THE USE OF ENVIREZ™ RESINS IN SMC APPLICATIONS

Ashland, Inc.

FEIPLAR 2010

Ashland Inc.

- *5 Commercial Units*
- *Total Revenues: $9.0* Billion*
- *Operations In More Than 100 Countries*

ASHLAND

Ashland Hercules Water Technologies

Revenue: $1.8B

The #1 global producer of papermaking chemicals.

Ashland Performance Materials

Revenue: $1.3B

The #1 global leader in unsaturated polyester resins and vinyl ester resins.

Ashland Aqualon Functional Ingredients

Revenue: $900MM

The #2 global producer of cellulose ethers.

Ashland Consumer Markets

Revenue: $1.7B

The #3 passenger car motor oil and #2 quick-lube chain in the United States.

Ashland Distribution

Revenue: $3.3B

The #2 plastics and #3 chemicals distributor in North America

*Revenues for FY 2010

APM Global Footprint

- Production and Research Facilities
  - **4 technology centers**
  - **27manufacturing facilities**
  - **7 joint ventures**

Responsible Care®

Outline of Presentation

- A Historical Perspective and Technical/Commercial Background
- Development/Commercialization of Renewable Resource-based Resins
- Benefits and Future of Renewable Resource-based Resins – The Future

Renewable Resource Definitions

Renewable Resource

Any natural resource that is depleted at a rate slower than the rate at which it regenerates. Renewable resources can be replaced by natural ecological cycles or sound management practices.

Renewable Energy Sources
- Solar
- Wind
- Geothermal
- Hydroelectric
- Biomass
- Waste

Renewable Product Sources
- Water
- Oxygen
- Aquatic life
- Animals
- Biomass (Trees, Crops, Grass)
- Soil

Non-Renewable Resource

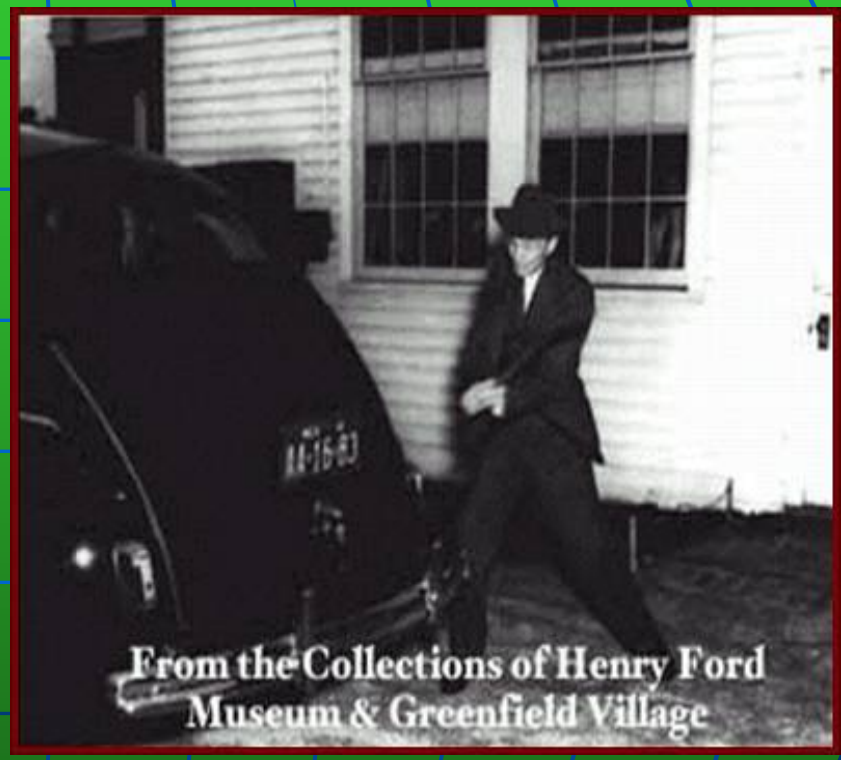
Has no mechanism to replenish itself or it is depleted at a rate greater than the rate at which it regenerates.
Examples: Coal, crude oil, natural gas

