CHARECTERISATION OF PALM OIL EMPTY FRUIT BUNCH (POEFB) FIBER VIA ENZYME TREATMENT

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LIST OF ABBREVIATIONS

JAS	Japanese Agriculture Standard
OSB	Oriented Strand Board
OPEFB	Oil Palm Empty Fruit Bunch
UTM	Universal Tensile Tester
ASTM	American Standard Testing Method

LIST OF SYMBOLS

˚C	Degree Celsius
%	Percentage
MPa	Mega Pascal
USD	United States Dollar
RM	Ringgit Malaysia
Tons	Tones
$	Dollar
pH	Power of Hydrogen
˚F	Degree Fahrenheit
g/cm^3	Gram per centimeter cube
µm	Micro meter
mm	Millimeter
M	Molarity
V	Volume
mL	Milli-Liter
g	Gram
h	Hour
cP	Centipoises
wt.	Weight
s	Second

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ABSTRACT

Lignocelluloses based natural fiber is being used as an alternative to traditional glass and carbon fiber in the composite materials due to its low density and higher specific properties. These reinforced plastics have got prospective applications in various sectors, including construction materials such as windows, sidings and roof tiles, grain and fruit storage and footwear, car door panel, consoles, seat backs, packaging and so on One of the natural fibers considered is palm oil empty fruit bunches (POEFB) fibers which offer advantages such as availability, renewability, low cost and the established technology to extract the fibers. POEFB is easily obtainable as wastage from palm oil industries but has not yet been fully materialized in the fabrication of biodegradable composites. The current work is focused on the treatment of POEFB fiber with enzyme. Surface modifications for better adhesion between fiber and matrix were carried out by Laccase enzyme treatment. Enzyme treatment here was analyzed by placing 2 mg of Laccase enzyme in 4 beakers and the POEFB is treated for 2,4,6 and 8 hours simultaneously. The POEFB fiber is then analyzed via Lignin test, water absorption test and tensile test. It was determined that 4 hour treated fiber presented a higher lignin lost and a significant increase in mechanical properties.

PENCIRIAN BUAH TANDAN SAWIT MINYAK KOSONG (POEFB) VIA RAWATAN ENZIM

ABSTRAK

Lignocellulose berasaskan gentian semula jadi kini digunakan sebagai alternatif kepada gentian kaca dan gentian karbon dalam bahan komposit kerana kepadatan rendah dan sifat-sifat fizikal tertentu yang lebih tinggi. Plastik bertetulang telah mendapat pengiktirafan dalam aplikasi termasuk bahan-bahan pembinaan seperti tingkap, jubin bumbung, penyimpanan bijian dan buah-buahan, kasut, panel pintu kereta, konsol, belakang kerusi, pembungkusan dan sebagainya. Salah satu gentian asli yang dipertimbangkan adalah buah tandan kelapa sawit kosong (POEFB). Gentian ini menawarkan kelebihan seperti ketersediaan, pembaharuan, kos rendah dan kesediaan teknologi untuk mengekstrak gentian ini. POEFB mudah diperolehi sebagai pembaziran daripada industri minyak sawit tetapi masih belum digunakan sepenuhnya dalam fabrikasi komposit terbiodegradasi. Kerja semasa tertumpu kepada rawatan gentian POEFB dengan enzim. Pengubahsuaian permukaan untuk lekatan yang lebih baik antara gentian dan matriks telah dijalankan oleh rawatan enzim Laccase. Rawatan enzim di sini telah dianalisis dengan meletakkan 2 mg enzim Laccase dalam 4 bikar dan POEFB dirawat selama 2,4,6 dan 8 jam secara serentak. Serat POEFB kemudiannya dianalisis melalui ujian lignin, ujian penyerapan air dan ujian tegangan. Ia telah ditentukan bahawa serat 4 jam dirawat dibentangkan lignin yang tinggi hilang dan peningkatan yang ketara dalam sifat-sifat mekaniknya.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Polymers are substances containing a large number of structural units joined by the same type of linkage. These substances often form into a chain-like structure. The word polymer is derived from the Greek polys, which means ‘many’, and meros, which means ‘part’, in other words, a polymer is something that consists of many parts.

