Zemea® Propanediol Performance in Sunscreen Applications

Performance is in our nature.

April 13, 2017
Agenda

• Company Overview
• Zemea® Propanediol Overview
• Zemea® Propanediol in Broad Spectrum Daily Facial Moisturizers
Company Overview
About Us

http://duponttateandlyle.com/
Company

DTL is a joint venture formed in 2004 between DuPont and Tate & Lyle to produce bio-based propanediol from fermentation of glucose.

DuPont is a world leader in science and innovation across a range of disciplines, including agriculture and industrial biotechnology, chemistry, biology, materials science and manufacturing. CY2016 revenues were $24.6 billion.

Tate and Lyle is a global provider of renewable ingredients, solutions and services to the food, beverage and industrial customers. Revenues were $4.3 billion for Fiscal Year ending March 31, 2015.
Process Technology
Renewably sourced feedstocks are harvested, fermented, and refined to manufacture Zemea® propanediol.

**Harvest**
Renewably sourced feedstocks are harvested, dried and then wet-milled to create a range of carbohydrate rich feedstocks such as glucose.

**Fermentation**
Glucose is converted into 1,3 propanediol using a patented microorganism under exact temperatures and conditions.

**Refining**
The 1,3 propanediol is refined to a final purity of 99.99% by deactivating and removing the microorganism, water, and other byproducts.
Production

Biotechnology enables our global headquarters and production in Loudon, Tennessee to produce a stable supply of renewably sourced 1,3 propanediol.

Awards
- 2003 EPA Presidential Green Chemistry Award
- 2007 ACS Heroes of Chemistry Award
- 2009 ACS-BIOT Industrial Biotechnology Award
- 2010 State of Tennessee Governor’s Award for Trade Excellence

Production
- Started November 2006
- Capacity expanded 35% in 2010
- Purity = 99.99%
- 100% sustainable and renewably sourced
Zemea® Propanediol Overview
Zemea® Propanediol - Multifunctional

- Preservative Booster
- Efficient Active Carrier
- Zemea® Propanediol 100% Natural
- Unique Solvent
- Humectant Emollient
- Sensorial Improver
- Non Irritating

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- Efficient Active Carrier
- Unique Solvent
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- Humectant Emollient
- Preservative Booster
Zemea® Propanediol in a Broad Spectrum, Water Resistant, SPF 25+ Daily Facial Moisturizer
Introduction

• Further need for broad spectrum sun protection, and particular protection during times of heavy sun exposure;

• Every day, broad spectrum UV protection is necessary to keep the skin looking youthful and healthy;

• The category is growing, but there continue to be concerns regarding the effectiveness, safety, and aesthetics of the sunscreen actives.

Two organic and water-soluble actives have been evaluated:

Ensulizole

Sulisobenzone
## Actives

<table>
<thead>
<tr>
<th>Active</th>
<th>Type</th>
<th>Performance</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensulizole</td>
<td>Organic, water-soluble UVB filter</td>
<td>Crystalline solid and loses effectiveness if too much solvent is lost</td>
<td>Mode of action is absorption</td>
</tr>
<tr>
<td>Sulisobenzone (Benzophenone-4)</td>
<td>Organic, water-soluble UVB and UVA (UVA-II) filter</td>
<td>Crystalline solid and loses effectiveness if too much solvent is lost</td>
<td>Needs combination of UVA absorber to attain broad spectrum protection</td>
</tr>
</tbody>
</table>
Zemea® Propanediol an Effective Solvent

- Ensulizole and sulisobenzone are utilized globally, but concerns exist around their effectiveness as they return to their crystalline state as they fall out of solution
- Multiple studies simulating an aqueous phase were completed:

  1. An aqueous phase of 4% ensulizole and Zemea® propanediol at 10% showed that solubility can be maintained when 75% of the water in the aqueous phase has evaporated
  2. An aqueous phase of 10% sulisobenzone and 10% Zemea® propanediol showed that solubility can be maintained when 75% of the water in the aqueous phase has evaporated

Zemea® propanediol is an essential ingredient for these actives, successfully keeping them in solution leading to greater efficacy for both
W/O Broad Spectrum Daily Facial Moisturizer

**Procedure:**

1. Add (B) to (A)
2. Add (C) until (AB) is clear
3. Add (D) with propeller stirring
4. Add (ABCD) to (E) VERY SLOWLY with propeller stirring
5. Add (F) with propeller stirring
6. Homogenize until glossy
Combining Organic and Inorganic Actives

- Combining organic and inorganic sunscreen actives lead to maximized sun protection with higher SPF
- The two water-soluble actives absorb mainly in the UVB spectra, but offer different absorbance profiles when overlaid and increase the SPF
- Organic or inorganic actives typically do not cause skin irritation or sensitivity
- Placing both organic and inorganic actives in both the aqueous phase and the oil phase is an effective tool to formulate higher SPF products
- This combination of actives allows the formulation to meet the critical wavelength of 377.8 nm.
# Testing and Results

<table>
<thead>
<tr>
<th>Testing</th>
<th>Location</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-panelists in-vivo SPF testing</td>
<td>AMA Laboratories</td>
<td>SPF between 26 and 28 (before and after water resistance testing)</td>
</tr>
<tr>
<td>40-minute water resistance testing</td>
<td>AMA Laboratories</td>
<td>Pass</td>
</tr>
<tr>
<td>Critical wavelength/broad spectrum testing</td>
<td>AMA Laboratories</td>
<td>377.8nm well above 370nm necessary for broad spectrum claim</td>
</tr>
<tr>
<td>In-vitro SPF testing</td>
<td>Heliosciences</td>
<td>SFP above 30 – reinforcing the confidence that full 10-panelist SPF testing would have desired level of protection</td>
</tr>
</tbody>
</table>
## Conclusions

<table>
<thead>
<tr>
<th><strong>Zemea® Propanediol</strong></th>
<th><strong>Confirmed</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zemea® is a high performing solvent keeping ensulizole and sulisobenzon in solution through evaporation boosting their efficacy</td>
<td>✓</td>
</tr>
<tr>
<td>Achieving combination of high SPF and critical wavelength is rare.</td>
<td>✓</td>
</tr>
<tr>
<td>Achieved an SPF 3x the level of sunscreen active is not common when using lesser-efficient sunscreens</td>
<td>✓</td>
</tr>
<tr>
<td>Combining organic and inorganic actives and placing both actives in the aqueous and oil phase maximize sun protection</td>
<td>✓</td>
</tr>
<tr>
<td>Zemea® improves aesthetics of formulation, specifically daily facial moisturizer (non-irritating, increased moisturization, excellent sensory characteristics)</td>
<td>✓</td>
</tr>
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**Zemea® Propanediol Commercial Applications**

**Skin Care:**
- **Cleansers**
  - Facial Cleansers
  - Body Wash
  - Shower Gels
  - Anti-Acne
  - Hand Sanitizers
- **Moisturizers**
  - Moisturizing Lotions
  - Anti-aging Serum
  - Skin Care Masks
  - Eye Creams
  - Scar Massage Gel
- **Sun Care**
  - Broad spectrum moisturizers
  - Sunscreen Lotions
  - Sunscreen Wipes
- **Baby Care Products**
- **Men’s Skin Care Products**

**Hair Care:**
- Shampoo
- Conditioner
- Various Styling Products

**Toiletries:**
- Deodorants
- Oral Care Products
- Personal Lubricants

**Cosmetics:**
- Foundation
- Concealer
- Mascara
- Makeup Remover

**Other Ingredients:**
- Natural Esters
- Fragrances
- Natural Preservatives
- Botanical Extracts
Please take a sample on the way out
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