Recent Trends & Industry Challenges in Coated Paper & Board market

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Polymer Dispersions Paper Coatings
Asia Pacific
Market Requirements and trends in Coated Paper Industry

BASF Innovation strategy activities

Innovation solutions to address market needs:

✓ High Solids Coating Technology
✓ New Range of Binders of low VOC and GB 9685 compliance – food contact grades
  ❑ Styronal ® ES grades
  ❑ Basonal ® FCB grades

Future path and recommendation
BASF innovation activities address trends, market drivers & Industry Challenges

Industry Challenges

1) Printability
2) Convertibility
3) Sustainability
4) Runnability
5) Cost In Use

1) Sustainability
2) Cost Reduction
3) Properties
4) Consistency

BASF Solutions

Continuous stream of Innovation
R&D Focus towards the key Industry Challenges

Binders with Sustainability & Compliance
New Range of Low VOC & Odor Binders
Food Contact & Liquid Packaging Board
High Performance Rheology Modifiers
High Performance Binders technology
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- High Solids Coating Technology
- New Range of Binders of low VOC and GB 9685 compliance – food contact grades
  - Styronal® ES grades
  - Basonal® FCB grades

Future path and recommendation
Value Proposition – Performance Benefits

- Faster Coating Immobilization
- Higher Water Retention
- Potential Binder Reduction
- Faster Coating
- Less Drying
- Energy Consumption
- Faster Coating Immobilization
- Homogenous coating Structure
- Better Smoothness
- Higher Sheet Gloss Potential
- Improved Printability
- Coating Color
- Base Board
- Coated Board
Value Proposition – Performance Benefits

**Coater Runnability**

- Ability to run high coating solids
- Faster Coating Immobilization
- Potential reduction in Binder Usage
Value Proposition – Performance Benefits

**Improved Drying Efficiency – post coating**

- Higher Coating Solids Formulation
- Reduced water in coated Paper
- Better Post Coating Drying Efficiency
- Increase in Coating Make Down Solids from 64% to 70% reduces energy cost by 25%
Value Proposition - Performance Benefits

*Improved Coated Board properties*

- Improved Coverage
- Better Smoothness
- Better Sheet Gloss
- Excellent Offset & Gravure Printability
Challenges in Attaining High Coating Color Solids

- Optimized recipe needed to have smooth coater runability
  - Coating Rheology

- Coating Ingredients solids
  - Carbonate at maximum 75% solids
  - Clay dispersed at maximum 70%
  - Other additives approx. 20% solids
  - Suitable Coating Rheology modifiers are required
  - Regular Latex at 50% solids
Challenges - High Solids Latex

**Emulsion Polymerization STD Latex**

1) Initially Polymerization at 53%
2) Chemical & Physical Deodorization
3) Condition ➔ ~ 50% Solids and Inherent Viscosity Range 100-800 cps

**Challenges in Polymerization Of High Solids Latex**

1) **High Inherent Viscosity build-up**
2) **Poor Latex Stability**

RISK of Reduction of Water
Challenges - High Solids Latex

High Inherent Viscosity Build-up

Viscosity is strongly depending on the particle size distribution.

Poor Latex Stability

- Electrostatic stabilization (DLVO-theory)
- Steric stabilization

Viscosity [mPas]

<table>
<thead>
<tr>
<th>Solids Content [%]</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>150nm</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>800nm</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>150nm/800nm (25/75)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Technical Concept – High Formulation Solids Latex

Innovative Technical Approach

1. Optimized Monomer Feeding Technology
   ➔ Balanced control of PS & PSD
   ➔ Minimize the inherent Viscosity

2. Clever choice of Non-ionic renewable resource based steric stabilization
   ➔ In-situ Polymerization onto colloidal surface
   ➔ Imparts superior latex stability
Value Proposition – Technological & Performance Benefits

Features

- Copolymer of Carboxylated Styrene-Butadiene
- Solids Content: > 55%
- Approx. Tg: 2°C
- Particle Size: Approx. 130 nm
- Lower Inherent Visc.: < 700 cps

Styronal® 7926 X

- High Solids Coating
- Excellent Coater Runnability
- Improved Drying Energy
- Excellent Coater Properties
Value Proposition – Technological & Performance Benefits

- **Technical & Commercial Advantage**
  - Improved Dynamic Water Retention
  - Improved Coverage
  - Better Smoothness & Sheet Gloss
  - Excellent Offset & Gravure Printability
  - Lower Dying energy Consumption
  - Logistic advantage

Data Comparison:
- **IGT Dry Pick**
- **Offset Test**
- **Printability**
- **Dynamic Water Retention**
- **Logistic Advantage**
- **Higher Solids Coating Color Formulation**
- **Lower Energy Consumption**

