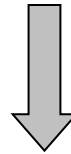


A NEW Global Leader In Specialty Chemicals & Materials

The New Momentive –Transformational Merger Forges An Industry Leader



+



Pro forma Revenue \$7.5 Billion

Global Leadership Across Technologies & Markets



Quartz



Epoxy Base Resins



Silicones



Phenolic Specialty Resins



Specialty Epoxy Resins



Versatic™ Acids & Derivatives



Oilfield Proppant Resins



Forest Product Resins

Leading market positions in more than 80% of its revenue base

A No Added Formaldehyde (NAF) resin for Decorative Plywood

Todd R. Miller
EWPA Conference

Why a “No Added Formaldehyde” (NAF) Resin?

- Use the term “No Added Formaldehyde” as opposed to “formaldehyde free” to underscore the fact that all wood composites emit formaldehyde regardless of the adhesive type.
 - “Why use a NAF system when very low fuming levels are achievable with current technology?”
 - “Do people want a No Added Formaldehyde product or simply low emissions?”
-

No Added Formaldehyde: What are the drivers?

- California Air Resources Board (CARB) Legislation from State of California.
 - Places limits on emissions from hardwood plywood, MDF and particleboard.
 - Increased regulation on formaldehyde emissions since 2009.
 - There are advantages (reduced testing) associated with using some adhesives.
 - NAF: No Added Formaldehyde.
 - ULEF: Ultra Low Emitting Formaldehyde
 - Market pull from end users as the general public becomes more conscious of “green” products.
 - Consumers becoming increasingly aware of sustainability.
 - All the above regulation is focused on interior use. How to develop a new resin?
-

Timetable for CARB Regulations

Table 1

Phase 1 and 2 Emission Standards for Hardwood Plywood (HWPW), Particleboard (PB), and Medium Density Fiberboard (MDF)¹

| Effective Date | ---- Phase 1 (P1) and 2 (P2) Emission Standards (ppm) ---- | | | | |
|----------------|--|----------|----------|----------|----------|
| | HWPW-VC | HWPW-CC | PB | MDF | Thin MDF |
| 1-1-2009 | P1: 0.08 | ----- | P1: 0.18 | P1: 0.21 | P1: 0.21 |
| 7-1-2009 | ----- | P1: 0.08 | ----- | ----- | ----- |
| 1-1-2010 | P2: 0.05 | | | | |
| 1-1-2011 | ----- | ----- | P2: 0.09 | P2: 0.11 | ----- |
| 1-1-2012 | ----- | ----- | ----- | ----- | P2: 0.13 |
| 7-1-2012 | ----- | P2: 0.05 | ----- | ----- | ----- |

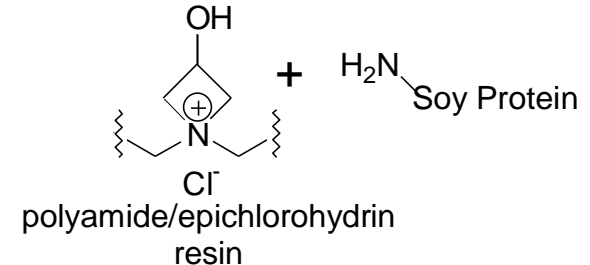
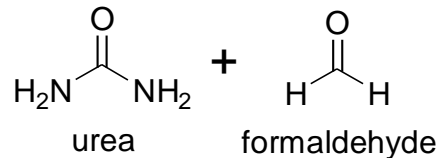
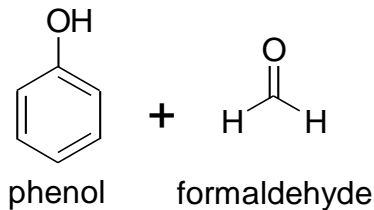
⁽¹⁾ Based on the large chamber test Method (ASTM E1333-96) in parts per million (ppm). HWPW-VC = veneer core; HWPW-CC = composite core, where the core material is PB or MDF.

NAF Resin Design

- The market will find the most economical system that satisfies all performance and regulatory requirements.
 - Momentive also seeks to provide the market a wise choice environmentally with low toxicity and produced from renewable or sustainable materials whenever possible.
 - Must be compatible with customer's existing equipment and processes.
 - We do not want to simply trade one concern for another.
 - Want to develop a system free of chlorinated organic compounds.
-

NAF Resin Design

- All wood products adhesives are combinations of crosslinking components.



