POLYOL FROM USED FRYING OIL (P-UFO)

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Palm oil is widely used in many countries especially in industrial and small scale frying activities. In 2006, our country produced about 15.9 million tonnes of crude palm oil, mostly used in food applications, especially for frying. The used frying oil (UFO) is either regenerated back to food-grade oil or used in non-food applications. One of the fast food restaurants in Malaysia alone produces about 1020 t of UFO a year, usually used to produce as animal feedstock. Recovered oil of good quality can be used as fatty acid source or in the production of feed oil, paint, ink, biodiesel, soap and other products, but the rest is burnt or discarded (Totani *et al.*, 2004). UFO can also be refined into useful oleochemical derivatives for making lubricants, greases, plasticizers, detergents, candles and emulsifiers.

In MPOB, the technology for using UFO to produce methyl esters has already been established (Loh *et al.*, 2003). The technologies to produce polyols from crude palm oil, RBD palm olein and RBD palm kernel olein is established in MPOB. This technology describes the potential use of UFO as an alternative for a new and cheaper raw material for the production of polyols. *Tables 1* and *2* show the properties of two batches of UFO collected and their fatty acid compositions, respectively.

POLYOL FROM USED FRYING OILS (P-UFO)

The common way to produce oleochemical polyols is by the ring of an epoxidized triglyceride or fatty alcohol, with mono/polyhydric alcohols or mono/polyethanolamine in the presence of an acid catalyst, such as sulphuric acid, phosphoric acid, sulphonic acid and boron trifluoride. Likewise, the UFO can also be subjected to similar reaction conditions as other vegetable oil-based raw materials. In this study, the UFO was first epoxidized with peracid to obtain epoxidized UFO. The epoxidized UFO was then reacted with a polyhydric alcohol, such as glycerol, ethylene glycol and propylene glycol. The polyol obtained was quite similar to the palm-based polyol, Poly EG (olein-based), obtained from the MPOB pilot plant, in terms of hy-

TABLE 1. PROPERTIES OF TWO BATCHES OF USED FRYING OIL

	IV (I_2/100 g)	PV (meq kg^{-1})	FFA (%)	Polymer compounds	(%) AN
Source 1	56	0.8	0.2	ND	ND
Source 2	52	3.0	3.9	3.9	5.4

Note: ND – not determined.

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TABLE 2. FATTY ACID COMPOSITIONS OF TWO BATCHES OF USED FRYING OIL

Fatty acid (%)	Source 1	Source 2
Lauric (C12:0)	0.4	0.3
Myristic (C14:0)	1.1	1.0
Palmitic (C16:0)	34.2	40.9
Palmitoleic (C16:1)	1.2	0.8
Stearic (C18:0)	4.0	4.5
Oleic (18:1c)	40.9	42.7
Oleic (18:1t)	trace	trace
Linoleic (18:2c)	10.8	8.1
Linoleic (18:2t)	trace	trace
Linolenic (C18 :3)	0.3	0.2
Arachidic (C20 :0)	0.3	0.3
Others	6.7	1.2

droxyl value, viscosity, iodine value and moisture, but slightly darker in colour (*Table 3*).

POLYURETHANE FOAM FROM P-UFO

The polyol from UFO (P-UFO) can be used to produce polyurethane (PU) foam. The P-UFO was reacted with suitable isocyanates to produce various types of PU foams, such as flexible, rigid and semi-rigid, in the presence of suitable additives and a blowing agent. Blending P-UFO with suitable petrochemical-based polyols is preferred to improve the properties of the foam. The foams produced were slightly orange/yellowish and their general properties are shown in *Table 4*.

POTENTIAL APPLICATIONS

The PU foam produced from P-UFO can be used to produce flexible foam for cushions and mattresses and rigid foams for insulators and construction materials.

ADVANTAGES

- P-UFO has similar properties to palm-based polyol made from RBD palm olein (Poly EG).

TABLE 3. PROPERTIES OF P-UFO AND POLY EG

Parameter	P-UFO	Poly EG
Hydroxyl value, mg KOH g^{-1}	120-150	155-175
Acid value, mg KOH g^{-1}	2.0-2.5	1.0 max
Viscosity@ 25°C, cP	4 000-7 000	4 000-8 000
Iodine value, g I_2/100 g	8-10	10-15
Moisture, %	0.1-0.3	0.3 max
Colour	Brown	Brownish-yellow

TABLE 4. PROPERTIES OF PU FOAMS FROM P-UFO

	Cream time, (s)	Gel time, (s)	Rise time, (min)	Tack-free time, (min)	Density (kg m^{-3})
P-UFO rigid foam	12-15	55-65	4.0-4.5	4.0-5.0	45-65
P-UFO flexible foam	11-13	30-40	2.0-3.0	4.0-5.0	40-60

Different sources of UFO also produced similar polyols;

- P-UFO is cheaper than Poly EG due to the lower price of the raw material. The UFO cost about 25% lower than crude palm oil;
- The raw material used is used frying oil, hence the technology developed promotes green environment and zero-waste campaign;
- The P-UFO can be formulated into both flexible and rigid PU foams, depending on the isocyanates and additives used; and
- The PU foams are environment-friendly because only water is used as the blowing agent.

CONCLUSION

P-UFO was prepared with similar properties as the polyols produced from fresh (new) oils. P-UFO blended with suitable petrochemical polyols and isocyanates produced PU foams of acceptable properties.

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