This feature of long molecular chains gives polymers the special properties that make them useful plastic and rubber materials. Polymers are produced via polymerization where small simple monomers are linked to produce a long chain molecule in general. The history of polymers started way back in the Egyptian era as follows:-

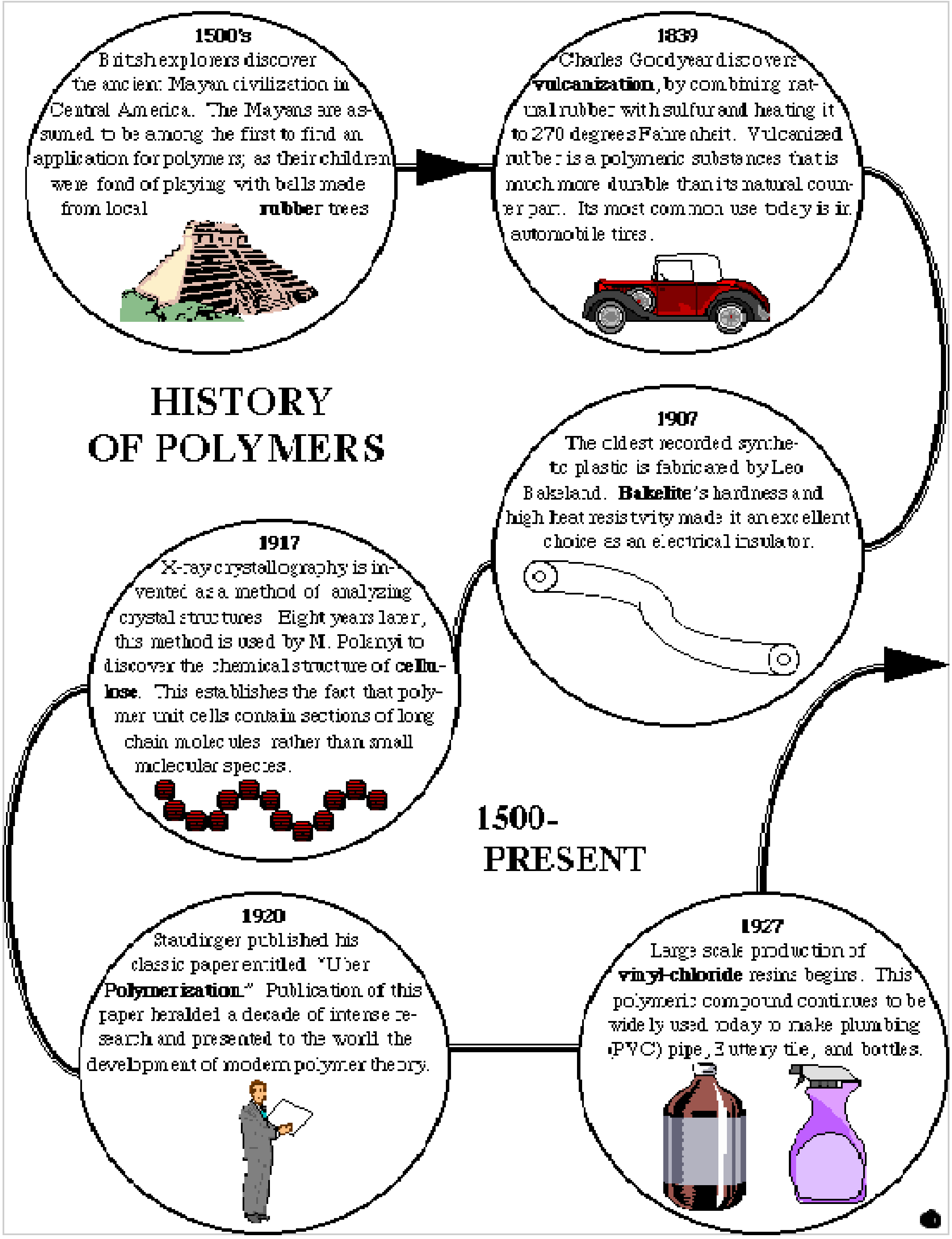

Figure 1.1: Historical Background of Polymer

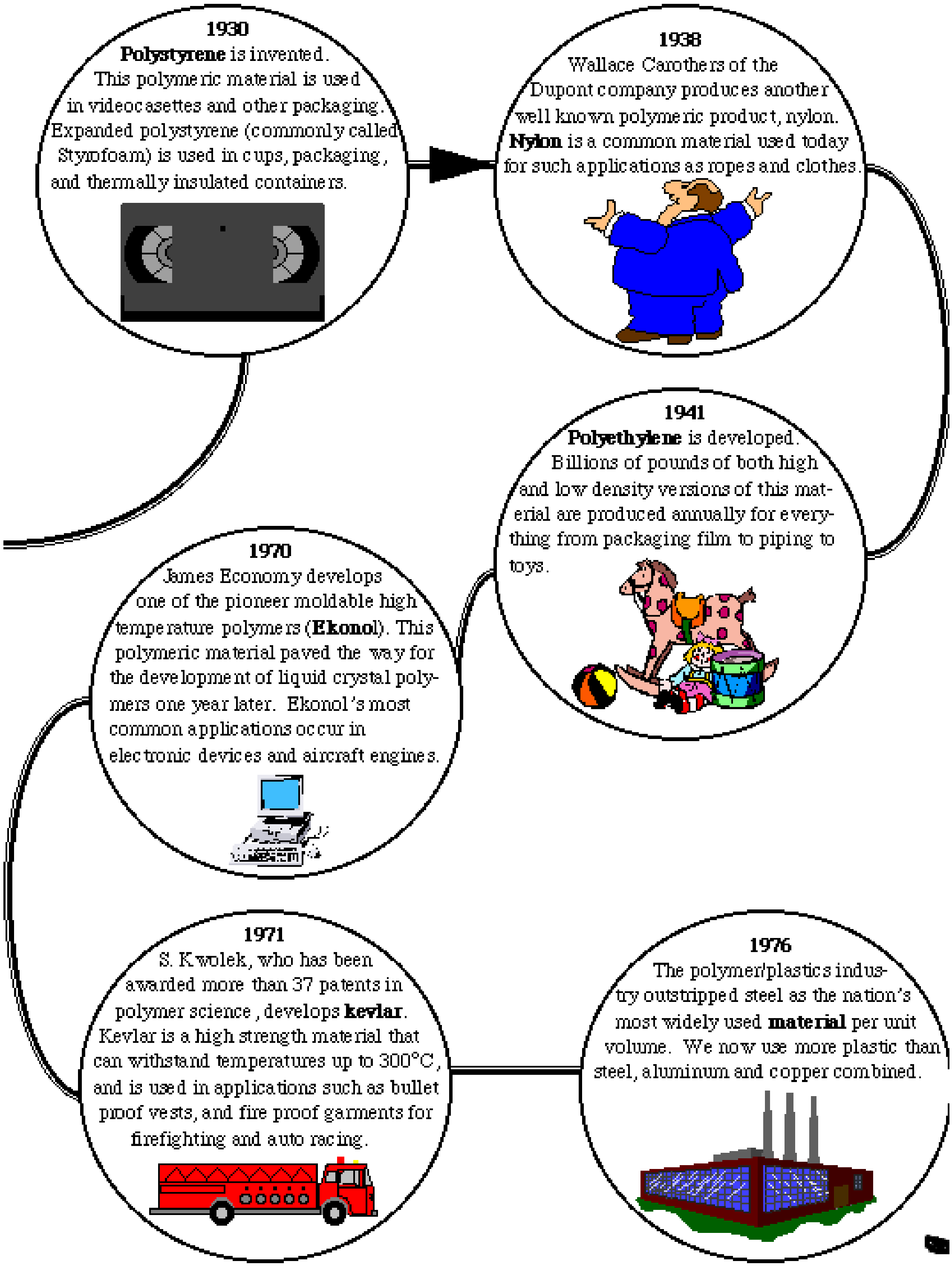

Figure 1.2: Historical Background of Polymer

Polymers have a wide range of usage which includes agriculture, sports, industry and medicine:-