Biomass as a renewable feedstock is a growing field of chemistry

Renewable Resource-based Plastics

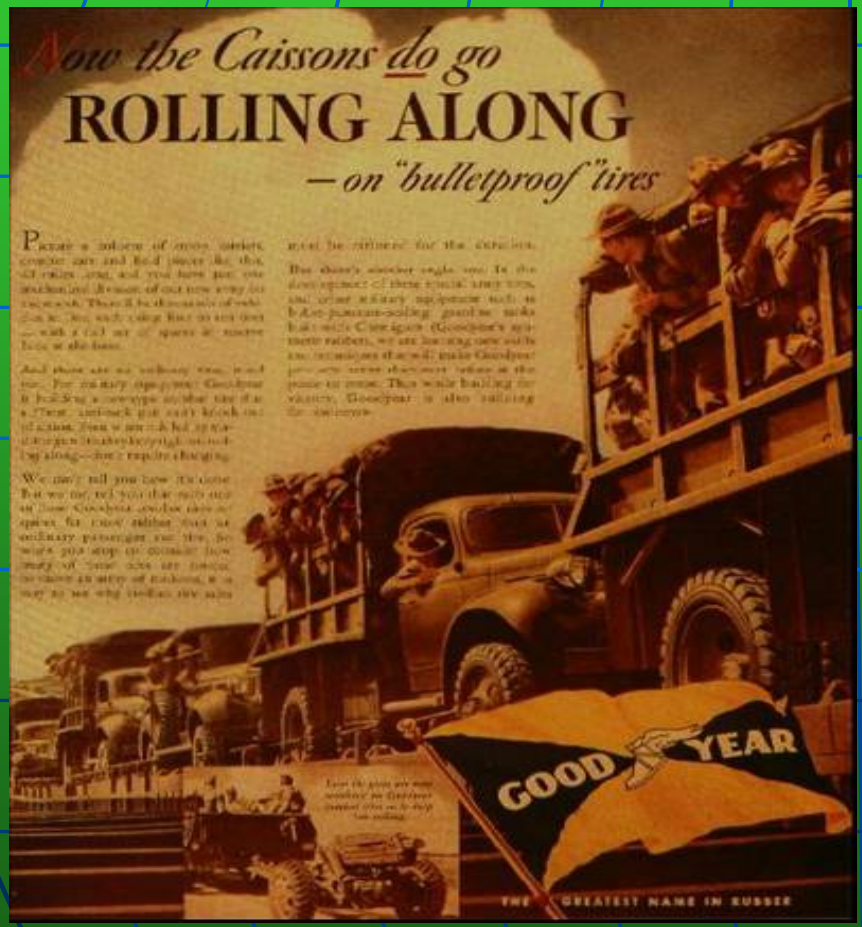
"I believe that industry and agriculture are natural partners" Henry Ford (1863-1947)

Robert Boyer and Henry Ford with the Soybean Car.



- Ford introduced an all-plastic motor car body in 1941
- The plastic body panels were made of 70% cellulose fiber and 30% phenolic resin extended with soybean meal, a by-product of the soybean oil extraction process

WW II Changed the Focus



- Synthetic rubber to replace natural rubber threatened by unstable supply
- Government subsidized large styrene plants for Styrene Butadiene Rubber
- Introduction of composites for radar domes and protection for aircraft fuel tanks

Along Comes a Customer with a Need for a Biobased Unsaturated Polyester Resin!

Why?

