RADIASURF ML
THE NATURAL BIOSURFACTANT BY OLEON
OUR SHAREHOLDER
FROM GRAIN TO FINISHED PRODUCTS

- Seeds
- Plant health products,
- Biotech,
- Other services for agriculture

100,000 agricultural producers

Collection of oilseed and protein grains

Crushing

Proteins

Proteochem®

Animal Nutrition, Biosecurity

Livestock Farmers

Genetics & Animal Health, Other Inputs and Services

Milk, Meat

Poultry

Eggs, Pork

Food

Renewable energies

Renewable chemistry

Oils

Collection of oilseed and protein grains

Crushing

Proteins

Proteochem®

Animal Nutrition, Biosecurity

Livestock Farmers

Genetics & Animal Health, Other Inputs and Services

Milk, Meat

Poultry

Eggs, Pork

Food

Renewable energies

Renewable chemistry

Oils
WHAT WE DO

- Extensive research & development
- Flexible production
- Dedicated sales
- oleochemical building blocks
  - biodiesel
  - polymer additives
- Agriculture & crop protection
- Lubricants
- Nutrition
- Detergents
- Cosmetics
- Coatings
- Oilfield
OUR KEY FIGURES

- 1000 employees
- Market share of 25% in Europe
- 530,000 tons/year
- 87% Renewable Raw Materials
- 6 production plants
- 12 offices in Europe, USA and Asia
- 2016 turnover + €630 mio
- 1000 employees
- Market share of 25% in Europe
- 530,000 tons/year
- 87% Renewable Raw Materials
- 6 production plants
- 12 offices in Europe, USA and Asia
- 2016 turnover + €630 mio
OLEON RADIA RANGE OF ESTERS
A LARGE NUMBER OF BIOBASED EMULSIFIERS FOR PESTICIDES, SKIN CARE, FOOD AND MANY OTHER APPLICATIONS

- Mono & Diglycerides
- Cytrilated Mono & Diglycerides
- Lactylated Mono & Diglycerides
- PEG Esters
- Glycerol & Polyglycerol Esters
- Propyleneglycol Esters
- Sorbitan Esters

- 90 % Renewable Raw Material
- 100% RSPO certified palm
- 96 % Share of new developments of non-classified products
RADIASURF ML: THE NATURAL BIOSURFACTANT BY OLEON

ECO-FRIENDLY MOLECULE

VERY HIGH SURFACE ACTIVITY

VERSATILE CHARACTERISTICS

MANNOSYLERITHRITOL LIPIDS
THE ‘NATURAL’ CONCEPT BY OLEON BIOTECH

A process inspired by nature!

Raw Material: A natural Vegetable Oil

Catalyst: A natural non GMO microorganism (Yeast)

Biosurfactant: a product which already exists in the nature
STRUCTURE : MANNOXYLERYTHRITOL LIPID

**Composition**: a mixture of 4 molecules
- MEL-A: R1 = R2 = acetyl
- MEL-B: R1 = acetyl and R2 = H
- MEL-C: R1 = H, R2 = acetyl
- MEL-D: R1 = R2 = H

**Structure**
- Short fatty acid chain
  - n = 8 - 12
- Partially acetylated

**A BICATENARY NON-IONIC SURFACTANT WITH GRADIENT OF POLARITY (PSEUDO-GEMINI SURFACTANT)**
HYDROPHILIC LIPOPHILIC BALANCE (PIT METHOD)

⇒ HLB between 8 and 10 : O/W emulsifier - Wetting agent

O/W emulsion: increase HLB with blend of ML + other surfactant

W/O emulsion: decrease HLB with blend of ML + other surfactant
## HIGH SURFACE ACTIVITY – CRITICAL MICELLE CONCENTRATION

