



## SUSTAINABLE LIGNIN POLYOLS

Performance-driven green chemistry.™

# Resinate Materials Group®

Performance. Value. Sustainability.

## Quick Facts

### Headquarters:

Plymouth, Michigan

### Active Patents:

31

### Executive

### Industry Exp:

180+ years

### Facility Sq. Ft:

8,200

### Awards:

ASC Innovation  
Award 2017

## Description

- Incorporated in 2011 by a group of investors with a vision to manufacture polyester polyols from recycled PET and further develop them into polyurethane dispersions (“PUD”) for coatings and adhesives.
- In 2014, Resinate shifted its focus from PUDs to polyols in order to expedite its path to revenue and reach a larger market. Routes to revenue;
  - Sale of Resinate Brand polyols
  - Licensing Agreements
  - Contract Research
- Resinate’s core technology is now focused on specialty polyester polyols. Resinate formulates with recycled content whenever possible, supplemented by renewable materials for up to 100% green content.
- Resinate’s technology focus includes not only specialty polyols for Coatings and Adhesives, but also for applications such as; (i) plasticizers, (ii) rigid and flexible foams, (iii) lubricants, and (iv) drilling fluids
- Resinate is able to differentiate itself not only through their extensive portfolio of active patents, but also through their lean organization and customer responsiveness. Expert and experienced resources are focused on developing innovative technology and responding to customer needs within days
- Driven by Resinate’s desire to avoid debt, all manufacturing is currently through tolling partners. This allows Resinate to; (i) utilize the expertise of these partners, (ii) reduce time to scale up, (iii) de-risk the supply chain, and (iv) reduce capital expenditures



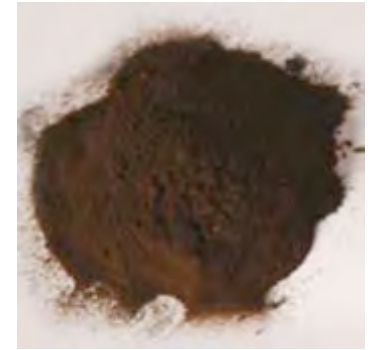
Recycled PET and Polycarbonate



Recycled Glycols



Biorenewable Ingredients . . .