JOHN DEERE

John Deere Focus

- support the farmer customer
- provide supply chain "pull" to initiate commercialization
- internal use based on cost parity
- offer John Deere brand name for marketing
- demonstrate green policy
  "Use recycled or renewable wherever feasible"
- "right" thing to do

From Corn & Beans to Machines

FARMER
Customers

refined soybean oil
ethanol

JOHN DEERE

ASHLAND

molded panels

HarvestForm
soybean- and corn-based composite material

ENVIREZ®

liquid resin

MOLDER

COMPOUNDER

ENVIREZ™ -based
SMC raw material

Different Hoods For Deere Tractors

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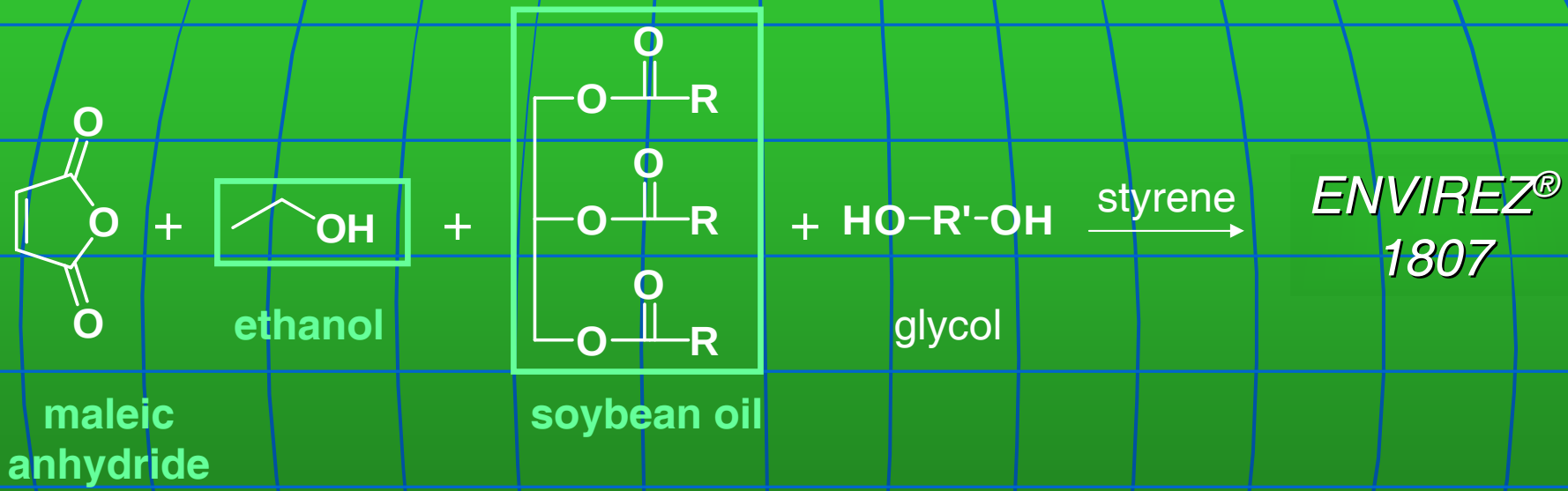
Development of ENVIREZ™ 1807 Resin

Ashland's first renewable resource-based UPR



R =

Oleic acid -- 29%

Palmitic acid -- 10%

Linoleic acid -- 51%

Stearic acid -- 2%

Linolenic acid -- 7%

Ashland U.S. Patent 6,222,005

Liquid Resin Properties

Property	Bio-based Resin ENVIREZ™ 1807	Standard Petrochemical Resin (control)
Viscosity (77 °F, cps)	850 – 1050	800 – 1000
Non-volatiles (%)	69.0 – 72.0	64.0 – 66.0
SPI Gel Test (180 °F, 1% BPO)		
Gel Time (min)	5.5 – 8.0	8.0 – 12.0
Peak Exotherm Time (min)	7.0 – 11.0	10.0 – 13.0
Peak Exotherm Temp. (°F)	385 – 415	420 – 460

Renewable resource-based resins are compatible with existing processes and equipment

Physical Properties (SMC panels)

