Reactive Diluents for Achieving High Solids Acrylic Polyurethane Coatings

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Dow’s PARALOID™ Resins can be used in a wide breadth of maintenance and protective applications, offering excellent performance properties that include:

- Weatherability
- Gloss and Color Retention
- Early Water Resistance
- Chemical Resistance
- Impact Resistance
- Dry Time

<table>
<thead>
<tr>
<th>Property</th>
<th>PARALOID™ AU-1453</th>
<th>PARALOID™ AU-830</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids (%)</td>
<td>70</td>
<td>77</td>
</tr>
<tr>
<td>Viscosity (cP)</td>
<td>4500</td>
<td>15000</td>
</tr>
<tr>
<td>Hydroxyl Equiv. Wt.</td>
<td>460</td>
<td>500</td>
</tr>
</tbody>
</table>

*Dow’s resins provide an excellent balance of properties, exceptional durability and chemical/solvent resistance*

Viscosity modifiers are commonly utilized to meet processing specifications, which may subsequently increase a formulation’s emission content.
Common Options for Decreasing Formulation Viscosity

Volatile organic compound (VOC) emissions continue to face increasing regulation

Option #1 – Solvents
- Increase VOC content
- Face tightening regulatory issues
- Hygroscopic solvents can lead to CO₂ bubble formation
- VOC-exempt solvent evaporation rates can diminish surface quality

Option #2 – Low-Viscosity, Reactive Diluents
- Non-volatile → VOC-compliant
- Covalently incorporate into the polymer network
- Maintain coating hardness
- Kinetically compatible with acrylcs
New Polyols for High Solids 2k PU Coatings

Dow has developed a New Polyol that excels as a reactive diluent for acrylic PU coatings, offering excellent mechanical performance and weatherability.

<table>
<thead>
<tr>
<th>Property</th>
<th>New Polyol</th>
<th>Polyester Polyol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>OH Number</td>
<td>350-410</td>
<td>310</td>
</tr>
<tr>
<td>Viscosity at 25 °C</td>
<td>260-400 cP</td>
<td>1190 cP</td>
</tr>
</tbody>
</table>

Lower Viscosity = Higher Solids
Clear Coat Formulations Were Used for Evaluations

Sample Coating Formulation

<table>
<thead>
<tr>
<th>Material</th>
<th>Solids Content (wt%)</th>
<th>Mass (g)</th>
<th>NV (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraloid™ AU-1453</td>
<td>70</td>
<td>50</td>
<td>35.0</td>
</tr>
<tr>
<td>New Polyol</td>
<td>100</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>HDI Trimer</td>
<td>90</td>
<td>22.3</td>
<td>20.0</td>
</tr>
<tr>
<td>Catalyst Solution in Solvent</td>
<td>1.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solvent</td>
<td></td>
<td>12.8</td>
<td></td>
</tr>
</tbody>
</table>

% New Polyol is reported by mass

Added to further adjust solids

- Coatings were applied to AL-412 and QD-412 Q-PANEL substrates
- An antioxidant package was not included in this study
- Coating samples were prepared at a solids level of 65%