Table 1.1 Applications of Polymers

FIELD	USAGE
Agriculture and Agribusiness	Polymeric materials are used in and on soil to improve aeration, provide mulch, and promote plant growth and health
Medicine	Heart valve replacements and blood vessels, are made of polymers like Dacron, Teflon and polyurethane
Industry	Automobile parts, windshields for fighter planes, pipes, tanks, packing materials, insulation
Consumer Science	Plastic containers, Clothing, floor coverings, garbage disposal bags
Sports	Playground equipment, various balls, golf clubs, swimming pools, and protective helmets

However, the strength of these polymers when converted to products was significantly low in terms of tensile strength, modulus of elasticity and etc. Hence polymer composite was introduced to the world. In general, composites refer to the combination of two or more elements. The reinforcing agents used must be more than 5% with the presence of an interphase. A composite material consists of three phases.

The first phase which is the “Matrix Phase” is a continuous phase. It holds the dispersed phase and shares a load with it. The second phase is the “Dispersed Phase” whereby it is imbedded in the matrix either in a continuous or discontinuous form. The last phase is the “Interphase”, a zone across the matrix and dispersed phases interact. Hence, Polymer Matrix Composite refers to a polymer matrix which is combined with a fibrous reinforcing dispersed phase. Polymer matrixes composite are preferred nowadays due to is low cost and simple production methods.

The reinforcement of polymer matrixes can be in various types. For example it could be a continuous fiber such as organic fiber, natural fiber, short fiber or even particles. There are three types of Polymer Matrix Composite which are Thermoset, Thermoplastic and Rubber. Taking a closer look at the fibrous reinforcing component, three main types of fiber are usually used which are glass fiber, carbon fiber and aramid (Kevlar).

In glass fibers, three types are used which are “E-Glass”, “S-Glass” and “C-Glass”. Glass fibers reinforced polymer matrixes composite are proved to have:-

- High strength-to-weight ratio
- High modulus of elasticity-to-weight ratio
- Good corrosion resistance
- Low thermal resistance

In Carbon fibers, 5 types of fibers are used which are ultra high modulus, high modulus, intermediate modulus, high tensile and super high tensile. Carbon Fiber Reinforced Polymers are proved to have:-

- Light weight
- High strength-to-weight ratio
- Very High modulus elasticity-to-weight ratio
- High Fatigue strength
- Good corrosion resistance
- Very low coefficient of thermal expansion
- Low impact resistance
- High electric conductivity

Kevlar fiber (aramid) on the other hand was proved to have:-

- High tensile strength (five times stronger per weight unite than steel)
- High modulus of elasticity
- Very low elongation up to breaking point
- Low weight
- High chemical inertness
- Very low coefficient of thermal expansion;
- High Fracture Toughness (impact resistance);
- High cut resistance

- Textile processibility
- Flame resistance.

Polymer matrix composite was a breakthrough in the polymer industry as its uses was varied being a stronger version then polymer matrix.

1.2 PROBLEM STATEMENT

In the current status quo, researchers have found three major problems in polymer matrix composites. The first would be a low maximum working temperature, the second would be a high coefficient of thermal expansion-dimensional instability and the third would be sensitivity to radiation and moisture. This by default causes a major loop hole in the polymer matrix composite to perform. One polymer matrix which has huge potential and facing this problem is Polylactic Acid (PLA). PLA is a thermoplastic based polymer and is one of the most promising biodegradable polymers (biopolymers). It is relatively cheap and has some remarkable properties, which make it suitable for different applications. One novel method to overcome this problem is by using enzyme treated natural fibers in this case Palm Oil Empty Fruit Bunch (POEFB) as a reinforcing agent for PLA matrix. POEFB is chosen as the fiber reinforcing agent due to two main reasons, firstly due to its wide abundance and secondly due to its strong bond between the fibers. Hence, before extrusion of PLA is done with his fiber, the fiber is first analyzed for its characteristics. This research is aimed to analyzed the characteristics of enzyme treated POEFB before the extrusion of PLA.

