EPOXIDISED PALM OIL CREATES EXCITING AVENUES FOR PALM-BASED INDUSTRIALISATION

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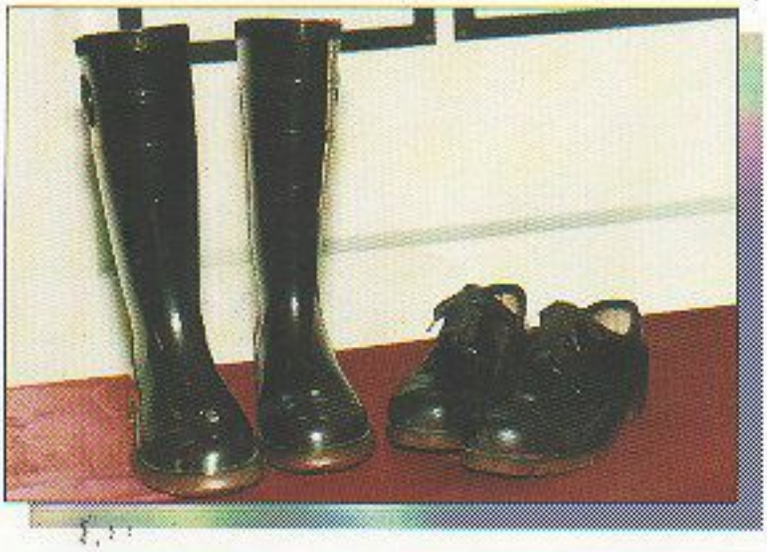
THE RATIONALE

Vision 2020 calls for more efforts towards an industrialised economy in Malaysia. One agreed strategy is to explore more downstream possibilities for our many natural resources through research and development (R&D).

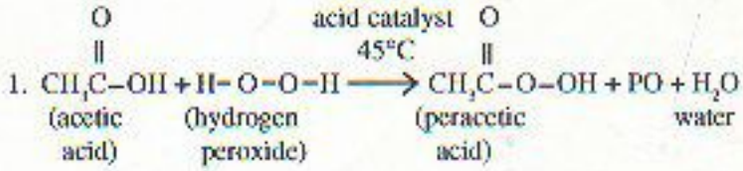
Recent research at the Palm Oil Research Institute of Malaysia (PORIM) has indicated exciting possibilities for a new product from palm oil (PO). This product is epoxidised palm oil (ePO). As a result of collaborative R&D with local organisations and industries, ePO has been shown to have a number of commercially realistic end uses, *e.g.* as additives in the plastic industry; as an agent in polyacrylate surface finishing and as an effective starting material to make polyol. Polyol, incidentally, is a key component in the production of the versatile and fast expanding industrial material, polyurethane.



REACTIONS

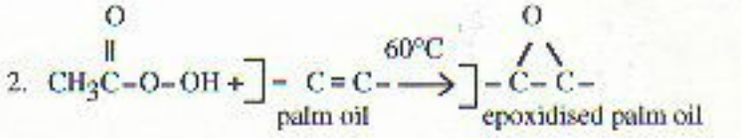
Laboratory scale studies carried out by PORIM has indicated that palm oil (crude or processed) or its derivatives can be converted to ePO economically via two methods.

(A) Preformed peracetic acid



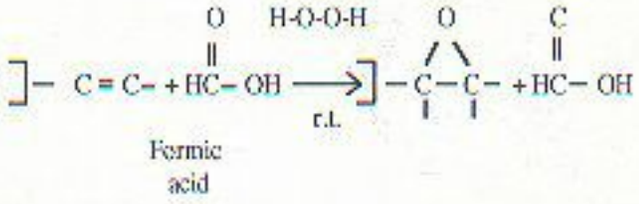
1. $CH_3C(=O)-OH + H-O-O-H \xrightarrow[45°C]{\text{acid catalyst}} CH_3C(=O)-O-OH + PO + H_2O$

(acetic acid) (hydrogen peroxide) (peracetic acid) water



2. $CH_3C(=O)-O-OH + \text{palm oil} \xrightarrow{60°C} \text{epoxidised palm oil}$

(B) Peroxyformic acid generated *in situ*



$$\text{palm oil} + HC(=O)-OH \xrightarrow[\text{r.t.}]{H-O-O-H} \text{epoxidised palm oil} + HC(=O)-OH$$

Formic acid

For the commercial production of ePO, method (ii), viz. the *in situ* generation of peroxyformic acid is preferred since this gives the possibility of recycling some of the formic acid used. This method is currently developed further by a local company.

