NEW HIGH FUNCTIONALITY POLYOL BASED ON PALM OLEIN

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730

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Polyols are prepared from unsaturated vegetable oils by introducing hydroxyl groups at the position of double bonds (Narine *et al.*, 2007). Hydroxyl groups can be introduced in many ways, resultingin different polyol structures, which when converted to polyurethane (PU), impart different properties to the final product (Lin *et al.*, 2007). Primary hydroxyl groups in polyols are desirable as they undergo rapid polymerisation processes and their compositions greatly influence the physical properties of the polymeric articles (Narayan *et al.*, 2006). One of the disadvantages of conventional palm-based polyols is their low functionality due to the lack of primary hydroxyl group. Therefore, transforming palm olein (POo) into high functionality polyol is desirable. One of the methods to increase the hydroxyl functionality of POo is through epoxidation of POo followed by epoxide ring opening with alcohols. Another method is through transesterification of POo with glycerol, which converts POo to mono- and diglycerides that contain primary hydroxyl groups (*Figure 1*). Combination of both methods will significantly increase the hydroxyl functionality of palm-based polyols (Arniza *et al.*, 2015).

PREPARATION OF THE HIGH FUNCTIONALITY PALM OLEIN-BASED POLYOL

This technology enables the production of a new class of palm-based polyol with high functionality and high hydroxyl value. The high functionality palm olein-based polyol is produced by transesterification of POo followed by epoxidation and alcoholysis as shown in *Figure 1*.

PROPERTIES OF THE HIGH FUNCTIONALITY PALM OLEIN-BASED POLYOL

The properties of the high functionality palm-based polyol are shown in *Table 1*. It is a light brown waxy solid (*Figure 2*) with a high hydroxyl value of more than 300 mg KOH g^{-1}.

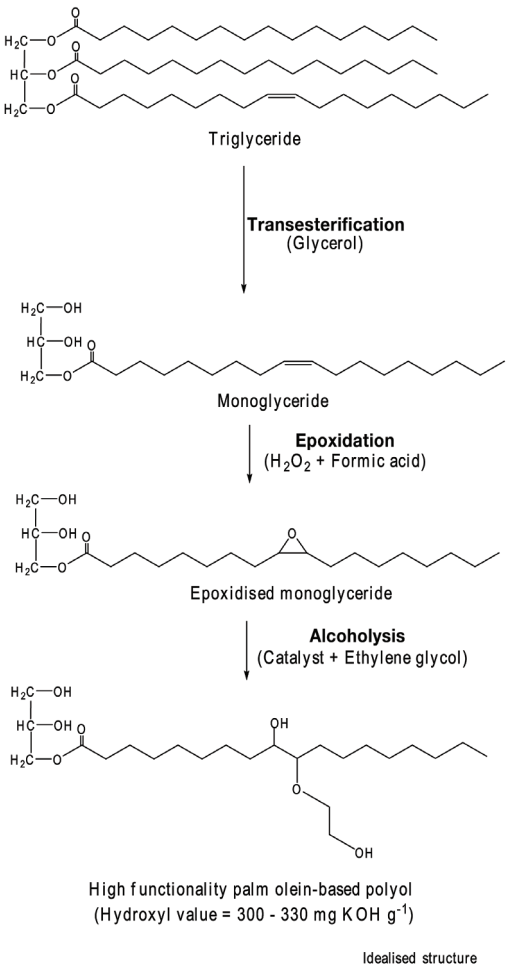

Figure 1. Synthetic pathway of preparing high functionality palm olein-based polyol.

TABLE 1. TYPICAL PROPERTIES OF HIGH FUNCTIONALITY PALM OLEIN-BASED POLYOL

Properties	Value
Moisture (%)	0.1
Acid value (mg KOH g^{-1})	2.0
Iodine value (g I_2 100 g^{-1})	2.5
Hydroxyl value (mg KOH g^{-1})	300 - 330
Weight-average molecular weight, Mw (Dalton)	1 000 - 1 100
Polydispersity index	1.2
Appearance at ambient	Light brown waxy solid

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Figure 2. High functionality palm olein-based polyol.

ADVANTAGES

This high functionality palm-based polyol offers higher hydroxyl values, targeted to be used in producing better quality palm-based rigid polyurethane foam products. Transesterification of POo with glycerol was aimed to increase functionality of POo by introducing primary hydroxyl groups to the triglyceride structure.

MARKET ANALYSIS

The total polyol consumption in the Asia-Pacific's polyurethane industry was about 4 million tonnes in 2014. Polyester polyols contributed approximately one million tonnes, which was 25% from the total polyol consumption. Furthermore, 5% (55 000 t) from the polyester polyols were consumed to produce rigid polyurethane foams.

ECONOMIC ANALYSIS

The investment and payback period of the high functionality palm-based polyol is given below:

Items	Value
Cost	RM 5.5 kg^{-1}
Capital expenditure	RM 16 000 000
Production capacity	7 000 t yr^{-1}
Internal rate of return (IRR)	25%
Payback period	4 years

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