Property	Bio-based SMC ENVIREZ™ 1807 Resin	Standard SMC (Control) Petrochemical Resin
Tensile Strength (MPa)	102	81
Tensile Modulus (GPa)	10.8	13.0
Flexural Strength (MPa)	194	208
Flexural Modulus (GPa)	9.8	11.1
Impact, Notched (J/m)	940	1,070
Impact, Unnotched (J/m)	1,260	1,270
Glass content (%)	29	29
Shrinkage (in/in) *Cold -part to cold-mold*	-0.0005	-0.0006
Water Absorption (%)	0.480	0.490

Formulations using bio-based resins have comparable physical properties to their petroleum-based counterparts

Paint Testing (SMC Panels)

Paint Testing Bio-based SMC	Requirements	Results	Pass / Fail
Adhesion	A	A	Pass
Initial Gloss JDM F9A – 20° Meter	≥ 80	83	Pass
Hardness	H	2H	Pass
Humidity	A	A	Pass
Chip – 1 Pint (–30 °C)	5A	9A	Pass
Chip – 3 Pint (–30 °C)	---	8A	Pass
Chemical Resistance – Cure (MEK)	No Removal	No Change	Pass
Chemical Resistance – Water Immersion	A	---	Pass
Environmental Cycling	---	---	Pass

SMC utilizing bio-based resins can meet current paint requirements

New ENVIREZ™ Products for SMC

- **ENVIREZ™ 10418**
  - Developed for Structural SMC Applications
  - 20% Bio Content
- **ENVIREZ™ 10465**
  - Developed for Class A SMC Applications
  - 10% Bio Content

New ENVIREZ™ Technology - Summary

Structural

- SMC based on ENVIREZ™ 10418 shows mechanical properties similar to ENVIREZ™ 1807 based SMC.
- SMC based on ENVIREZ™ 10418 shows surface smoothness significantly improved over ENVIREZ™ 1807 based SMC.

Class A

- SMC based on ENVIREZ™ 10465 shows mechanical properties similar to HMR with significantly improved surface smoothness.

New ENVIREZ™ Products: SMC – Structural

Property	Structural SMC ENVIREZ™ 10418	Structural SMC ENVIREZ™ 1807 (Control)
Glass Content, %	30	32
Tensile Strength, MPa	103	100
Tensile Modulus, MPa	12	12.2
Flexural Strength, MPa	250	235
Flexural modulus, MPa	12.3	13
Base Resin HDT, °C	175	134
Orange Peel, >7	8.2	7.7
ALSA Index, <80	55 - 65	65 - 75
DOI, >80	90	70
Bio-Content, %	20	18

New ENVIREZ™ Products: SMC – Premium Class A

Property	Class A SMC ENVIREZ™ 10465	AROTRAN™ HMR Class A Control
Glass Content, %	29	30
Tensile Strength, MPa	80	81
Tensile Modulus, MPa	10.6	11.1
Flexural Strength, MPa	170	206
Flexural modulus, MPa	11.2	9.5
Base Resin HDT, °C	192	178
Orange Peel, >8	9	8.6
ALSA Index, <60	40 - 55	50 - 65
DOI, >85	98	95
Mold Shrinkage*, %	-0.08	-0.08
Bio-Content, %	10	0

