Just the two of us –
new hybrid binder for
wood-based panels

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11th European Wood-based Panel Symposium
11 October 2018
At a first glance, UF and pMDI are not really ideal components to combine

<table>
<thead>
<tr>
<th>Urea formaldehyde resin (UF)</th>
<th>Isocyanate (pMDI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>polar</td>
<td>polarity</td>
</tr>
<tr>
<td>good</td>
<td>miscibility with water</td>
</tr>
<tr>
<td>polycondensation (elimination of water)</td>
<td>reaction mode</td>
</tr>
</tbody>
</table>
At a first glance, UF and pMDI are not really ideal components to combine

Nevertheless, they can act synergistically!
Polyurea network contributes to final board properties

Curing of pMDI $\rightarrow$ polyurea network

Microscopy of a particle board
$\Rightarrow$ (partially) separate curing of UF and pMDI

pMDI: red fluorescent
UF: blue fluorescent

Source: Brodel, Zillessen, Marutzky, unpublished results
Synergistic effect: reactivity increase

Curing onset is shifted to lower temperature

Potential explanation:
UF methylol groups react with isocyanate

Simon, et al., Holzforschung, 2002, 56, 327-334
and
These known UF/pMDI synergies are already used by particle board producers to increase productivity.

\[ x\% = \text{relative maximum process speed}^* \]

Can we enhance this effect?

Is it possible to increase speed by more than 10%?

* BASF internal data, estimated for particle board production
The purpose of our R&D project

deepen the understanding of the UF/pMDI synergies

develop a new isocyanate component to enhance synergies

reduce cost in particle board production
Unique conditions
Two binder types – one company

- **Production**
  several facilities for amino resins and isocyanates

- **Application**
  long term experience with both wood-binder technologies

- **Research**
  strong expertise for condensation resins and polyurethanes
The technological concept: additional activation of the UF by an improved isocyanate component
known effect of previous hybrid systems
(standard UF + standard pMDI)

Proof of concept by DSC measurements

![DSC Measurement Graph]

- Heat flow [W/g]
- Temperature [°C]

Legend:
- UF + hardener
- UF + hardener + pMDI
Proof of concept by DSC measurements

known effect of previous hybrid systems
(standard UF + standard pMDI)

enhanced effect of test system
(standard UF + improved isocyanate)
From the test system to the final formulation

<table>
<thead>
<tr>
<th>Optimization of reactivity</th>
<th>Final formulation</th>
<th>Standard pMDI (for comparison)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCO number(^1) ca. 32% + additional adjustments</td>
<td>NCO number(^1) ca. 32%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Adjustment of viscosity</th>
<th>Final formulation</th>
<th>Standard pMDI (for comparison)</th>
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<tbody>
<tr>
<td>100 mPas(^2)</td>
<td>ca. 250 mPas(^2)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension of storage stability</th>
<th>Final formulation</th>
<th>Standard pMDI (for comparison)</th>
</tr>
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<tr>
<td>&gt; 6 months</td>
<td>&gt; 6 months</td>
<td></td>
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<table>
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<th>Lab board trials</th>
<th>Final formulation</th>
<th>Standard pMDI (for comparison)</th>
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<tbody>
<tr>
<td>Significant reduction of presstime</td>
<td></td>
<td></td>
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<tr>
<td>Suitable board properties</td>
<td></td>
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</tr>
</tbody>
</table>

\(^1\) ASTM D 5155
\(^2\) at 25 °C, DIN 53018
Final check by pilot customer trials

- 18 mm particle boards on a continuous line (without pre-heating)

**Typical recipe (E1)**

- **Surface**: 10% Kaurit glue 347 S + hardener
- **Core**: 7% Kaurit glue 347 S + hardener + 0.4% new pMDI
- **Surface**: 10% Kaurit glue 347 S + hardener

**Large scale trials (> 20 tons new pMDI): Reliable speed increase by > 20%**

Confirmed by a trial with a second pilot customer

**First customer trials: speed increase > 15%**
Product Launch in September 2018

Kauranat MS 1001: special pMDI grade for UF/pMDI hybrid binders

- can be used like standard pMDI (storage, safety, application, etc.)

- enables higher productivity at same emission level
- enables lower FA emission at same production speed

New product  
Drop-in solution  
Benefits
Important to know

- Mixed immediately before application (preferred) or separate application
- FA emission is mainly determined by the UF component

New hybrid binder
UF + Kauranat MS 1001

Binder system for the core layer (not recommended for surface layers)

- Contribution of Kauranat to board properties (IB and swelling) analogous to standard pMDI

Recommended ratio
UF (solids) : Kauranat = 100 : 3 to 100 : 10
Just the two from us

Kaurit glue + Kauranat MS 1001

New hybrid binder for the core layer of particle boards

Benefit

Increased productivity by > 20 %