NV = Non-Volatile
Performance of the Acrylic Coating is Preserved

<table>
<thead>
<tr>
<th>Test</th>
<th>PARALOID™ AU-1453 Control</th>
<th>10% New Polyol</th>
<th>20% New Polyol</th>
<th>10% Polyester Comparative</th>
<th>20% Polyester Comparative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film Thickness (mil)</td>
<td>3.0-3.5</td>
<td>3.0-3.5</td>
<td>3.0-3.5</td>
<td>3.5-4.0</td>
<td>3.5-4.0</td>
</tr>
<tr>
<td>Cross Hatch Adhesion</td>
<td>5B</td>
<td>5B</td>
<td>5B</td>
<td>5B</td>
<td>5B</td>
</tr>
<tr>
<td>MEK Double Rubs</td>
<td>&gt;200</td>
<td>&gt;200</td>
<td>&gt;200</td>
<td>&gt;200</td>
<td>&gt;200</td>
</tr>
<tr>
<td>König Hardness (s)</td>
<td>89 ± 8</td>
<td>78 ± 10</td>
<td>98 ± 7</td>
<td>53 ± 4</td>
<td>46 ± 2</td>
</tr>
<tr>
<td>Pencil Hardness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gouge</td>
<td>2B</td>
<td>2B</td>
<td>B</td>
<td>&lt;4B</td>
<td>&lt;4B</td>
</tr>
<tr>
<td>Scratch</td>
<td>B</td>
<td>B</td>
<td>HB</td>
<td>&lt;4B</td>
<td>&lt;4B</td>
</tr>
<tr>
<td>Gloss</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20°</td>
<td>116 ± 1</td>
<td>120 ± 2</td>
<td>120 ± 1</td>
<td>118 ± 3</td>
<td>116 ± 1</td>
</tr>
<tr>
<td>60°</td>
<td>114 ± 1</td>
<td>117 ± 1</td>
<td>116 ± 1</td>
<td>116 ± 2</td>
<td>114 ± 1</td>
</tr>
<tr>
<td>85°</td>
<td>102 ± 1</td>
<td>100 ± 1</td>
<td>100 ± 1</td>
<td>100 ± 1</td>
<td>102 ± 1</td>
</tr>
<tr>
<td>Direct Impact (in*lbf)</td>
<td>120</td>
<td>140</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Indirect Impact (in*lbf)</td>
<td>120</td>
<td>140</td>
<td>120</td>
<td>140</td>
<td>140</td>
</tr>
</tbody>
</table>

- ASTM methods D5402, D3359, D4366, D3363, D523, and D2794 were followed
- Samples were prepared at 65% solids

Dow’s New Polyol maintains the superb properties observed for PARALOID™ AU-1453 coatings
High Performance Weatherability is Achieved

- ASTM Method D4587; QUV-A
- 8 h Exposure; 4 h Dark/Humidity Cycles
- Data are normalized to initial gloss reading

Gloss retention holds above 80% after 5000 h of testing
Minimal Yellowing is Observed in QUV Weathering

Color change in the presence of Dow’s New Polyol is almost indistinguishable from the control formulation
Excellent Moisture Resistance is Realized

- ASTM Method D2247
- 100% Humidity at 60°C
- No blistering or hazing
- Gloss retention values were normalized relative to \( t = 0 \) h measurements

High humidity tolerance is observed for coating compositions containing Dow’s New Polyol
PARALOID™ AU-830 Formulations Echo Outstanding Performance

- The New Polyol preserves coating performance
- Excellent gloss and hardness are attained
- Long-term weatherability studies validate durability

Dow’s New Polyol is compatible with multiple acrylic resin systems

**Excellent UV stability**

**High moisture tolerance**
Dry Times are not Extended by the New Polyol

Dry Times Measured for PARALOID™ AU-1453 Formulations

- ASTM Method D5895
- Solids levels are adjusted to achieve a viscosity of 50-60 cP

The New Polyol’s reactivity profile matches well with the acrylic polyol
Formulation is Easily Adjusted to Offset Pot-Life Reduction

Data collected using a Brookfield DV-II+ Viscometer
Spindle = L-61

Organic acid can be used to slow the reactivity of higher solids formulation
Conclusions

- Dow has developed a New Polyol that excels as a reactive diluent for 2k acrylic coatings
- Industrial coating formulators can achieve high solids acrylic coatings without compromising mechanical performance
- Excellent UV weatherability was observed for acrylic coatings using the New Polyol as a reactive diluent
- Dry times are not affected by the presence of Dow’s New Polyol
- Additives can be incorporated to allow for tuning of the pot-life values observed for high-solids formulations

Sampling

- The New Polyol (Reactive Diluent 330) is TSCA approved
- Samples can be requested by contacting Chris Letko at dowpolyurethanes@dow.com