* - negative shrinkage indicates expansion

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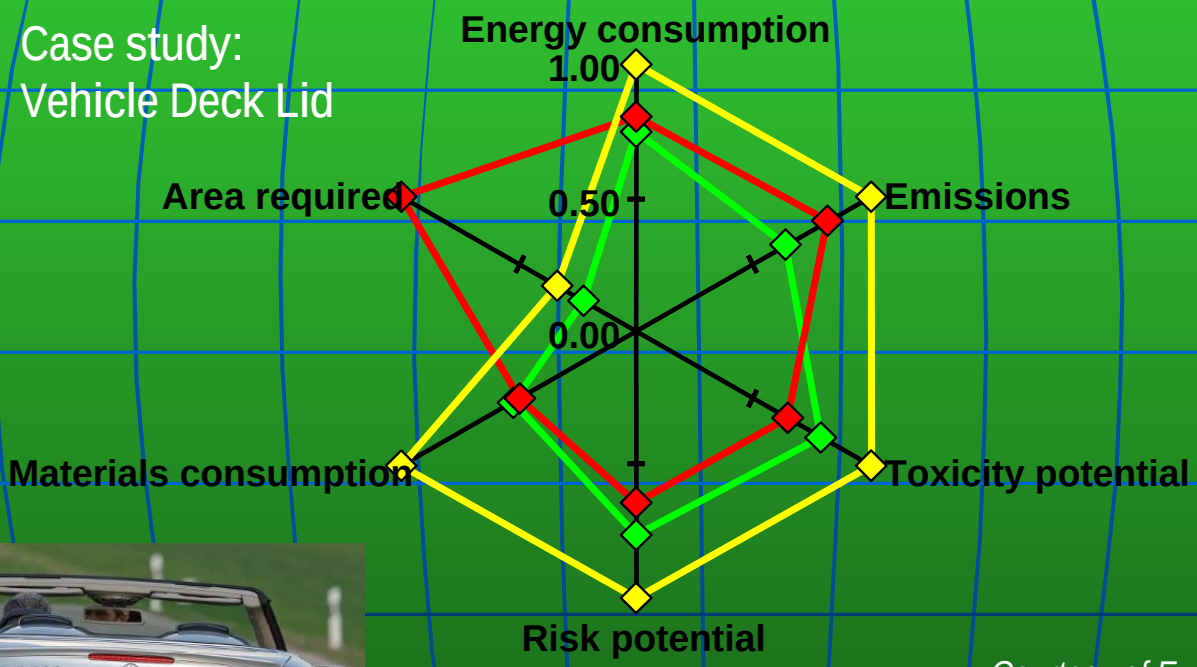
Reduced Environmental Impact

- Composites: lower environmental impact solution vs. other types of materials

Case study:
Vehicle Deck Lid



Courtesy of European Alliance for SMC/BMC

- How can we improve further?

→ ***Renewable Resource-based UPRs***

Environmental Benefits

Example:
One Batch (38,000 lb.) of ENVIREZ™ 1807 Resin

- Saves 10 Barrels of Crude Petroleum*
- Removes an Estimated 34,000 lbs of CO_2**

