

# **CHAPTER 1**

## **INTRODUCTION**

### **1.0 Chapter Overview**

This chapter explains the rational and motivation of the present research on the synthesis of bio-based polyester polyol.

### **1.1 Background of Study**

Natural leathers commonly obtained from animals which have beautiful appearance, soft and porous structure are popular in market. However, the market of natural leather is less because of the restricted source, expensive price as well as awareness in protecting animal. As an alternative, synthetic leather based on nonwoven support material coated with polyurethanes (PU) is commercialized (Chen et al, 2006).

PU are commonly used in producing the familiar products such as coating, elastomers, solid articles, films and in the manufacturing of foams. According to Markets and

Markets, the global polyurethanes market is forecasted to grow at a compounded annual growth rate (CAGR) of 6.8% between 2011 and 2016. Asia-Pacific, especially China has traditionally been the largest producer and exporter of polyurethane materials. Robust growth in key end-user industries such as construction, automotive, furniture and electronics has resulted in Asia-Pacific dominating the demand for polyurethanes with market share of 40.2% in 2010. Markets and Markets estimates polyurethane demand in Asia-Pacific to reach 7,469.21 kilo tonnes in 2016, at a CAGR of 5.3% from 2011 to 2016. Grand View Research (2014) estimates that, the market of polyurethane in Asia-Pacific is growing at a CAGR of 5.9% from 2014 to 2020. As the demand of polyurethanes is growing in the Asia-Pacific region, it has emerged as the largest consumer of polyurethanes in recent years.

The various usages require polyurethanes to exhibit certain properties such as low temperature flexibility, high tensile strength, tear strength, elongation, abrasion resistance and solvent resistance to ensure that the products made can withstand the environments in which they are used (Cirujano, 2014). Conventionally, polyurethanes are obtained by reacting polyester polyol with a di-isocyanate (Sharmin et al, 2012). These raw materials of PU are derived from petroleum (Desroches, 2012).

## **1.2 Motivation**

Currently, the whole world is currently concerned about the expected depletion of natural petroleum resource, instability in price of crude oil, environmental pollution and global warming. Numerous research works have been carried out to find a renewable and environmental friendly alternative as the substitution to the products derived from petroleum.

Polyurethane derived from petroleum is non-biodegradable. In order to dispose polyurethane petroleum-based, Yang et al (2012) said, originally polyurethane wastes managed in landfill or by incineration. Low density of polyurethane cause landfill will be serious waste of land resources and polyurethane waste are very difficult to decompose in natural conditions. Therefore, landfill treatment is not wise for polyurethane waste. Through burning, the wastes volume can be reduced by 99 %. The waste shattered into grain as fuel alternative coal, oil and natural gas recovery energy. But if the incineration

process is incomplete combustion, it will produce poisonous gas which seriously polluted the atmospheric. Therefore the method is being phased out gradually.

Polyester polyols can be synthesized by heating polyol (an alcohol which has more than two hydroxyl groups in a chain) with dicarboxylic acid at a very high temperature in consideration of the melting temperature of both reactants and catalyst used. The use of bio-based polyol and dicarboxylic acid derived from plant has yielded a biodegradable polyester polyols. Degradation of biodegradable products is disintegrated by bacteria, fungi, or other microorganisms. They have ability to decompose into the soil safely and relatively quickly. Besides, they are renewable and cause no harm to the earth since less greenhouse gas and harmful carbon emitted.

### **1.3 Problem Statement**

Conventionally, esterification reactions are carried out using homogeneous catalysts. Examples of homogenous catalysts used in esterification of polyol with fatty acid are p-toluene sulfonic acid, sulfuric acid and phosphoric acid. The homogeneous catalysts have caused higher capital and operating costs due to its corrosiveness and necessity to be separated from the product for reuse purposes. Comparing to the homogeneous catalyst, heterogeneous catalysts have many significant advantages such as different phase from the product, less corrosive and less toxic, leading to the reduced production cost and environmental problem (Hidayat et al, 2015).

In previous study, there are some existing studies of esterification of polyol with fatty acid catalysed by heterogeneous acid catalyst. Esterification of glycerol and oleic acid catalysed by a type of zeolite, faujasite exhibits 80% conversion of oleic acid at reaction temperature 180°C. (Márquez-Alvarez, 2004). Esterification of trimethylolpropane and oleic acid was run to test the behaviour of cation exchange resins which are Dowex 50wx2, Amberlyst 36, Purolite CT482 and Purolite CT275DR. All four catalysts accelerate the kinetic reaction (Kuzminska et al., 2014). This existing studies show, the reaction between polyol with fatty acid catalysed by heterogeneous acid catalyst exhibit high conversion.