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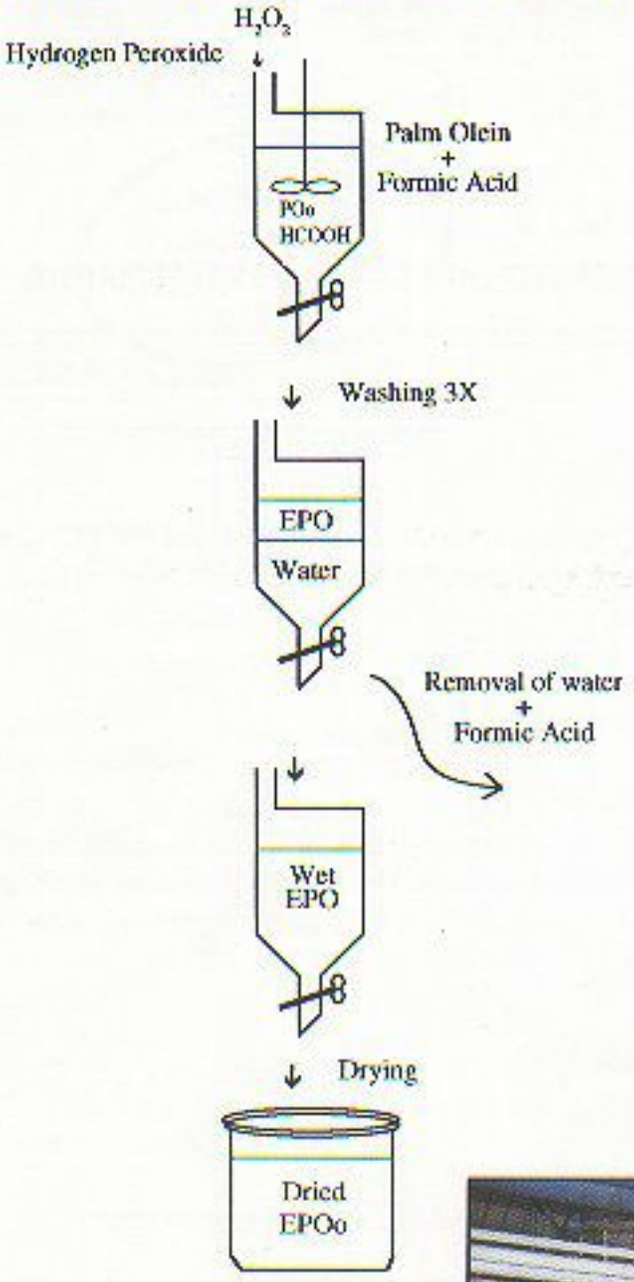
PROCESS

EPOXIDATION PROCESS OF PALM OLEIN



APPLICATIONS OF EPO

1. Plasticizers/Stabilizers

When added to plastics, plasticizers reduce the intermolecular forces within the polymer chains, thereby increasing softness, flexibility and elongation of the plastics. In contrast, stabilizers when added to plastics, help to reduce the rate of degradation process that occurs when plastics are exposed to heat, light, weather and microorganism. Some chemicals however can function as both plasticizer and stabilizer.

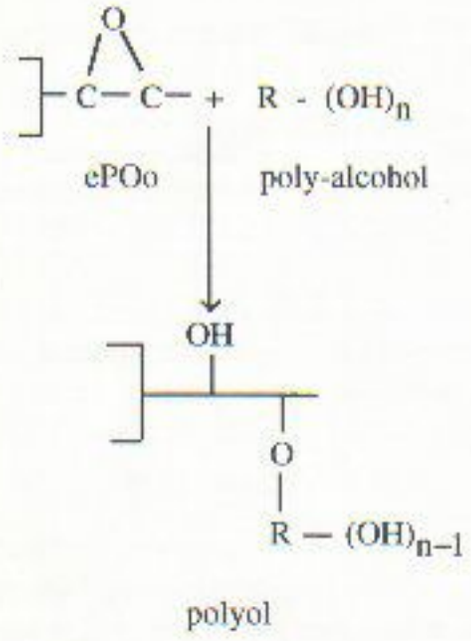
2. Polyols

Polyol is a generic term for polyfunctional alcohols. Polyols are one of the main raw materials used in the manufacture of polyurethane (PU) and are mainly derived from petrochemicals.