<table>
<thead>
<tr>
<th>SURFACTANT</th>
<th>CMC (PPM)</th>
<th>SURFACE TENSION (mN/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADIASURF ML</td>
<td>1-10</td>
<td>26.1</td>
</tr>
<tr>
<td>POLYSORBATE 80</td>
<td>13-15</td>
<td>30.0</td>
</tr>
<tr>
<td>APG C10 &amp; C16</td>
<td>48</td>
<td>28.4</td>
</tr>
<tr>
<td>POLYSORBATE 20</td>
<td>60</td>
<td>32.0</td>
</tr>
<tr>
<td>PEG8-LAURATE</td>
<td>114</td>
<td>28.0</td>
</tr>
<tr>
<td>SLES-2EO (23% ACTIVE)</td>
<td>171</td>
<td>25.0</td>
</tr>
<tr>
<td>SDS (29% ACTIVE)</td>
<td>185</td>
<td>26</td>
</tr>
<tr>
<td>SOPHOROLIPIDS</td>
<td>553</td>
<td>35.6</td>
</tr>
<tr>
<td>LECITHIN</td>
<td>1000</td>
<td>25.2</td>
</tr>
</tbody>
</table>

![Graph showing surface tension vs. concentration for RADIASURF ML](image-url)
HIGH SURFACE ACTIVITY – WETTING PROPERTIES ON APOLAR SURFACE

Wetting on parafilm (apolar surface)
RADIASURF ML in demin water

Contact angle - ellipse (°)

Time (sec)

- 1%
- 0.1%
- 0.01%
- 0.001%
- 0.0005%

Bad wetting
Good wetting
Complete wetting
C159 = RADIASURF ML10 + POLYGLYCEROL FATTY ACID ESTER (PG4 CAPRATE – JOLEE 7931)

- To overcome high viscosity and water insolubility of ML10
- To replace Cocamide DEA or SLS or SLES in formulation

<table>
<thead>
<tr>
<th>PROPERTIES</th>
<th>UNIT</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 1% in water</td>
<td></td>
<td>4,75</td>
</tr>
<tr>
<td>Dynamic viscosity @ 20°C</td>
<td>Pa.s</td>
<td>142,4</td>
</tr>
<tr>
<td>Dynamic viscosity @ 25°C</td>
<td>Pa.s</td>
<td>83,16</td>
</tr>
<tr>
<td>Dynamic viscosity @ 40°C</td>
<td>Pa.s</td>
<td>13,72</td>
</tr>
<tr>
<td>Density @ 60°C</td>
<td>g/cm³</td>
<td>1,11998</td>
</tr>
<tr>
<td>1% in water Surface tension @ 25°C K100/K10</td>
<td>mN.m</td>
<td>25,8</td>
</tr>
<tr>
<td>1% in water Interfacial tension against Min. oil @ 25°C</td>
<td>mN.m</td>
<td>0,7</td>
</tr>
<tr>
<td>HLB (slope PIT)</td>
<td></td>
<td>9,8</td>
</tr>
</tbody>
</table>

**CMC**

- $\text{CMC}_{\text{ML10}} = 15 \text{ ppm}$
- $\text{CMC}_{\text{C159}} = 12 \text{ ppm}$
BOOSTER OF YOUR FOAMING FORMULATIONS

- **Cleansing:**
  - Caps with foundation (0.1 g)
  - Contact with different test solutions in water for 15 min while shaking
  - Quantification of make-up removal

- **Thickening + foaming + cleansing**

<table>
<thead>
<tr>
<th>Test</th>
<th>Set-up</th>
<th>Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1% C159</td>
<td>96</td>
</tr>
<tr>
<td>2</td>
<td>0.5% C159</td>
<td>99</td>
</tr>
<tr>
<td>3</td>
<td>0.1% SLES</td>
<td>91</td>
</tr>
<tr>
<td>4</td>
<td>0.5% SLES</td>
<td>98</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>82</td>
</tr>
</tbody>
</table>

RADIASURF ML – THE NATURAL BIOSURFACTANT BY OLEON
BOOSTER OF YOUR FOAMING FORMULATIONS

SHAMPOO

Process:
- Disperse SLES and/or C159 in water
- Adjust pH to 5.8 with citric acid → mix
- Add cocoamidopropyl betaine → mix
- Add preservative and fragrance → mix

<table>
<thead>
<tr>
<th>Raw material</th>
<th>wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>up to 100,0</td>
</tr>
<tr>
<td>C159</td>
<td>0,0-48,0</td>
</tr>
<tr>
<td>SLES</td>
<td>0,0-48,0</td>
</tr>
<tr>
<td>Cocoamidopropyl betaine</td>
<td>3,0</td>
</tr>
<tr>
<td>Sodium benzoate</td>
<td>0,5</td>
</tr>
<tr>
<td>Perfume</td>
<td>0,2</td>
</tr>
<tr>
<td>pH regulator</td>
<td>Till pH 5,8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100,0</td>
</tr>
</tbody>
</table>