Formulations:
- **Standard Soft SB Latex (50% Solids)**
- **Styronal 7926 X (55% Solids)**
## Future Path Forward

### Market Drivers & Requirements

<table>
<thead>
<tr>
<th>Needs</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>High Coating Solids</td>
</tr>
<tr>
<td>N</td>
<td>Improved Coater Runnability</td>
</tr>
<tr>
<td>N</td>
<td>Energy saving</td>
</tr>
<tr>
<td>N</td>
<td>Improved Coated Board Properties</td>
</tr>
</tbody>
</table>

### BASF’s Solution

<table>
<thead>
<tr>
<th>Solution</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Styronal® 7926 X</td>
</tr>
</tbody>
</table>

Considering the market needs and requirements of the end users, it is recommended to take the advantage of the new advance products from BASF for mill trial to confirm the above.
Market Requirements and trends in Coated Paper Industry

BASF Innovation strategy activities

Innovation solutions to address market needs:

- High Solids Coating Technology

- New Range of Binders of low VOC and GB 9685 compliance – food contact grades
  - Styronal® ES grades
  - Basonal® FCB grades

Future path and recommendation
Trends

Sustainability & Food safety becoming prominent topic in P&B coating Industry

➢ Higher requirement seen in Asia – especially China

➢ Trends towards Stringent Food Compliances, Low VOC and “zero” Odor while maintaining the coated P&B quality

➢ Conventionally Food Packaging Grade
  ❑ Comply with FDA (US) and BfR (Germany)
  ❑ China – new food safety standard for Food Contact Materials (FCM)
  ❑ China’s new stringent food compliance ➔ GB 9685:2016
  ❑ Specific hygiene standard for use of additives in food container or packaging materials
  ❑ Formaldehyde free
Trends

➢ Volatile Organic Component (VOC) requirements

- (YCT/207; 21 components < 40 ppm)
- VOC concentrations can be quite accurately measured e.g. by sampling methods and GC analysis

➢ Odor / Taint

- There are almost no legislative regulations for taint and odour
- Maximum concentrations of substances, which contribute to odour are highly subjective and individual furthermore, extremely difficult to measure
- Common test method is “Round Robbin Test”
- Odor can also can be emitted during converting process
Test Method
GC- Headspace & Direct Injection

## GC - Headspace

<table>
<thead>
<tr>
<th>Headspace- paper coating</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td>DB-1</td>
</tr>
<tr>
<td>Inlet temperature</td>
<td>150 °C</td>
</tr>
<tr>
<td>Detector temperature</td>
<td>250 °C</td>
</tr>
<tr>
<td>Column temperature</td>
<td>40 °C, 2 mins</td>
</tr>
<tr>
<td></td>
<td>180 °C, 15 mins</td>
</tr>
</tbody>
</table>

➢ 21 Components
➢ YC/T207 < 40 ppm

## GC - Direct Injection

<table>
<thead>
<tr>
<th>GC direct injection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td>DB-1</td>
</tr>
<tr>
<td>Inlet temperature</td>
<td>200 °C</td>
</tr>
<tr>
<td>Detector temperature</td>
<td>280 °C</td>
</tr>
<tr>
<td>Column temperature</td>
<td>50 °C, 3 mins</td>
</tr>
<tr>
<td></td>
<td>130 °C, 5 mins</td>
</tr>
<tr>
<td></td>
<td>200 °C, 5 mins</td>
</tr>
<tr>
<td></td>
<td>220 °C, 1 mins</td>
</tr>
</tbody>
</table>

➢ 11 Components
➢ Target 6 Components
### VOC specification (YC/T 207)

**GC - Headspace**

<table>
<thead>
<tr>
<th>VOC Items</th>
<th>Specification (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Methanol</td>
<td>&lt;1</td>
</tr>
<tr>
<td>2  Ethanol</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>4  Acetone</td>
<td>&lt; 0.5</td>
</tr>
<tr>
<td>5  Methyl Acetate</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>6  n-Propyl alcohol</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>7  2-butanol</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>8  Ethyl Acetate</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>9  Benzene</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>10 Isopropyl acetate</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>11 n-Butanol</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>12 1-methoxy-2-propanol</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>13 Propyl Acetate</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>14 4-Methyl-2-pentanone</td>
<td>&lt; 1.5</td>
</tr>
<tr>
<td>15 1-Ethoxy-2-propanol</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>16 Toluene</td>
<td>&lt; 2</td>
</tr>
<tr>
<td>17 Butyl Acetate</td>
<td>&lt; 6</td>
</tr>
<tr>
<td>18 VCH</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>19 Ethylbenzene</td>
<td>&lt; 7</td>
</tr>
<tr>
<td>20 Xylene</td>
<td>&lt; 2</td>
</tr>
<tr>
<td>21 Styrene</td>
<td>&lt; 8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>&lt; 40</td>
</tr>
</tbody>
</table>

