Kraton® polymers for rheology modification of oils

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Outline

- Introduction to Kraton® polymers
- Introduction to Kraton modified oils
- How to incorporate Kraton polymers into oil?
- Benchmark study
- Conclusions
What are Kraton® polymers?

Styrenic Block Copolymer (SBC)* is a Thermoplastic Elastomer (TPE) enabling viscosity modification of oils

*Certain SBC’s are INCI and IECIC-2014 listed and not considered as nanomaterials nor classified according to CLP Regulation N°272/2008

Residual styrene in Kraton polymers is below 1ppm.
Introduction to Kraton® modified oils

Polymer structuring in paraffinic oil*

- **Tri-block** (eg. Kraton® G1652)
  - Three dimensional solid gel
  - Micelles providing shear thinning

- **Di-block** (eg. Kraton G1701)
  - In oil

- **Star-shape** (eg. Kraton® MD6953)
  - Thickening

* Other types of oil may lead to different rheologies
How to incorporate Kraton® polymers into oil?

1. Addition of Kraton® polymer to warm oil
2. Mixing under high or low shear
3. Gel formation upon cooling down
Benchmark study
Various thickeners in non-polar to polar emollients

Objective

- Determine the compatibility of various solid thickeners in non-polar to polar emollients

Measurables

- Handling
- Visual aspects
- Type of rheology
## Benchmark study

### Emollients

<table>
<thead>
<tr>
<th>INCI name</th>
<th>Origin</th>
<th>Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caprylic/Capric Triglyceride</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Canola Oil</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Helianthus Annuus (Sunflower) Hybrid Oil</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Butyrospermum Parkii Butter</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Shea Butter Ethyl Esters</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Limanthes Alba (Meadowfoam) Seed Oil</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Neopentyl Glycol Diethylhexanoate</td>
<td>Vegetable/Synthetic</td>
<td>High</td>
</tr>
<tr>
<td>Olea Europaea (Olive) Fruit Oil</td>
<td>Vegetable</td>
<td>High</td>
</tr>
<tr>
<td>Dicaprylyl Ether</td>
<td>Synthetic</td>
<td>Low</td>
</tr>
<tr>
<td>Squalane</td>
<td>Vegetable</td>
<td>No</td>
</tr>
</tbody>
</table>
### Benchmark study

#### Thickeners

<table>
<thead>
<tr>
<th>INCI name</th>
<th>Product form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stearalkonium Hectorite</td>
<td>Brownish powder</td>
</tr>
<tr>
<td>Disteardimonium Hectorite</td>
<td>Brownish powder</td>
</tr>
<tr>
<td>Silica</td>
<td>White powder</td>
</tr>
<tr>
<td>Silica dimethicone silylate</td>
<td>White powder</td>
</tr>
<tr>
<td>Polyamide-8</td>
<td>Transparent pellet</td>
</tr>
<tr>
<td>Hydrogenated styrene/isoprene copolymer</td>
<td>White Crumb</td>
</tr>
<tr>
<td>Hydrogenated styrene/butadiene copolymer</td>
<td>White Crumb</td>
</tr>
</tbody>
</table>
Benchmark study
Handling/Processing

**Hectorites**
- Require polar additives to activate which complicates processing
- Incorporation at room temperature

**Silicas**
- Very low bulk density, potential safety issue
- Incorporation at room temperature

**Polyamide-8**
- Easy handling
- Incorporation at 85-95°C

**Kraton® Styrenic Block Copolymers**
- Easy handling
- Incorporation at 70-120°C
## Benchmark study

### Visual aspects in oil

<table>
<thead>
<tr>
<th>Hectorites</th>
<th>Silica’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Brownish, hazy appearance in both non-polar and polar emollients</td>
<td></td>
</tr>
<tr>
<td>- Phase separation in polar emollient after 24 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Crystal clear to hazy depending on type of emollient</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Polyamide-8</th>
<th>Kraton® Styrenic Block Copolymers</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Hazy in most emollient types</td>
<td></td>
</tr>
<tr>
<td>- Phase separation in polar and non-polar emollient after 1 week</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Crystal clear to slight haze depending on type of emollient</td>
</tr>
</tbody>
</table>
Benchmark study
Rheology

Hectorites
- Thickening and Shear thinning

Silica’s
- Thickening and Shear thinning

Polyamide-8
- Thickening and Shear thinning

Kraton® Styrenic Block Copolymers
- Thickening and shear thinning or solid gel depending on polymer and emollient type
Benchmark study

Conclusions

Kraton® polymers provide

- Easy incorporation in a wide range of emollients
- Crystal clear to slightly hazy appearance
- Various rheology profiles
Why choosing Kraton® polymers?

Value Proposition

**Appearance and feel**
- crystal clear natural oil formulations
- high gloss
- silky, smooth texture on skin

**Stability improvement**
- stabilisation of water in oil (W/O) emulsions
- homogeneous dispersion of particles such as glitters, pigments

**Rheology modification**
- compatibility with a large range of oils
- viscosity boost of oil phase

**Film formation**
- easy and uniform spreading
- moisturizing effect
- water resistant: formation of protective layer, resistant to rinse-off
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Disteardimonium Hectorite in non-polar emollient
Silica in polar emollient
Polyamide-8 in non-polar emollient
Polyamide-8 in low polar emollient
Polyamide-8 in polar emollient
Kraton in various emollients

- Polar emollient
  - Kraton in polar emollient
- Non-polar emollient
  - Kraton in non-polar emollient
- Low-polar emollient
  - Kraton in low-polar emollient
Representative Rheology profile of Hectorite in oil
Representative Rheology profile of silica in oil

8% wt Silica dimethicone silylate in squalane

Squalane
Representative Rheology profile of PA-8 in oil

8% wt Polyamide-8 in squalane

Squalane
Representative Rheology profiles of Kraton in oil

![Graph showing rheology profiles](image)

- 8% wt Kraton® MD6953 in squalane
- 8% wt Kraton® G1701 in squalane

Viscosity at 25°C, mPa.s vs. Shear rate, s⁻¹