Polyurethane is a very versatile 'plastic' material and PU-products have made our world more comfortable because of their applications in almost every aspect of human life and activities, e.g. in foot wear, transport, furniture and housing construction. PORIM is now investigating the conversion of palm oil into polyol with the hope that the product can replace the existing petroleum-based polyol used by the industry.

In this investigation epoxidised palm oil is reacted with simple short-chain alcohols to give polyols which are

light yellow to brown in colour and are of different viscosity. The process is summarized below:



polyol

Certain characteristic tests have been carried out on some of the polyol samples prepared which are as follows :

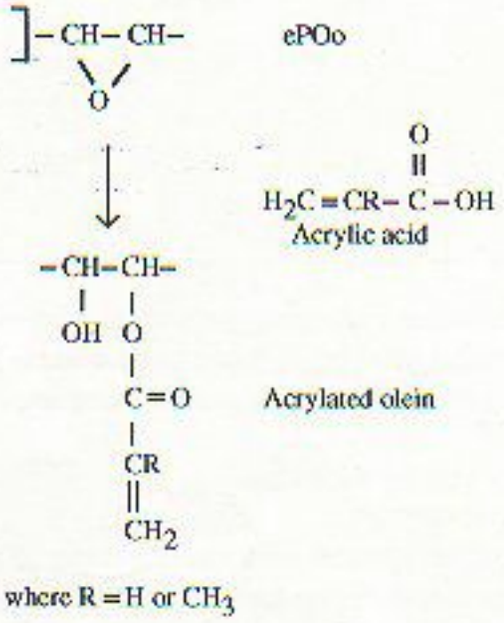
	Ratios (oil : alcohol)		
	1:1	2:1	4:1
Hydroxyl (value)	350-450	200-300	150-200
Viscosity (60°C) mPa.s	980-1,300	1,700-2,100	3,500-4,700
Oxirane oxygen content (%)	0.04-0.2	0.02-0.06	0.07-0.06

Based on a preliminary comparison with the existing polyols, palm-based polyols are found to be suitable for the manufacture of rigid to semi-rigid polyurethanes.

3. Polyacrylates as Surface Coatings

The development of new radiation curable material for application in radiation curing technology is an important research area. Most of the radiation curable resins available commercially are derived from synthetic raw materials. Only a few, which are known as acrylated oils, are obtained from natural substances such as soyabean and linseed oils.

The synthesis of acrylated palm olein (EPOLA) was a collaborative work between PORIM and UTN whereby acrylic acid was used to cleave the oxirane ring of ePOo. Oxirane oxygen content, iodine value, acid value and infra-red absorption data were used as confirmatory parameters of the product. The reaction is summarized below:



The EPOLA is capable of polymerizing through its double bond in the presence of initiating species. In the initial study, a liquid layer of the EPOLA liquid sample containing 5% benzophenone was applied to a tin-coated steel plate which was then cured by UV radiation to form a thin solid film.

Some of these coating materials have been applied to flooring furnishes such as parquets. Currently, extensive work is being carried out to evaluate the strength and durability of these surface coatings.

MARKET POTENTIAL OF EPO

Based on these findings the following market potential for EPO can be envisaged:-

1. Epoxidised palm oil can be a partial substitute for epoxidized soyabean oil in many of the latter's commercial applications.

2. Palm-based polyacrylates are potential substitutes for solvent-based polyacrylate coatings. Ultraviolet as well as electron beam irradiation has eliminated the use of solvents and in addition can increase the rate of curing process.

3. It is estimated that the growth rate for polyurethane consumption in the 1990s is approximately 3.5% per annum, leading to a consumption figure of 7 million metric tonnes for the year 2000. This is an enormous market, and it is hoped that through our R&D PU from palm-based polyols will secure a slice of it. Furthermore, the switch from petroleum-based polyols to palm-based polyols as feedstock in PU manufacture offers the advantage of a renewable resource coupled with a gentler impact on the environment of such PU products.

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