Dinonylnaphthalene (Mono) Sulfonic Acid (DNNSA) based catalysts for amino thermoset coatings, adhesives and inks offer formulators not only the typical catalyst benefit of shorter cure times at lower cure temperatures resulting in energy savings, but a number of performance characteristics and improved film properties because of their unique chemical composition and structure.

Recommended for use in solventborne systems, advantages of DNNSA catalysts are:

- Hydrophobicity
- Superior corrosion resistance
- Excellent adhesion
- Excellent substrate wetting
- Strong resistance to telegraphing
- Reductions in conductivity
- Excellent control of wrinkling
- Minimization of the undesirable effects of catalyst-pigment interactions

These performance attributes have made King’s DNNSA based catalysts a popular choice for high bake amino crosslinked systems such as coil coatings and metal decorating.

King was an early pioneer of the use of DNNSA based catalysts for the cure - crosslinking of melamine resins in the late 1960’s. Today, King offers five commercial products including a free acid version and four latent catalysts using amine and polymeric blocking technologies and is happy to work with customers to tailor make specific catalysts.
I. Corrosion Resistance Advantages

The hydrophobic nature of DNNSA catalysts make them well suited for applications where corrosion resistance is paramount. Typically offering superior corrosion resistance compared to catalysts based on more hydrophilic acid types, DNNSA catalysts provide excellent substrate wetting properties.

The photograph in the top right (Photo 1.1) shows the salt fog performance of King’s DNNSA based NACURE 1419 covalently blocked catalyst versus a Dodecylbenzene (DDBSA) blocked catalyst at 250 hours of exposure. Both catalysts were used at equal acid equivalency to cure a Polyester/HMMM coil coating.

As demonstrated in Photo 1.2, similar results were obtained when NACURE 1323 was compared to a blocked p-TSA catalyst in a high solids, polyester/acrylic/melamine coil coating after 500 hours of salt fog exposure.
II. Resistance to Telegraphing

Telegraphing in coatings can be defined as surface imperfections that amplifies the presence of contaminants such as fingerprints, oils, solvents or water spots on the surface of the substrate.

In the photographs shown to the left, resistance to telegraphing of surface imperfections over oily substrates is demonstrated. A skin cream containing oil was applied to the hand and imprinted onto the steel test panel prior to coating with a high solids acrylic enamel. As shown, the DNNSA catalysts improved wetting and reduced the telegraphing of the metal surface significantly.

III. Improved Adhesion

DNNSA catalysts provide excellent adhesion compared to other catalyst types. Photo 1.4 to the left illustrates that performance advantage comparing NACURE 1051 acid catalyst to a straight DDBSA acid catalyst. Similar results were obtained when the DNNSA catalyst was compared to other sulfonic acid catalysts.
IV. Excellent Conductivity

An electrostatic coating process used by many applicators utilizes spraying techniques to apply the coating. The electrostatic nature of the coating helps reduce paint losses and improve coverage of areas on the substrate that are hard to reach. An electrostatic charge is applied to the atomized particles of paint exiting the spray gun. The object that is being coated is grounded, and the paint particles are attracted to the grounded surface.

Most acid catalysts will have an influence on the conductive properties of the coating. Small levels of polar acids such as para Toluene Sulfonic Acid can raise the electrical conductivity of the coating, and result in ineffective coverage and poor surface appearance. Use of highly conductive acids may require adjustments in solvents and other formulation components to reestablish the optimum conductive range required for superior spray and coverage.

Using a DNNSA acid catalyst has a much smaller influence on the coating’s conductivity and allows more latitude in reaching the target of conductive properties needed.

The two graphs above show comparisons of DNNSA to more polar sulfonic acids when diluted in water to 1000 ppm sulfonic acid content. Unblocked as well as amine or polymeric blocked sulfonic acids based on DNNSA have lower conductivity values than the other acid catalysts.
V. Excellent Resistance to Wrinkling

Wrinkling is typically caused by the film’s surface curing too fast or disassociation of the volatile amine when blocked catalysts are used.

Wrinkling problems tend to be more pronounced at higher cure temperatures (above 150°C) in such applications as coil and can coatings.

NACURE DNNSA catalysts provide a balanced cure profile allowing sufficient time to release volatile components and minimize differential cure.

VI. Minimization of Catalyst/Pigment Interaction

Catalyst and pigment interactions can result in film defects ranging from lower gloss to loss of catalytic activity on aging and to increased thixotrophy of the coating.

In the case of titanium dioxide, special attention should be given to the surface treatment of the pigment. Highly treated surfaces will interact with the polar sulfonic acid group of the catalyst, leading to lower surface gloss.

Of all catalyst types, DNNSA catalysts offer the best resistance to loss of gloss from catalyst/pigment interaction.

