Unique chemistries to help you build and maintain better roads.

Anova™ Asphalt Solutions
There’s nothing better than seeing a newly paved road stretching for miles. Smooth blacktop for as far as the eye can see. No ruts, no cracks, no raveling. While creating that perfect road is always the goal, mixing the right combination of binder, aggregate, modifiers and polymers to meet the stringent specs of the job can be tricky. And, keeping it looking great can be equally challenging.

INTRODUCING CARGILL’S ANOVA™ ASPHALT SOLUTIONS.

• Full line of rheology modifiers, rejuvenators, anti-strip additives and emulsifiers
• Unique bio-based chemistries to create new-to-the-world products.
• Fully functional asphalt binder analysis and applications lab to simulate real-life conditions such as aging and traffic patterns. We also have the ability to further characterize asphalt beyond PG grading, including asphalt fractionation and molecular size distribution.
• Cargill can provide consistent global sourcing and supply of diverse vegetable oil-based materials enabling enhanced price stability and supply availability.

We take a collaborative approach with each of our customers to help them meet their specific needs. No two jobs are alike – weather, crude type, aggregate and job specs – all influence product choices. We understand these varying dynamics and will work with you to help create the best solution for your particular situation. Because we all want to experience driving on that endlessly smooth blacktop.
Enhancing Low Quality Bitumen: improved cracking resistance.

Anova bitumen additives are viscosity reducers and rheology modifiers that increase the “useful temperature interval” (UTI) of bitumen from many different crude sources through higher softening at lower temperatures while limiting high temperature grade loss.

A useful tool for asphalt binder producers and contractors, Anova modifiers can be used to achieve the following:

- Reduce the low temperature grade of the asphalt, to attain -34, -40 and lower grades.
- Excellent polymer compatibilization and enhancement for polymer modified bitumen producers.
- Easy grade correction with small dosages (<1%) to counter drifts during storage and production.
- Paving grade bitumen produced from non-conventional streams.

PRODUCT HIGHLIGHTS

- High impact at low dosage rate: Improves most asphalt binders by one PG or penetration grade with as little as 2-3% by weight of binder.
- Low VOCs which lead to low volatile mass loss (as measured by the RTFO).
- Highly compatible with bitumen: Can be easily blended into bitumen without need of high shear agitation.
- High flash point (in excess of 240°C/460°F) compared to petroleum-based bitumen modifiers allowing safer handling without changing current processes.
- Compatible with both natural and synthetic polymer, resulting in improved dispersion.
- Access to industry expertise, technical support and formulation services and our state-of-the-art asphalt application laboratory.

Anova modifiers are significantly more dosage-efficient in terms of improving the low temperature PG compared to petroleum-based products (1.9°C grade improvement per every 1% Anova modifier vs. 0.6°C improvement using 1% of the commercial aromatic oil). Cargill lab tested using ASTM D6648.

Anova modifiers have higher flash points than petroleum-based softeners (more than 20°C higher than the high flash commercial aromatic product). Cargill lab tested using ASTM D92.
Anova™ Asphalt Rejuvenators

Rejuvenation of aged bitumen: Increasing RAP and RAS content while maintaining performance.

Pavements continually age during their performance life leading to increased stiffness and brittleness and lower ability to relax stress. Increasing the usage of recycled asphalt material from pavements or roofing shingles necessitates the reversal of the impact of aging on the asphalt’s rheological and damage properties.

Anova rejuvenators were developed with the understanding that “softening” does not equal “rejuvenating.” Anova rejuvenators rebalance the chemical composition of aged pavements and bitumen by replenishing high-performing fractions lost during aging.

These products are excellent tools for a wide range of pavement types and pavement preservation applications:

- High RAP and RAS mixtures with up to 100% RAP, while reducing construction temperatures.
- Rejuvenating asphalt emulsions for surface seals and cold in place recycling.
- Oils and emulsified oils for hot in place recycling and surface rejuvenating applications.

### PRODUCT HIGHLIGHTS

- In addition to shifting the PG grade of virgin bitumen, Anova modifiers also rejuvenate RAP and RAS restoring properties of the aged bitumen, allowing for more versatility in mix designs.
- Does not negatively impact rutting resistance of rejuvenated RAP mixture.
- Enhances low temperature cracking resistance of asphalt mixture, even at high RAP content.
- High flash point (in excess of 240°C/460°F) compared to petroleum-based bitumen rejuvenators, allowing safer handling without changing current processes.
- Low VOCs which lead to low volatile mass loss (as measured by the RTFO).
- Has been shown to reduce required compaction temperature by as much as 20°C in high RAP pavements.
- Access to industry expertise, technical support and formulation services and our state-of-the-art asphalt application laboratory.