- Fortunately Momentive has a large technology portfolio, and can draw from and a wide range of application experience.

| | |
|----------|-----------|
| Phenolic | Acrylic |
| Amino | Vinyl |
| Epoxy | Polyester |

- Several adhesive platforms were screened, and the acrylic platform looked to be the most promising.

Modification of Acrylic Polymer for Forest Products

- The polymer that showed early promise is produced as a base formulation for paint. It had many components that were not necessary in a wood adhesive.

- Leveling agents
 - Anti yellowing compounds
 - Special amino crosslinker
- } add cost but no value in wood

- Other adaptations were needed

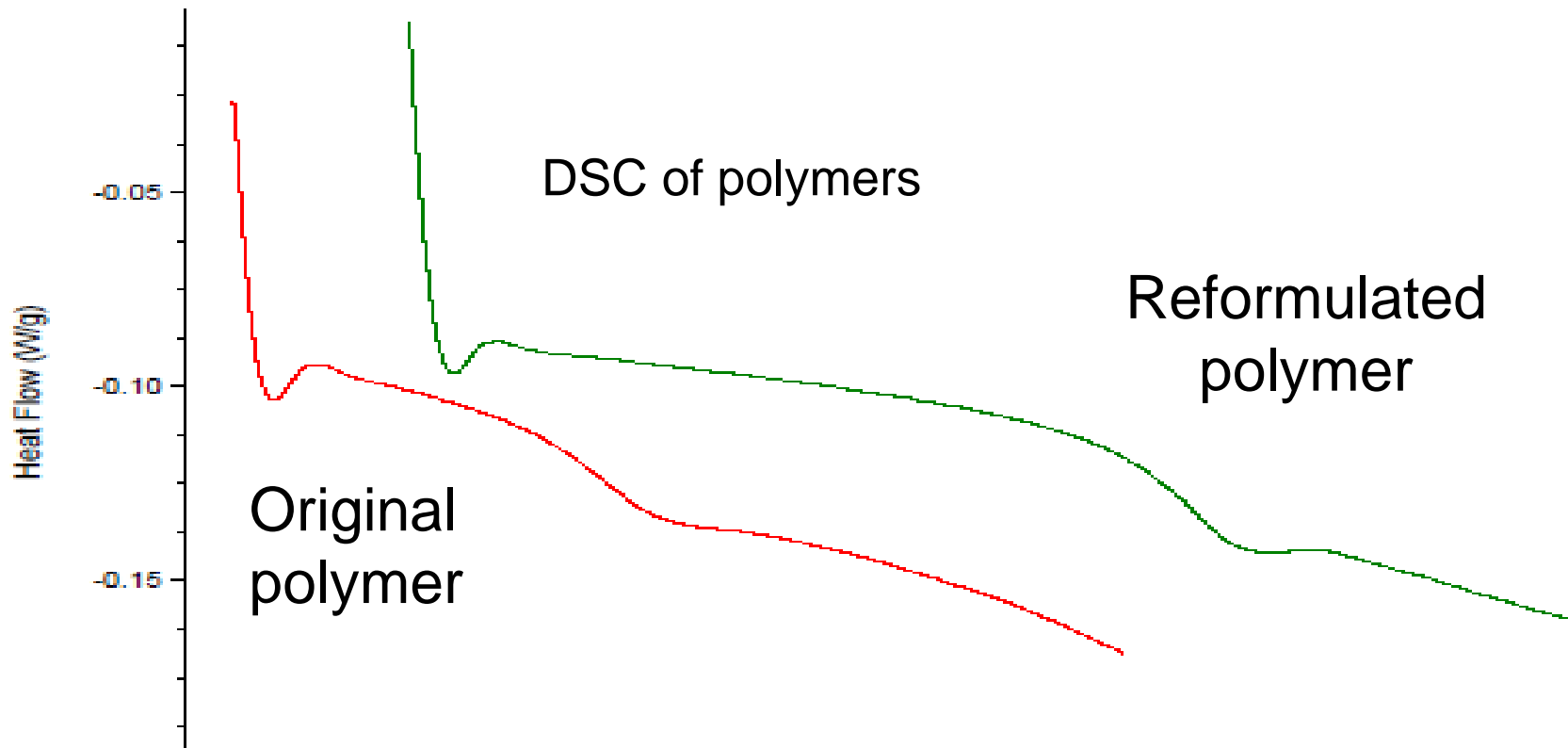
Flexible polymer → Rigid polymer

Amino crosslinker → Soy protein

- This is an alternative chemistry to formaldehyde based polymers
-

Modification of Acrylic Polymer for Forest Products

- The new adhesive uses the same crosslinking chemistry but we altered the polymer backbone to make it more hydrophobic and more rigid to perform better in water soak tests.



Adhesive Characteristics

Adhesive Mix

- Water
- Acrylic Latex emulsion
- Soy component (flour)
- Base (pH modifier)
- Flow modifiers



Mix Characteristics

40-42% non volatile content

Viscosity 20,000- 40,000 cps very shear thinning

1.05- 1.10 g/mL

Panel construction and pressing parameters

- 7 ply (5 ply Doug fir and White fir and 2 hardwood veneer such as oak cherry birch or maple)
 - 345- 390 g/m² (DGL) adhesive application
 - 5-20 minute open assembly time and 5 minute cold prepress.
 - Hot press at 121 °C platen temperature to an inner glue line temperature of 99 °C
-

Bond Performance

- Adequate performance in 3 cycle soak test with open assembly times of up to 20 minutes.
 - 390 g/m² spread, 5' open assembly = **100% / 100%**
 - 390 g/m² spread, 20' open assembly = **100% / 100%**
 - 345 g/m² spread, 5' open assembly = **100% / 100%**
 - 345 g/m² spread, 20' open assembly = **100% / 90%**



Chisel Results

Emission Characteristics

- The polymer itself can react with formaldehyde to give very low Small Chamber emissions.
 - Typical small chamber values are from below 0.002 (limit of quantification) to 0.03 ppm which is at or below the range of natural wood. F**** or below
-

Path Forward