1.3 RESEARCH OBJECTIVE

The objectives of this research as below:

RO 1: To characterize enzyme treated POEFB

RO 2: To enhance the mechanical properties of POEFB

1.4 SCOPE OF THE STUDY

The method will be discussed in this part. The process begins with treatment of EFB fiber with the enzyme laccase. Details of the enzyme and EFB will be discussed later on. Once the treatment in done, the treated fibers are then subjected to a lignin test and the tensile test. The treated fiber is also subjected to moisture content test to determine the amount of moisture present. In terms of tensile test, Universal Testing machine will be used to obtain the results.

1.5 RATIONALE AND SIGNIFICANCE

It should give advantages to the polymer composite after mixing empty fruit bunch fiber in the polylactic acid matrix. Firstly, a high tensile strength polymer composite might be produced. Besides that, a lower thermal expansion and a high working temperature might be obtained with the new composite. Furthermore, this new product might be possible in terms of commercialization due to the strong bonds between the matrix and reinforcement. This is crucial as the demand for a stronger polymer matrix composite is high as various products are being innovated from this material.

CHAPTER 2

LITERATURE REVIEW

2.1 POLYMER

Polymers are substances containing a large number of structural units joined by the same type of linkage. Polymers are produced via polymerization, chemical reaction in which high molecular mass molecules are formed from monomers. There are two types of polymerization reaction; chain reaction (addition) and step reaction (Condensation). Chain-Reaction polymerization is the common type of polymerization which involves three steps which are 'Initiation", "Propagation" and "Termination". This process involves two chemical entities, first the monomer and second is the catalyst. In the initiation process, a double boned carbon monomer breaks apart due to the reaction with a free radical catalyst. The monomer then forms a bond with the free radical while the electron is transferred out:-

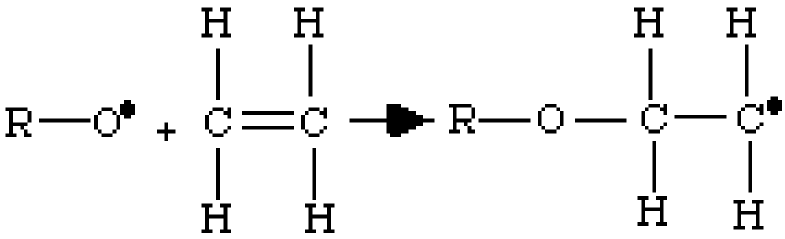

Figure 2.1: Initiation Step in Polymerization

In propagation, the operation is repeated whereby a long chain molecule is formed. The double bonds of the monomers are constants broke up while the electron is passed along the line:-

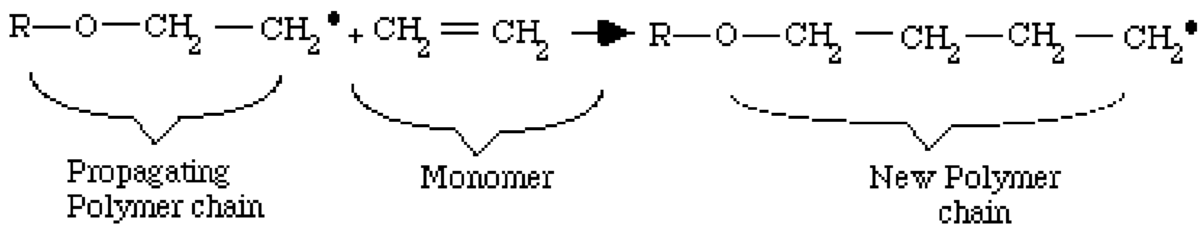

Figure 2.2: Propagation Step in Polymerization

The final step termination occurs when a free radical reacts with another free radical or two unfinished chains bond together. This reaction produces a complete polymer chain.

