability of the PHA in the natural environment Methods of testing biodegradable plastics based on the measurement of gas evolution and residual sample weight have been carried out by many researchers. Test for measuring the biochemical oxygen demand (BOD), carbon dioxide evolution and weight loss were

also studied. The test methodology to measure the intrinsic biodegradability should take into consideration the local environmental condition as well as the local microbial organism. A parallel test in real world system needs to be run to confirm and establish biodegradability.

To harmonise the various standards for biodegradation, evaluation of the various standards such as Sturm test for ready biodegradability, the Japanese MITI test for biodegradation, the American Standard Organisation, and the ASTM standard for intrinsic biodegradability of plastic materials under an aerobic and anaerobic environment should be performed as well.

Malaysia like many developing countries is facing the problem of waste disposal and pollution. By using the biodegradable polymers in our everyday life instead of the conventional plastics, it is possible that one day this problem can be reduced.