

# PALM-BASED POLYURETHANE FLEXIBLE SLABSTOCK FOAMS

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**P**olyurethanes, or PU, constitute a group of polymers with highly versatile properties and a wide range of commercial applications. The material is used in almost every aspect of human life, in a multitude of applications in industries such as construction, automobile, refrigeration, furniture including mattresses, adhesives and sealants, footwear, ship building, transport, packaging, coating and paints.

PU is formed by reacting a polyol with a diisocyanate or polymeric isocyanate in the presence of suitable catalysts and additives. A polyol is actually an alcohol with more than two reactive hydroxyl groups per molecule. A broad spectrum of materials can be produced because of the variety of diisocyanates and polyols that can be used for different applications. Generally, there are three types of PU - rigid, semi-rigid and flexible. In this technology, the use of palm-based polyol in flexible PU slabstock is described.

## PALM-BASED POLYOLS AND PROPERTIES

To produce palm-based polyols, palm oil is first epoxidized to epoxidized palm oil (EPO), followed by reacting the EPO with polyhydric alcohols. Palm-based polyols with a range of hydroxyl groups per molecule can be produced, depending on the type of polyhydric alcohol used.

The typical properties and specifications of a polyol from palm oil are shown in *Table 1*.

Flexible PU foams constitute more than 40% of the total global urethane market and are the single largest application for urethanes. Flexible foams are found in virtually all furniture and bedding as well as all automotive soft interior components, *i.e.* seats, headrests, armrests, door panels, *etc.* As with petroleum polyol, palm-based PU is also made by reacting palm-based polyol treated with various additives with diphenylmethylene diisocyanates (MDI) or toluene diisocyanates (TDI).

Flexible PU foam in slabstock is made by continuous and discontinuous processes in large blocks with cross-sections of up to about 2.2 m wide by about 1.25 m high. They are made in three main chemical types - foam based on polyester polyols reacted with TDI, conventional polyether polyol and TDI-based foam - and several types of high resilience foams are made from modified polyethers and/or modified isocyanates. The main types of foam may, in turn, be subdivided into polyester- and polyether-based slabstock.

To evaluate the feasibility of producing palm-based flexible PU slabstock in commercial scale, a collaborative production trial between MPOB,

TABLE 1. PROPERTIES OF A TYPICAL PALM-BASED POLYOL

Colour	Brownish yellow	Visual
Odour	Slight / typical	Odour
Hydroxyl value, mg KOH g <sup>-1</sup>	170 – 200	AOCS CD 13-6
Viscosity, mPa.s @ 35°C	3 500 – 4 500	ASTM D 4878
pH	6.5 – 7.5	pH meter
Acid value	3.0 max	AOCS CS 3D-63
Water, %	0.30 max	AOCS CA2E-84
Specific gravity	0.95 – 0.98	Gravimetric

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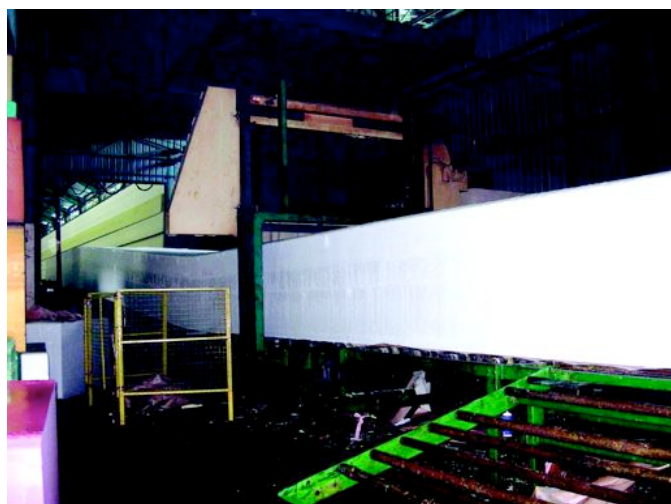
Intermed and Wansern was run. Palm-based polyols was used to produce more than 150 m of flexible PU slabstock. The foam exhibited equivalent properties to the existing petroleum-based products even without addition of polymer polyol. The tensile strength and elongation at break were only slightly inferior. *Table 2* compares the properties of the palm-based and hydrocarbon polyols. *Figure 2* shows the palm-based flexible PU foam slabstock.

## ADVANTAGES

- Palm-based polyol is made from a natural renewable resource.
- The production process for polyol is simpler and plant investment lower
- Cost of production is cheaper than conventional petroleum flexible slabstock – about 10%-15% less.

**TABLE 2. COMPARISON OF PALM-BASED AND HYDROCARBON POLYOL POLYURETHANES**

Property	Hydrocarbon polyol	Palm-based polyol	Test method
Density	12.7 kg m <sup>-3</sup>	12.3 kg m <sup>-3</sup>	ASTM D 3574 A
Hardness @ 25%	94 N	98 N	ASTM D 3574 B1
Hardness @ 65%	198 N	200 N	ASTM D 3574 B1
Tensile Strength	62.0 KPa	57.3 KPa	ASTM D 3574 E
Elongation	98%	72%	ASTM D 3574 E



*Figure 2. Palm-based flexible PU foam slabstock.*

## MARKET POTENTIAL

The total global market for PU in 2005 was about 10 million tonnes, of which about 4.5 million tonnes were for flexible foam which required about 3.0 million tonnes of flexible polyol for production.

## COMMERCIAL TAKER

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