- The adhesive system needs still more open assembly time. It is good at 20 minutes but ideally should have at least 30 minutes.
 - There are a few strategies we can use to get the desired characteristics.
 - Polymer composition to get the right flexibility
 - Film forming agents
 - Coalescing agents
-

Conclusions

- *The market will find the most economical solution that satisfies all performance and regulatory requirements.*
 - Momentive has technical and production capabilities over a broad portfolio of technologies which gives us the ability to pursue many different NAF options.
 - An acrylic latex has been developed with thermal and hydrophobic properties sufficient to pass water durability requirements with formaldehyde emission levels at or below that of wood itself.
 - The system is currently undergoing commercial trials, and is one more alternative to existing adhesive systems.
 - Improvements are ongoing to develop more open assembly time
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Acknowledgements

- Springfield Oregon Laboratory Staff
 - Kevin Wiese
 - Lee Johnson
 - Mark Clark
 - Larry Anderson
 - Roebuck, South Carolina Production Staff
 - Rick Pitts
 - Dave Boyle
 - Joey Miller
 - **Thank you for your attention!**
-

Questions???



Todd Miller Introduction

- Todd R. Miller Ph. D. is manager of the Momentives Phenol-Formaldehyde resins development group in Springfield, Oregon. Todd began working with Momentive in 1996, as a Technical Specialist in resin development and commercialization.
 - Todd leads the product development and commercialization efforts of resins for plywood, LVL, OSB, and hardwood plywood. Focus areas of Todd's group include Ultra Low Emitting Formaldehyde (ULEF) and No Added Formaldehyde (NAF) adhesives for hardwood plywood.
 - In addition Todd's group is active in applying Momentives broad technology portfolio to the development of resin systems derived from more sustainable materials, and NAF resin systems.
 - Todd received his B.S. in chemistry from the University of Oregon in 1990, and Ph. D. in Organic Chemistry from the University of Washington in 1995.
 - Today Todd will be talking about Momentives developments in no added formaldehyde resin technology and in particular our progress on a new adhesive system for hardwood plywood.
 - So please provide a warm welcome to Todd Miller
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