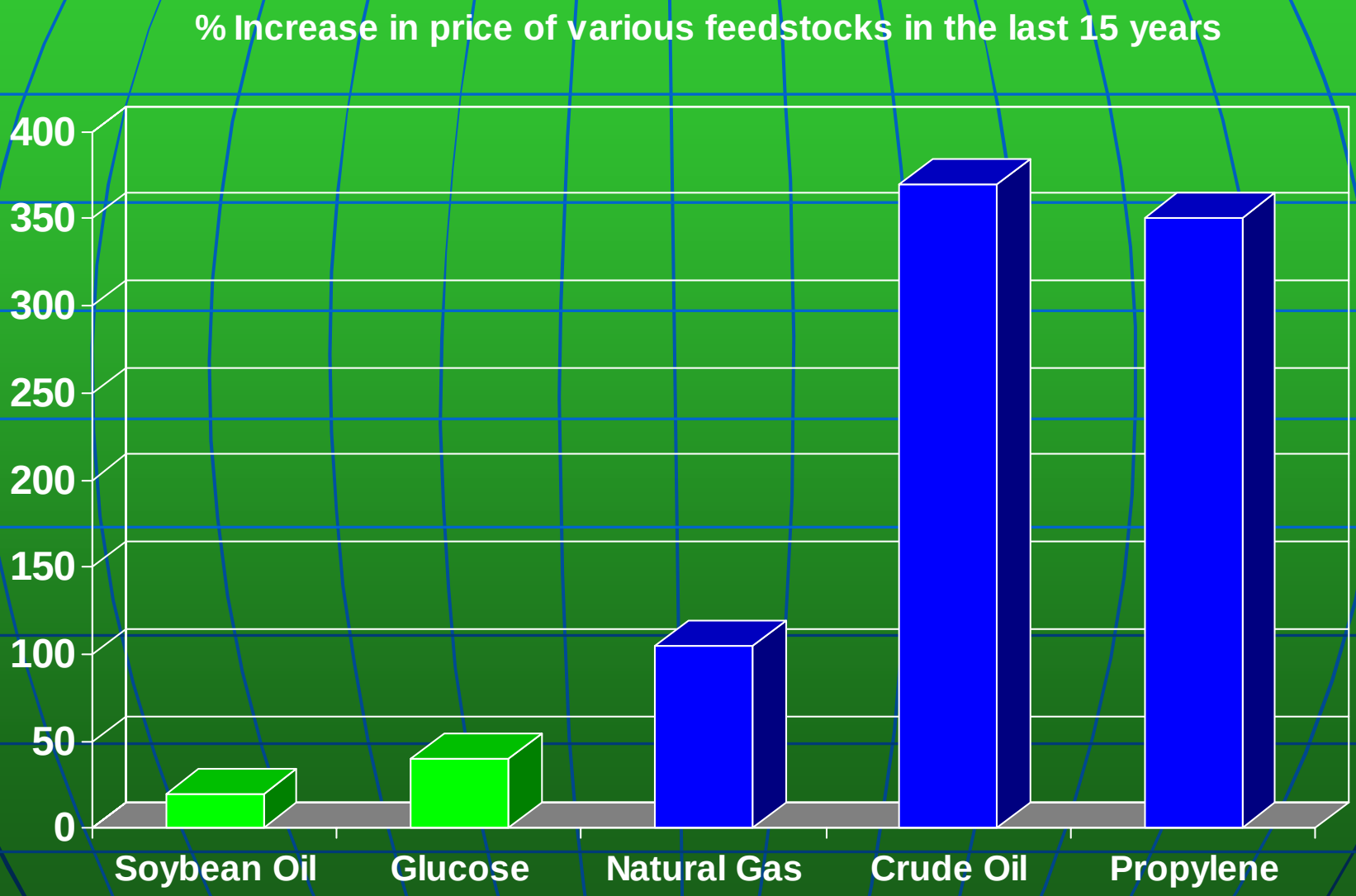
Compared to Similar Petroleum-based Resins

**This calculation is the net of the energy consumed in manufacturing as well as by farming and processing soy and corn into oil and ethanol, respectively.*

***For each pound of soy oil produced, 2.67 pounds of CO_2 are removed from the air.For each pound of ethanol produced, 1.5 – 2.0 pounds of CO_2 are removed from the air.*