**GC – Direct Injection**

<table>
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<tr>
<th>VOC Items</th>
<th>Specification (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Acetone</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>2  Methanol</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>4  Ethanol</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>3  Styrene</td>
<td>&lt;=20</td>
</tr>
<tr>
<td>5  PCH</td>
<td>&lt;=60</td>
</tr>
<tr>
<td>6  VCH</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>7  Ethylbenzene</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>8  N-Butyl Acrylate</td>
<td>&lt;=20</td>
</tr>
<tr>
<td>9  Acrylonitrile</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>10 Toluene</td>
<td>&lt;=10</td>
</tr>
<tr>
<td>11 n-Butanol</td>
<td>&lt;=20</td>
</tr>
<tr>
<td>12 T-Butanol</td>
<td>&lt;=10</td>
</tr>
<tr>
<td><strong>Total (VOC-EU, Tb &lt; 250 C)</strong></td>
<td>&lt;=100-300</td>
</tr>
</tbody>
</table>

**Formaldehyde Free**
## Sources of VOC & Odor in P&B Coating

<table>
<thead>
<tr>
<th>Components</th>
<th>Potential Source Of VOC &amp; Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Paper &amp; Board</td>
<td>Fibres and Wet-end Chemicals</td>
</tr>
<tr>
<td>Pigment Slurry</td>
<td>Dispersant, Neutralizing agent &amp; Bacteria</td>
</tr>
<tr>
<td>Synthetic Binder</td>
<td>Neutralizing agent, by-products &amp; Raw material impurities</td>
</tr>
<tr>
<td>Strach</td>
<td>Bacteria &amp; Degraded Products</td>
</tr>
<tr>
<td>Thickners</td>
<td>Neutralizing agent &amp; Residual Monomers</td>
</tr>
<tr>
<td>Crosslinkers</td>
<td>By-products</td>
</tr>
<tr>
<td>Wet Strength Agent</td>
<td>Neutralizing agent &amp; by-products</td>
</tr>
</tbody>
</table>
Sources of VOC & Odor in Paper Coating Binder

- Neutralizing agent: ammonia
- Volatile organic components (VOC):
  - S / Butadiene: Styrene, VCH, PCH
  - VCH: vinyl cyclo hexadiene - Diels-Alder product of Bu + Bu
  - PCH: phenyl cyclo hexadiene - Diels Alder product of S + Bu
  - Formation of C-12 Olefins by CTA
BASF innovation activities to address challenges - Reduce VOC & Odor & GB 9685:2016 Compliance

Innovative Activities taken to minimize VOC & Odor

1. Optimized Production process  
   Styronal® ES

2. Flexible Production Technology  
   Basonal® FCB
Steps being taken to minimize VOC & Odor

- minimizing side components of monomers from the suppliers:
  - e.g. - Styrene (EB, Xylene, Toluene)
  - Butadiene (VCH)
- GB 9685 Compliant raw materials
Steps being taken to minimize VOC & Odour

- Raw materials
- Polymerization
- Chemical deodorization
- Physical deodorization
- Conditioning

- Optimizing process conditions (Special feeding…)
- Optimizing recipe parameters with special CTA

Optimized Production Process to Reduce VOC & Odour & GB 9685 Compliance
Optimized Production Process to Reduce VOC & Odour & GB 9685 Compliance

Steps being taken to minimize VOC & Odour

- Optimizing the Chemical Stripping conditions
- To minimize the residual monomers (Redox System)
- Use of formaldehyde free redox systems
Steps being taken to minimize VOC & Odour

- Advanced column deodorization
  (~ 20-25% steam/dispersions)
- To minimize residual organic components
Optimized Production Process to Reduce VOC & Odour & GB 9685 Compliance

Steps being taken to minimize VOC & Odour

- Use of sodium hydroxide to adjust pH
- Use of organic solvent free Biocides
- Use of FA free Biocide
Optimized Production Process to Reduce VOC & Odour ➔ Styronal® ES Grades & GB 9685 Compliance

raw materials
polymerization
chemical deodorization
physical deodorization
conditioning

Styronal® ES
Our Styronal® ES grades – Standard Products with optimized VOC and low odor & GB 9685 Compliance