RADIASURF ML – THE NATURAL BIOSURFACTANT BY OLEON
BOOSTER OF YOUR EMULSIFICATION POWER (O/W EMULSIONS)

C161 = RADIASURF ML10 + GLYCEROL OLEATE CITRATE

- Glycerol oleate citrate (R2935K) is known O/W emulsifier (HLB = 13)
- Combination with Radiasurf ML10 = C161
  - 100% renewable carbon
  - Like C159, no influence on physico-chemical properties
  - Liquid @ ambient temperature → cold processing
  - Fully dispersible in water
  - Macro-emulsion → nano-emulsion
    - Water thin emulsions → water thin and sprayable (< 4000 mPa.s)
    - Stable > 2 months @ room temperature → wet wipes

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>70</td>
</tr>
<tr>
<td>MCT</td>
<td>27</td>
</tr>
<tr>
<td>Emulsifier</td>
<td>3</td>
</tr>
</tbody>
</table>

Emulsifier | Dv(10) (µm) | Dv(50) (µm) | Dv(90) (µm) |
-------------|-------------|-------------|-------------|
R2935K       | 9,2         | 22,3        | 40,1        |
C159         | 0,1         | 0,4         | 3,3         |

Mix water and emulsifier
Gradually add oil
Mix intensively for 1 min (Ultra-Turrax)
Mastersizer analysis

RADIASURF ML – THE NATURAL BIOSURFACTANT BY OLEON
BOOSTER OF YOUR EMULSIFICATION POWER
O/W EMULSIONS – WET WIPE FORMULATION

Process:
- Blend phases A and B separately at ambient T
- Add A to B under high stirring (1300 rpm)
- Homogenize with Ultra-Turrex (10 000 rpm) for 1 min
- Add phase C during stirring

<table>
<thead>
<tr>
<th>Phase</th>
<th>Raw material</th>
<th>wt%</th>
<th>R2935K</th>
<th>C161</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Emollients (R7202, R7750 &amp; R7104)</td>
<td>33,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Glycerine</td>
<td>2,5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R2935K or C161</td>
<td>3,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Perfume</td>
<td>0,2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preservative</td>
<td>0,2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100,0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dv(50) 3,5 µm → 0,03 µm Nano-emulsion

RADIASURF ML – THE NATURAL BIOSURFACTANT BY OLEON
BOOSTER OF YOUR EMULSIFICATION POWER (W/O EMULSIONS)

W/O EMULSIONS

- Polyglycerol polyricinoleate (R2251K) is known W/O emulsifier (HLB = 3)
- Combination with Radiasurf ML10 = C162
  - 100% renewable carbon
  - Like C159 & C161, no influence on physico-chemical properties
  - Liquid @ ambient temperature → cold processing
  - Compatible with standard oils e.g. sunflower, MCT, ...
  - Decrease in particle size & viscosity
  - Improved stability even under challenging processing conditions (high pressure homogenizer or anti-spattering test)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>69</td>
</tr>
<tr>
<td>MCT</td>
<td>30</td>
</tr>
<tr>
<td>Emulsifier</td>
<td>1</td>
</tr>
</tbody>
</table>

Mix oil and emulsifier
Gradually add water under stirring
Mix intensively for 1 min (Ultra-Turrax)
Homogenize 1 min
Mastersizer analysis

<table>
<thead>
<tr>
<th>Emulsifier</th>
<th>Dv(10) (µm)</th>
<th>Dv(50) (µm)</th>
<th>Dv(90) (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2251K</td>
<td>9,8</td>
<td>17,8</td>
<td>31,0</td>
</tr>
<tr>
<td>C162</td>
<td>1,8</td>
<td>3,6</td>
<td>22,5</td>
</tr>
</tbody>
</table>
**BOOSTER OF YOUR EMULSIFICATION POWER**