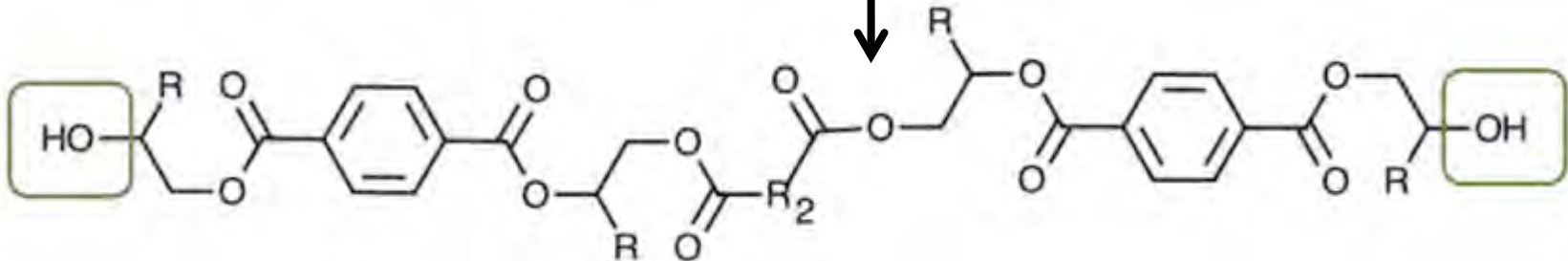


. . . including Lignin



Glycolysis Process

Resinate High Performance Polyols for Specialty Applications

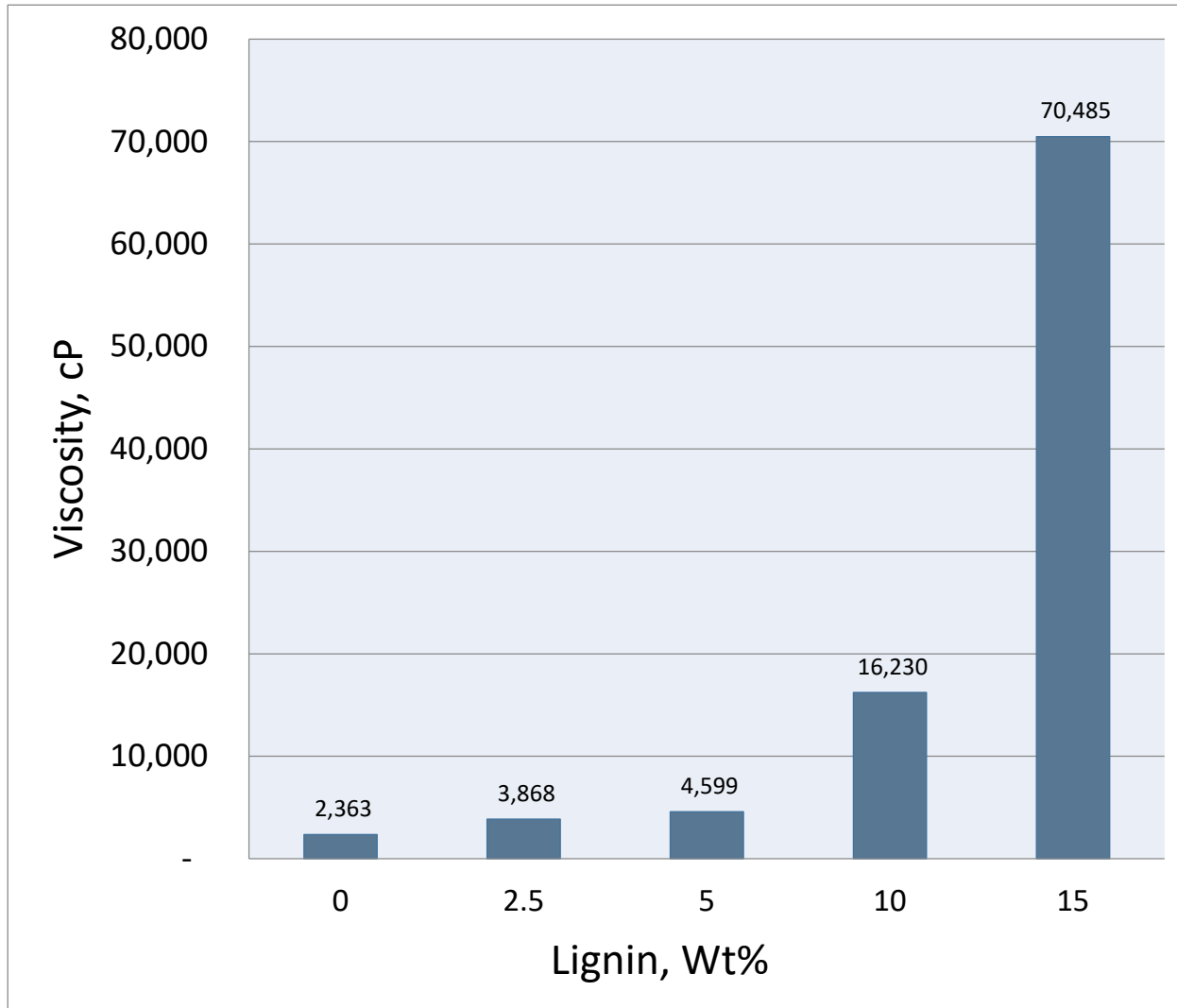


# Lignin Polyol Market Drivers and Resinate

- Polyols containing lignin and other biorenewable content are eligible for USDA Biopreferred® Certification – making the US govt. an instant customer.
- The rigid foam polyol global market for 2016 was 4 billion pounds.
- Halogenated FR agents are being eliminated due to concerns related to:
  - Bioaccumulation in people;
  - Toxicity;
  - Carcinogenicity;
  - Environmental toxicity.
- Resinate has developed products and IP covering lignin polyols (US 9,481,760; US 9,751,978; and a 3rd patent pending) with improved FR performance and biorenewable content.
- Presented at the Polyurethanes Tech. Conference, in New Orleans, Oct. 2017
- “Aromatic Polyester Polyols Containing Lignin for Polyurethane Applications”, IP.com Number: IPCOM000246787D, IP.com Publication Date: June 30, 2016.