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Film properties (1)</th>
<th>Odor</th>
<th>GB 9685 (2)</th>
<th>FDA reg. 21 CFR (2)</th>
<th>BfR XXXVI (2)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Styronal® ES 7900</td>
<td>soft</td>
<td>low</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes High binding power latex, esp. suitable for precoat applications</td>
</tr>
<tr>
<td>Styronal® ES 7902</td>
<td>medium</td>
<td>low</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes Standard overall performance latex, suitable for both precoat and topcoat applications</td>
</tr>
<tr>
<td>Styronal® ES 7936</td>
<td>medium-hard</td>
<td>low</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes Best suitable for topcoat applications with high requirements in terms of printability and convertibility</td>
</tr>
</tbody>
</table>

(1) Film properties: <= 0 °C: soft; 0 – 10 °C: medium; 10 - 20 °C: medium-hard; > 20 °C: hard;
(2) In any case regarding food contact status, the above does not replace the detailed information in the Food Contact Compliancy statement. For more detailed information on specific country requirements and conditions of use, please refer to the relevant Food Contact Compliancy statement. Please contact your account representative to get the full statement.
BASF’s Solution:
Binders with Minimum **Odor** and volatiles

Highly optimized flexible production technology

Key Performance

Reduced Odour levels

Basonal® FCB

Key Monomer Choices
Basonal® FCB – Tailor-Made 3-in-1 Solution for Food Contact Board

1. Low Odor & Low VOC
2. Excellent Printability
3. GB 9685 Compliant
LOW ODOR – from latex production all the way to the end consumer

**Latex**

VCH (the lower the better)

- **Basonal® FCB**: N.D. - 15
- **Styronal® ES**: <5
- **Competition**: N.D. - 1

PCH (the lower the better)

- **Basonal® FCB**: 20 - 50
- **Styronal® ES**: <20
- **Competition**: ~10

**Odor Ranking**

- **Basonal® FCB**: 1st
- **Styronal® ES**: 2nd
- **Competition**: 3rd

**BASF Advantages:**

- Lowest VCH and PCH
- Lowest odor after UV printing

1 Non-Detectible
SUPERIOR PRINTABILITY in terms of ink absorption, brightness, mottle and yellowing

2 Excellent Printability

✓ Excellent Brightness
✓ No Yellowing over time
✓ Excellent Mottle
✓ Good water/ink balance

Yellowing Index
CIE Brightness stored @ 40 °C over a period of 5 weeks

Mottle

Basonal® FCB

Competitor
Basonal® FCB complies with all common standards

- GB 9685 – for paper application
- US FDA 176.170 and 176.180
- Germany BfR XXXVI
# Our Tailor-Made Basonal® FCB Grades for high-performance Food Contact Board

<table>
<thead>
<tr>
<th>Product name</th>
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<th>BfR XXXVI (2)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basonal® FCB 7961</td>
<td>soft</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>Tailor-Made, low VOC / very low odor latex grades with outstanding printability</td>
</tr>
<tr>
<td>Basonal® FCB 7962</td>
<td>medium</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Basonal® FCB 7963</td>
<td>medium</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

(1) Film properties: \( \leq 0 \, ^\circ C \): soft; \( 0 - 10 \, ^\circ C \): medium; \( 10 - 20 \, ^\circ C \): medium-hard; \( > 20 \, ^\circ C \): hard.
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Summary

Higher requirements for VOC and Compliances becoming important in Asia

Trends towards GB 9685 compliance, low VOC and “Zero Odour” with no compromise in quality

➢ BASF has added **Styronal® ES grades** to it’s standard portfolio (Styronal® and Acronal®)

➢ In addition to that, the recently developed novel 3-in-1 Basonal® FCB grades are available to meet stringent customers demand for food contact board segment
Coated paper & board – Market needs

- Consistency of quality
- Managing deteriorating furnish
- Cost & Quality performance
- Printability
- Managing needs of exports / Compliance

Packaging

- Recycled Board Duplex
  - Consistency of quality
  - Managing deteriorating furnish
  - Cost & Quality performance
  - Printability
  - Managing needs of exports / Compliance

- FBB – Food Contact (Cig & LPB)
  - Complying to Food Contact laws
  - Smoothness and Printability
  - Convertibility
  - Odor of the board

- FBB/ SBS Non Food Contact
  - Printability
  - Convertibility – Stiffness, Bulk, Glueability
  - Cost & Quality performance

Graphical

- Wood Free Art Board
  - Printability
  - Convertibility – Crack-at-fold
  - Cost & Quality performance

- Wood Free C2S/C1S
  - Cost & Quality performance
  - Suitability for Flexible packaging
  - Printability
  - Cost & Quality performance