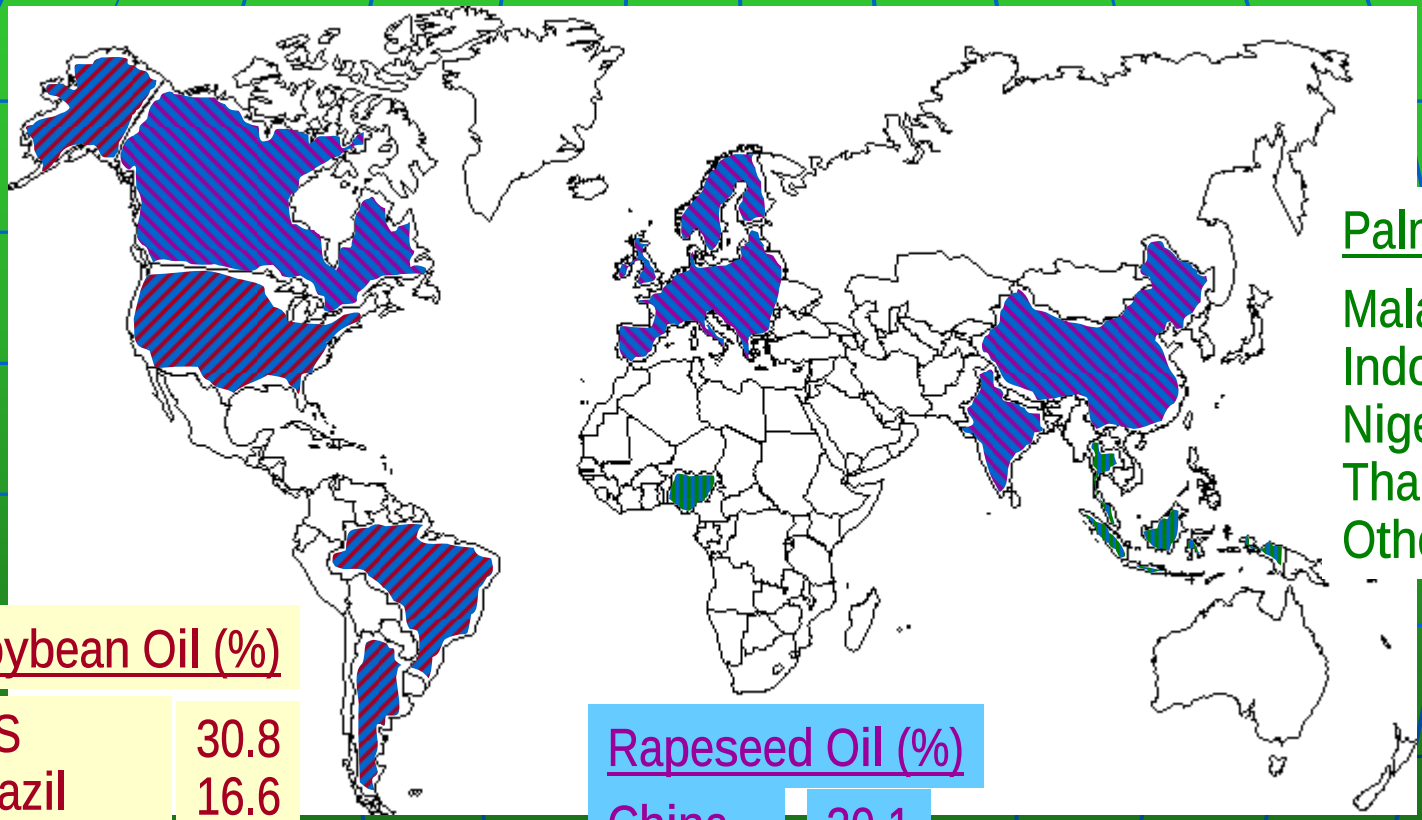
Calculations by Omni Tech International, Ltd.

Reduced Reliance on Petroleum



Local Sources for Renewable Materials

World Oil Crops Production by Country (1998 – 2003)



Palm Oil (%)

Malaysia	48.0
Indonesia	34.3
Nigeria	3.2
Thailand	2.7
Other	11.8

Soybean Oil (%)

U S	30.8
Brazil	16.6
Argentina	13.2
China	11.3
Other	28.1

Rapeseed Oil (%)

China	30.1
Europe	29.0
India	10.1
Canada	9.0
Other	21.8

Data from "Analysis of the World Oil Crops Market" 2004 by J. Mattson, C. Sun, W. Koo

Availability of New Renewable Raw Materials

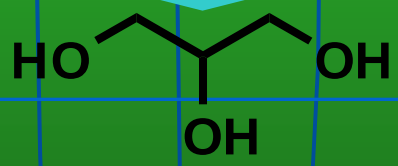
Opportunities from growth in bio-based fuels