# Effect of Lignin Content on Viscosity



# Current Lignin Polyol Development Focus

- Our customers are asking for high lignin content polyols in order to achieve Biopreferred certification and FR performance.
- Resinate has prepared 50% lignin content polyol prototypes for sampling.
- Resinate is developing a 35% Lignin polyol product with FR, foam and foam processing performance.



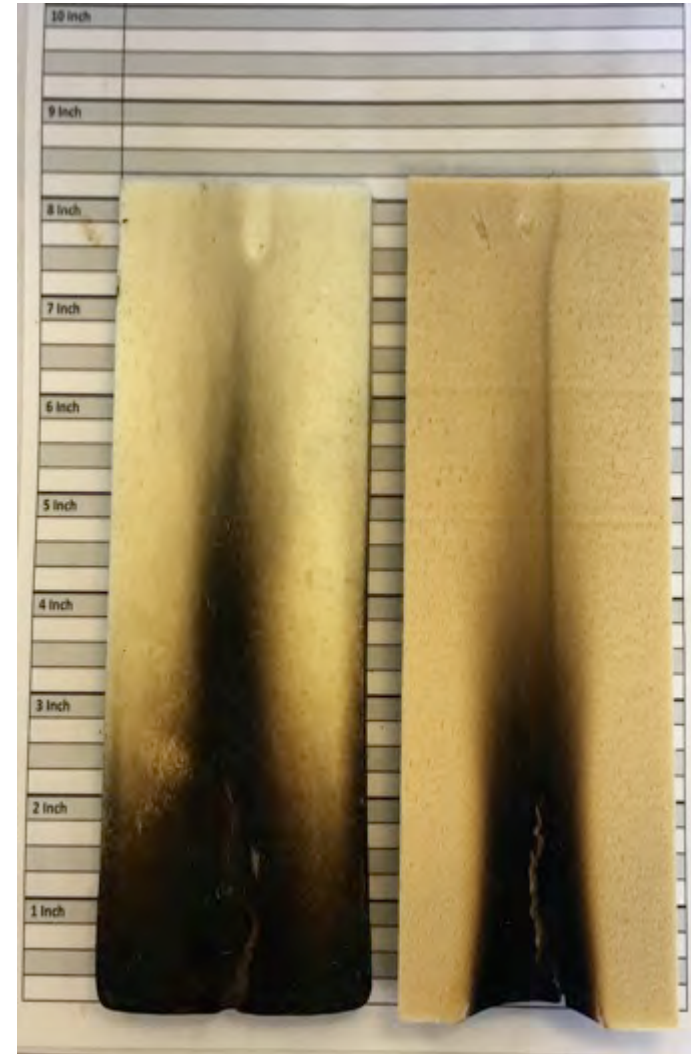
50% Lignin Content  
Prototype



rPET-Lignin Foam Cuts

# Conclusions

- Addition of lignin will increase compressive strength of foam, potentially permitting a reduction in foam density (and cost?).
- Lignin addition does not affect the thermal conductivity significantly.
- Rigid foam formulations may require adjustments depending on lignin content.
- <https://www.youtube.com/playlist?list=PL6Drd2WsslD7SAQ8655dkg7w2ZwEgAC4>



PA Polyol

rPET-Lignin Polyol



# Conclusions (continued)

- Low lignin content (<5 wt.%) in cone calorimeter testing provides reduction in:
  - heat release rate
  - heat of combustion
  - smoke release
- . . . And yields reduced mass loss at high temperature
- Increasing lignin content provides an increase in high temperature char formation
- Lignin content in coatings can provide improved coating performance.



PA Polyol



rPET-Lignin Polyol



# Lignin Polyols for 2K Coating Applications

Lignin (Wt%)	OHV (mgKOH/g)	Konig Hardness (sec)	Pencil Hardness	Mandrel Bend	MEK Double Rubs
0	358	164	H	Fail	48
0.5	335	127	HB	1/8"	50
2	321	124	3H	1/8"	80
5	315	180	2H	1/8"	105
10	300	187	H	1/4"	113

- Lignin polyols in coatings provide improved hardness, chemical resistance, and flexibility.