NEW POLYOLS BASED ON PALM OIL DERIVATIVES AND TETRAHYDROFURAN

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Global consumers are increasingly concerned with environmental issues and this has encouraged industries to introduce environmental-friendly products (Ragauskas *et al.*, 2006). One of such industries that is adopting the 'green' movement is the polyol and polyurethane (PU) industries, where polyol producers and scientists worldwide have been actively producing polyols from renewable feedstock such as palm oil and soyabean oil (Desroches *et al.*, 2012).

The most common method to produce polyols from palm oil is through epoxidation of triglycerides followed by epoxide ring opening with alcohols to yield polyols (Hazimah *et al.*, 2011). In general, polyols prepared through this method are monomeric triglycerides molecules that have molecular weights in the range of 1000 – 1200 Da. These polyols are suitable for making flexible PU foams due to their low molecular weight and functionality. On the other hand, they are less suitable for making elastomeric PU and in accordance with this drawback, new types of polyols based on palm oil need to be synthesised for use in elastomeric PU.

The technology (Hoong *et al.*, 2015) highlights the preparation of new polyols based on palm oil derivatives and tetrahydrofuran that are found suitable for making elastomeric PU. The palm oil derivatives used in this technology were methyl oleate and palm olein. The first step in the synthesis of these new polyols involved epoxidation of palm oil derivatives followed by ring opening copolymerisation between epoxidised palm oil derivatives and tetrahydrofuran (*Figure 1*).

PROPERTIES OF NEW POLYOLS BASED ON PALM OIL DERIVATIVES AND TETRAHYDROFURAN

In general, the properties of these novel polyols depend on the palm oil derivatives used as starting material. The palm oil derivatives content in the prepared polyols was in the range of 20% to 40%. Meanwhile, the hydroxyl values of these polyols were between 30 and 50 mg KOH g^{-1}. On the other hand, the acid values of these polyols were below 1 mg KOH g^{-1}, which is a common specification of polyols. In terms of average molecular weight, these polyols exhibited values between 3000 Da and 30 000 Da. Further detailed properties of these polyols are listed in *Table 1*.

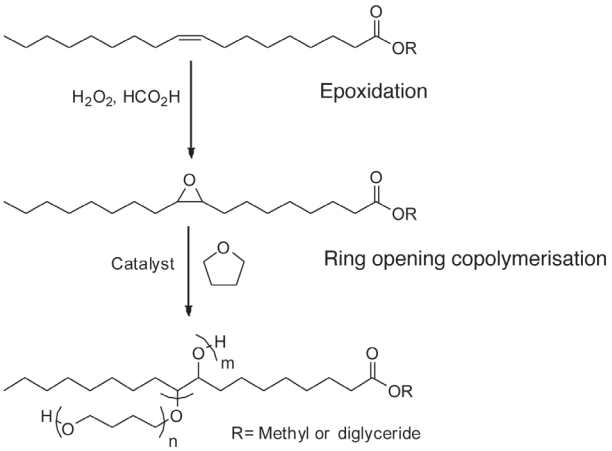

Figure 1. Idealised synthetic pathway of preparing new polyols from palm oil derivatives and tetrahydrofuran.

BENEFITS OF NEW POLYOLS BASED ON PALM OIL DERIVATIVES AND TETRAHYDROFURAN

- These new polyols contain about 20% to 40% renewable content that promote environmental-friendliness, which will appeal to 'green' consumers.
- These new polyols contain palm oil derivatives that function as internal plasticiser, which contribute to softer properties in PU elastomers.

POTENTIAL APPLICATION

Initial studies showed that these new polyols were found suitable for use in making elastomeric PU.

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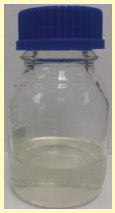
TABLE 1. PROPERTIES OF POLYOLS BASED ON PALM OIL DERIVATIVES AND TETRAHYDROFURAN

Polyol name	EMO-THF	EPO-THF
Description	Polyol based on methyl oleate and tetrahydrofuran	Polyol based on palm olein and tetrahydrofuran
Palm oil derivatives content (%)	35 - 40	20 - 25
Appearance	Light yellow liquid	White solid
		
Hydroxyl number, mg KOH g^{-1}	45 - 50	30 - 35
Acid value, mg KOH g^{-1}	0.3 – 0.7	0.1 – 0.2
Viscosity at 25°C, cPs	1 500 - 2 000	solid
Average molecular weight (m_n), Da	3 500	28 000

These polyols were reacted with diisocyanate such as 4,4'-methylene diphenyl diisocyanate and yielded soft PU elastomers. Besides, these polyols can also be used to make PU coatings and sealants.

POTENTIAL MARKET

The Asia-Pacific's polyols market in year 2009 for PU CASE (coatings, adhesives, sealant, elastomers) products was about 1.7 million tonnes, with almost one million tonnes of polyols were used in PU elastomers production (IAL, 2011).

ECONOMIC ANALYSIS

An economic model was projected based on a plant capacity of 6000 t per annum. The following are outline of the economic model:
Capital expenditure = RM 15 million.
Operation expenditure = RM 480 000.
Payback period = 4 years.
Internal rate of return = 25%.

SUMMARY

These new polyols offer an opportunity for industry members to produce palm oil-based products that meet the growing global consumer demand for environmental-friendly products.

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