### TABLE OF PERFORMANCE GRADE MODIFICATION WITH USE OF ANOVA 1055 AND ANOVA 1003

<table>
<thead>
<tr>
<th>Base Binder Grade</th>
<th>Cargill Additive</th>
<th>Other Additive (SBS, PPA)</th>
<th>Standard PG</th>
<th>True PG</th>
<th>Change in DSR Grade Per 1% Anova</th>
<th>Change in m-Grade Per 1% Anova</th>
<th>Change in S-Grade Per 1% Anova</th>
<th>O-DSR</th>
<th>R-DSR</th>
<th>S-BBR</th>
<th>m-BBR</th>
<th>RTFO</th>
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<tbody>
<tr>
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<td>PG 58-28</td>
<td>PG 58-30</td>
<td>-1.6</td>
<td>-1.6</td>
<td>-1.4</td>
<td>50.5</td>
<td>61.4</td>
<td>-37.5</td>
<td>-42.1</td>
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<td>PG 50-37</td>
<td>PG 52-36</td>
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<td>-0.8</td>
<td>-1.2</td>
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<tr>
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<td>PG 48-40</td>
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<td>-1.0</td>
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<tr>
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<td>PG 63-28</td>
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<tr>
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<td>PG 64-22</td>
<td>PG 62-30</td>
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<td>-2.5</td>
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<tr>
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<td>-</td>
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</tr>
<tr>
<td>PG 64-22</td>
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<td>-15.1</td>
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</tr>
</tbody>
</table>
The graph to the right shows how aging shifts the master curve toward lower frequencies (higher stiffness at lower frequencies/higher temperatures). The Anova rejuvenator reverses the effect of 20 hours of additional PAV aging by shifting the curve back toward higher frequencies, while the commercial aromatic oil recycling agent is less effective.

Functional requirement tests were performed on asphalt mixtures containing approximately 70% RAP (76% RAP binder replacement ratio). Source of the RAP was open graded pavements in the Netherlands.

- A blend of Anova rejuvenator and a Pen 70/100 bitumen was compared to a similar mixture using a Pen 160/200 bitumen.
- Results show that use of the Anova rejuvenator significantly improved the compactability of the high RAP mixture (a 20°C shift in the compaction curve).
- The 4-point bending fatigue test showed that the Anova rejuvenator significantly improved fatigue resistance and properties.
- The high-RAP mixture using the Anova rejuvenator passed the rutting requirement, while the control mixture using soft bitumen failed the rutting test.

Anova rejuvenator produced a workable high-RAP mixture that passed all functional requirement tests with a wide margin.
Anova™ Anti-strip

Improve adhesion while reducing moisture damage.

Anova anti-strip is a high-performance non-toxic additive that enhances asphalt-aggregate adhesion and significantly reduces moisture damage in hot and warm mix asphalt as well as cold patch and cold mix applications.

**PRODUCT HIGHLIGHTS**

- Very effective in improving adhesion and reducing moisture damage of low-quality bitumen-aggregate combinations.
- Compatible with multiple aggregate sources.
- Compatible with Polyphosphoric Acid (PPA) modified bitumen in terms of both adhesion performance and maintaining the asphalt high temperature grade.
- Made from non-toxic agricultural sources.

Compatible with Polyphosphoric Modified Asphalt: Unlike amine-based antistrips, Anova 1400 does not significantly effect PPA high temperature grade modification.

The tensile strength of both the dry unconditioned sample and the sample subjected to freeze-thaw and moisture conditioning cycles increased as a result of adding Anova anti-strip.

NCAT study (3/2015) used the Indirect Tensile Strength Ratio (AASHTO T283) to show that Anova anti-strip is highly effective in binders with and without Polyphosphoric acid modification.

NCAT study (5/2014) showed the Indirect Tensile Strength Ratio (AASHTO T283) was improved from 27% to 83% with only 0.5% dosage.
Anova™ Emulsifiers

Versatile performance for greater control over mixing times.

Anova emulsifiers are tree-free, liquid emulsifiers designed for use in a variety of asphalt emulsions, particularly, quick-setting asphalt emulsions.

The emulsifiers are formulated for use with highly reactive aggregates in slurry seal applications.

PRODUCT HIGHLIGHTS

- Versatile performance based on the product chemistry and/or dosage rate allowing greater control over mixing times.
- The product provides excellent curing characteristics with a wide range of asphalts and aggregates, particularly slurry and microseal.
- Compatible with natural and synthetic polymer modifiers.
- Made from vegetable oil derivatives.
- Cargill can provide enhanced price stability and supply availability.
- Access to industry expertise, technical support and formulation services and our state-of-the-art asphalt application laboratory.

Cargill lab tested using ISSA TB-13.
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