Biomass

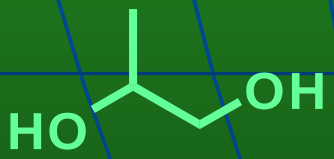
Biodiesel Production

Biodiesel

10% Biodiesel by-product



crude glycerol



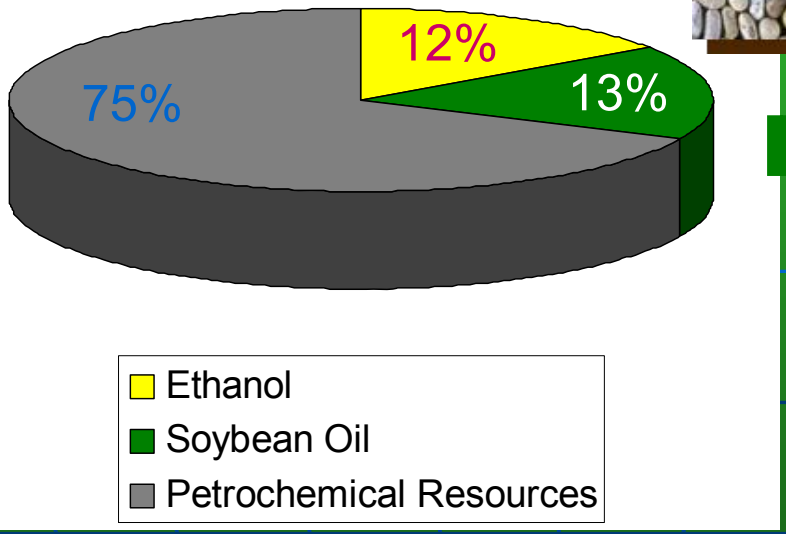
propylene glycol

ethanol

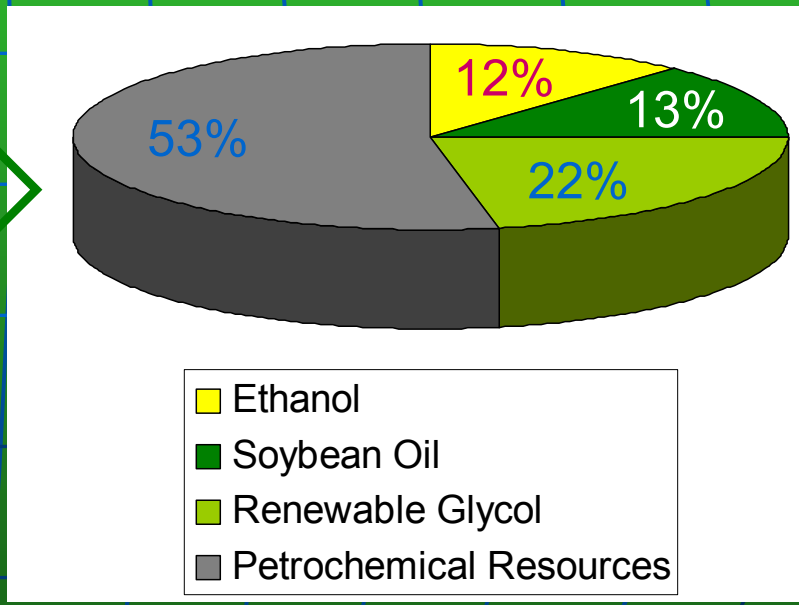
epichlorohydrin

Availability of New Renewable Raw Materials

Current Bio-based Resin
Input Raw Materials



Bio-based Resin
Input Raw Materials
with Renewable Glycol



Summary

- Unsaturated polyester resins can be based on renewable resources materials
- Bio-based unsaturated polyester resins have been used commercially for many years
- New developments have generated products with increased bio content that show improvements in mechanical properties and produce a Class A SMC
- The use of renewable resource based resins can reduce environmental impact and reliance on petroleum products.
- Increased activity in renewable resource products will allow even more bio content to be incorporated in SMC resins


Thank you for your attention!

With good chemistry great things happen.™