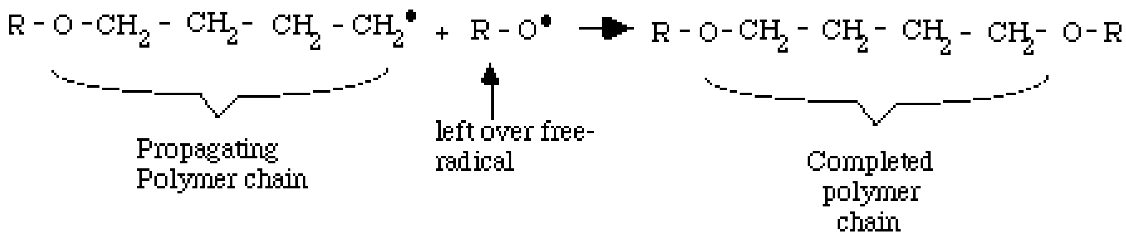

Figure 2.3: Termination Step in Polymerization

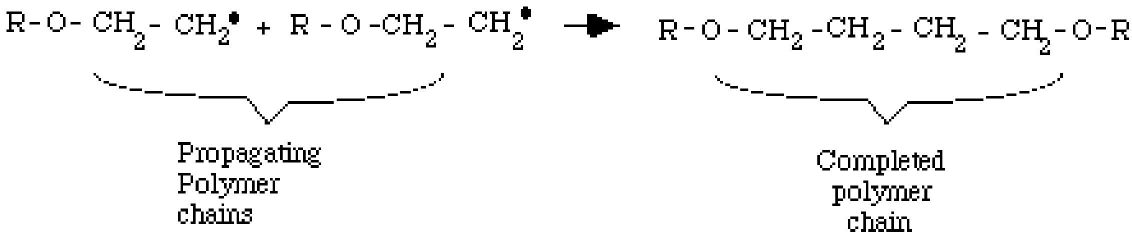

Figure 2.4: Termination Step in Polymerization

In step-reaction, two different types of di-functional monomer group is required which will react to form a chain. Condensation produces a small by-product such as water or hydrochloric acid. Taking an example of the formation of Nylon 66:-

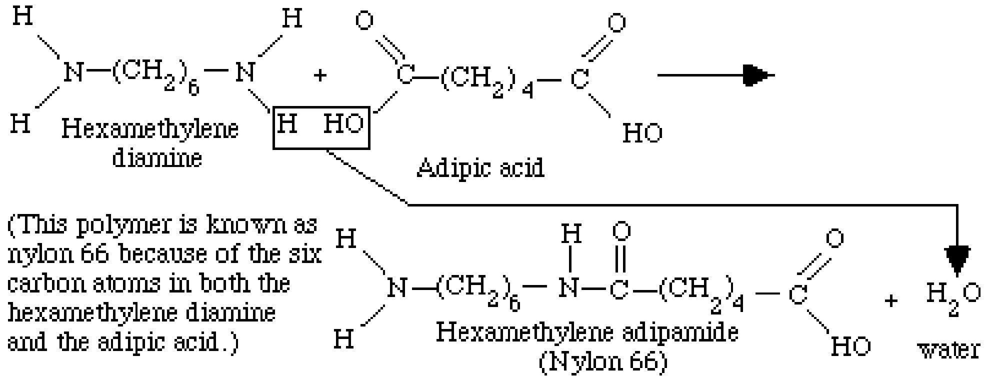

Figure 2.5: Condensation Process of Nylon 66

From the figure, we realise that the monomers present are hexamethylene diamine and adipic acid react to form Nylon 66 and the by-product water is produced.

2.2 COMPOSITE

Combination of two or more than two is known as composite. Composites have been created to improve combinations of mechanical characteristics such as stiffness, toughness and ambient and high temperature strength (Callister, W. D. & Rethwisch, D. G., 2008). "Most of the composite materials are composed of just two phases. One is termed the matrix, which is continuous and surrounded the other phase, often called the dispersed phase" (Callister, W. D. & Rethwisch, D. G., 2008).

In this research, the polylactic acid (PLA) can be characterized it as the matrix because it is used to surround the palm oil empty fruit bunch fiber (POEFB). The matrix used to protect the surface of the fiber from any defect cased by external forces. It would cause of minimizing the strength of the fiber that would lead to crack propagation. This kind of composite is considered as bio-composite (Maya Jacob John, Sabu Thomas, 2007) which is environmental friendly. This aspect is crucial because this helps to promote green technology and reduce environmental hazards.

2.3 POLYLACTIC ACID (PLA)

Poly(lactic acid) or polylactide (PLA) is the most extensively researched and utilized biodegradable and renewable thermoplastic polyester, with potential to