W/O EMULSIONS – SUNSCREEN FORMULATION

<table>
<thead>
<tr>
<th>Phase</th>
<th>Raw material</th>
<th>wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Emollients (R7202, R7750 &amp; R7104)</td>
<td>20,5</td>
</tr>
<tr>
<td></td>
<td>R2251K or C162</td>
<td>4,0</td>
</tr>
<tr>
<td>B</td>
<td>Glycerine</td>
<td>4,0</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MgSO₄·7H₂O</td>
<td>0,8</td>
</tr>
<tr>
<td>C</td>
<td>UV filters (Avobenzone &amp; Oxybenzone)</td>
<td>9,0</td>
</tr>
<tr>
<td>D</td>
<td>Perfume</td>
<td>0,2</td>
</tr>
<tr>
<td></td>
<td>Preservative</td>
<td>0,2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>100,0</strong></td>
</tr>
</tbody>
</table>

**Process:**
- Heat phase A and B separately till 75°C
- Add B to A under high stirring (1300 rpm)
- Homogenize with Ultra-Turrex for 1 min
- Below 40°C add components of phases C and D

<table>
<thead>
<tr>
<th></th>
<th>R2251K</th>
<th>C162</th>
</tr>
</thead>
<tbody>
<tr>
<td>μ (mPa.s)</td>
<td>1780</td>
<td>3100</td>
</tr>
</tbody>
</table>

**Microscopy**

RADIASURF ML – THE NATURAL BIOSURFACTANT BY OLEON
CROP PROTECTION

- **Adjuvant**
  - Biosurfactant
  - Wetting adjuvant

- **Biocontrol**: a natural booster for your formulation
  - Facilitation of biocontrol mechanisms of microbes
  - Plant pathogen elimination and increased bioavailability of nutrients for beneficial plant-associated microbes
"New Powerful 100% renewable biosurfactant.\" presented by Oleon
17/06/2016 from 11:20-11:40 in Regency Grand Ballroom Main

**RADIASURF® 8780**
BIOSURFACTANT FOR HYDROPHILIC FORMULATIONS

Oleon biotechnology developed a safe, non-toxic and eco-friendly wetting agent for hydrophilic formulations based on a 100% renewable biosurfactant: Mannosyl Erythritol Lipid (MEL).

<table>
<thead>
<tr>
<th>NAME</th>
<th>RADIASURF® 8780</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect</td>
<td>Cloudy</td>
</tr>
<tr>
<td>Density at 20°C (g/mL)</td>
<td>1,024</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>94</td>
</tr>
<tr>
<td>Viscosity at 20°C (mm²/s)</td>
<td>197</td>
</tr>
<tr>
<td>pH 1% in demi water</td>
<td>7,4</td>
</tr>
</tbody>
</table>

**RADIAMIX® 8790**
WETTING ADJUVANT

Based on RADIASURF® 8780, Oleon developed a new non-phytotoxic wetting adjuvant demonstrating good penetration efficiency, low foaming potential and good storage stability.

### Contact angle

![Contact angle graph](image)

![Radiamix 8790](image)
RADIASURF® 8781
BIOSURFACTANT FOR HYDROPHOBIC FORMULATIONS

Oleon biotechnology developed a safe, non-toxic and ecofriendly wetting agent for hydrophobic formulations based on a 100% renewable biosurfactant: Mannosyl Erythritol Lipid (MEL).

<table>
<thead>
<tr>
<th>NAME</th>
<th>RADIASURF® 8781</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect</td>
<td>Cloudy</td>
</tr>
<tr>
<td>Density at 20°C (g/mL)</td>
<td>0.956</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>94</td>
</tr>
<tr>
<td>Viscosity at 20°C (mm²/s)</td>
<td>83</td>
</tr>
<tr>
<td>pH, 1% in demi water</td>
<td>7.7</td>
</tr>
</tbody>
</table>

RADIAMIX® 8791
CROP OIL CONCENTRATE

Based on RADIASURF® 8781, Oleon developed a new non-phytotoxic penetrating adjuvant with good wetting properties, low foaming potential and good storage stability.

Source: Biotransfer
RADIAMIX® 8791 shows better penetration and wetting properties than an MSO based adjuvant when testing on CHEAL leaves.
THANK YOU

Dominique Charlemagne, PhD
Business Developer Biotechnology
+33 680 92 16 54
dominique.charlemagne@oleon.com