As shown in the adjacent graph, DNNSA has lower loss of catalytic activity due to reduced catalyst/pigment interaction.
Standard Products Available

To improve storage stability of one component acid catalyzed formulations, acid catalysts are available in a pre-neutralized or blocked form, using amines or polymer components as blocking agents. Products listed in the chart below offer:

- A good balance of cure, stability and film performance
- Faster cure
- Excellent solubility and compatibility
- Hydrophobicity
- Less interaction with basic pigments

DNNSA Straight Acid Catalyst

<table>
<thead>
<tr>
<th>Product Code</th>
<th>% Active</th>
<th>Diluent(s)</th>
<th>Acid # or pH*</th>
<th>Minimum Cure**</th>
</tr>
</thead>
<tbody>
<tr>
<td>NACURE 1051</td>
<td>50</td>
<td>2-Butoxyethanol</td>
<td>60-64</td>
<td>125°C</td>
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</table>

Amine & Polymeric Blocked Catalysts

<table>
<thead>
<tr>
<th>Product Code</th>
<th>% Active</th>
<th>Diluent(s)</th>
<th>Acid # or pH*</th>
<th>Minimum Cure**</th>
</tr>
</thead>
<tbody>
<tr>
<td>NACURE 1323</td>
<td>21</td>
<td>Xylene</td>
<td>6.8-7.5</td>
<td>150°C</td>
</tr>
<tr>
<td>NACURE 1419</td>
<td>30</td>
<td>Xylene/MIBK</td>
<td>NA</td>
<td>150°C</td>
</tr>
<tr>
<td>NACURE 1557</td>
<td>25</td>
<td>Butanol</td>
<td>6.5-7.5</td>
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<tr>
<td>NACURE 1953</td>
<td>25</td>
<td>Butanol</td>
<td>6.5-6.9</td>
<td>150°C</td>
</tr>
</tbody>
</table>

*pH (1:1 ratio), **Cure schedule: 30 minutes, Resin/Urea (60/40 ratio)

DNNSA Catalysts Offer Broad Solubility

With the exception of water, DNNSA catalysts are soluble in the broadest range of solvents compared to other catalyst types. For example, while blocked p-TSA and DDNDSA catalysts have limited solubility in aliphatic hydrocarbons and are not soluble in aliphatic hydrocarbons, DNNSA catalysts are fully soluble. Similarly, while blocked DDBSA catalysts have limited solubility in ketones, DNNSA are fully soluble. This characteristics make DNNSA catalysts an ideal choice for universal solubility independent of solvent type for non-aqueous systems.

Solubility In Common Solvents

<table>
<thead>
<tr>
<th>Solvent</th>
<th>NACURE 1051</th>
<th>NACURE 1323</th>
<th>NACURE 1419</th>
<th>NACURE 1557</th>
<th>NACURE 1953</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
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<tr>
<td>Glycols</td>
<td>S</td>
<td>S</td>
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<tr>
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<tr>
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<td>S</td>
<td>S</td>
<td>N/R</td>
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<td>S</td>
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<tr>
<td>Esters</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
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<tr>
<td>Ketones</td>
<td>S</td>
<td>S</td>
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<td>S</td>
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<tr>
<td>Aromatic Hydrocarbons</td>
<td>S</td>
<td>S</td>
<td>S</td>
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</tr>
<tr>
<td>Aliphatic Hydrocarbons</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

KEY: S=Soluble, P=Partially, I=Insoluble, NR=Not recommended
DNNSA Catalyst Use Levels

As with any catalyst, DNNSA catalysts use levels are dependent on a variety of factors and conditions including cure time and temperature, whether the catalyst is blocked or unblocked, substrate and film thickness.

The following chart provides good starting point use levels by type based on a 30 minute cure schedule for a typical binder resin/HMMM ratio of 75/25 at various cure temperatures. The percentage of catalyst shown is as supplied based on total resin solids.

Do not over catalyze. Using too much catalyst can be a costly mistake and one that can cause film properties to suffer significantly.

A ladder study of catalyst levels should be conducted to optimize performance.

Starting Point DNNSA Use Levels

![Graph showing DNNSA catalyst use levels](image-url)

- Blocked DNNSA Catalysts
  - NACURE 1051
  - KING DNNSA 2013

- Do not over catalyze. Using too much catalyst can be a costly mistake and one that can cause film properties to suffer significantly.

- A ladder study of catalyst levels should be conducted to optimize performance.
Catalyst Selection Chart by Application

For Additional Information

Please visit our web site: www.kingindustries.com or contact us as shown below.

WORLD HEADQUARTERS
King Industries, Inc.
1 Science Rd.
Norwalk, CT 06852
Phone: 203-866-5551
Fax: 203-866-1268
Email: coatings@kingindustries.com

ASIA-PACIFIC OFFICE
Synlco Tech (Zhongshan) Co., Ltd.
106 Chuangye Building, Kang Le Ave.
Torch Development Zone,
Zhongshan, China
Phone: 86 760 88229866
Fax: 86 760 88229896
Email: alex.he@kingindustries.com

EUROPEAN OFFICE
King Industries, International
Noordkade 64
2741 EZ Waddinxveen
The Netherlands
Phone: 31 182 631360
Fax: 31 182 621002
Email: mg@kingintl.nl

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