Polyurethane Automotive and Sustainability Conference

3 & 4 June 2015
Sheraton Charlotte Hotel, Charlotte, North Carolina

Dr. Peter Talbiersky
Polypropylene glycol (DPG)

Sustainable
100% Biobased
High Performance Polyols
Overview

1) WeylChem Group of Companies
2) Biobased Polypropanediol PO3G
3) PO3G – Markets, Applications, Benefits
1) WeylChem Group of Companies

2) Biobased Polypropanediol PO3G

3) PO3G – Markets, Applications, Benefits
1) WeylChem Group of Companies

- WEYLCHERM US
- PPC POTASSE ET PRODUITS CHIMIQUES (France)
- NEASE PERFORMANCE CHEMICALS (USA)
- WEYLCHERM Lamotte (France)
- ALLESSA (Germany)
- MITENI (Italy)
- HYDROCHEM ITALIA
- WEYLCHERM Frankfurt (Germany)
- WEYLCHERM Wiesbaden (Germany)

We live know-how.
1) WeylChem Group of Companies

Business

- Custom Manufacturing & Tolling (CM&T)
- Advanced Intermediates & Reagents (AI&R)
- Performance Products
- Essential Chemicals
- Detergent Chemicals

Sales by Business

- Custom Manufacturing & Tolling
- Advanced Intermediates & Reagents
- Detergent Chemicals
- Essential Chemicals
- Performance Products
1) WeylChem Group of Companies

Markets:

- Agro
- Pharma: Non-GMP
- Polymer
- Specialties e.g.
  - Electronics
  - Dye & Pigments
  - Food & Feed
- Personal Care
- Detergents

Sales by Market

- Agro
- Pharma
- Polymer
- Specialties
- Personal Care
- Detergents
Overview

1) WeylChem Group of Companies

2) Biobased Polypropanediol PO3G

3) PO3G – Markets, Applications, Benefits
2) Biobased Polypropanediol PO3G

PO3G is made of Bio-PDO® (1,3-Propanediol)

DuPont Tate & Lyle Bio Products Company developed and patented an innovative proprietary fermentation and purification process derived from glucose
2) Biobased Polypropylene-1,3-diol (PO3G)

Biomass → D-Glucose → 1,3-Propanediol (100% Bio content)

Yeast

E. coli

enzymes

Corn sugar Fermentation
2) Biobased Polypropanediol PO3G

- Bio-PDO® is **GMO-free** and has a purity of >99.7%
- Bio-PDO® is a USDA 100% **Certified Bio-Based Product**
- Bio-PDO® is a 100% sustainable and renewable-sourced diol
2) Biobased Polypropanediol PO3G

Fermentation plant is located in Loudon, Tennessee (capacity 70,000 tons p.a.)

**Environmental friendly Process**

- Renewably-sourced ingredient
- Safer manufacturing process
- Less material intensive
- Less energy consumption
- Less GHG emission

**Petro-based processes**

1) Acrolein-based Process (1998 DuPont, Degussa)
2) Hydrocarbonylation of ethylene oxide (Shell)

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
2) Biobased Polypropanediol PO3G

Biomass → D-Glucose → 1,3-Propanediol (100% Bio content) → PO3G (100% Bio content)

Yeast

E. coli enzymes

Corn sugar Fermentation

Polycondensation
2) Biobased Polypropanediol PO3G

Overview of all available PO3G grades at Allessa

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>H650</th>
<th>H1000</th>
<th>H1400</th>
<th>H2000</th>
<th>H2400</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS content</td>
<td>%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>Dalton</td>
<td>600-700</td>
<td>900-1100</td>
<td>1300-1450</td>
<td>1900-2100</td>
<td>2300-2500</td>
</tr>
<tr>
<td>Hydroxyl number</td>
<td></td>
<td>187.0-160.3</td>
<td>124.7-102.0</td>
<td>86.3-77.4</td>
<td>59.1-53.4</td>
<td>48.8-44.9</td>
</tr>
<tr>
<td>Polydispersity</td>
<td>Mw/Mn</td>
<td>1.4-1.6</td>
<td>1.4-1.6</td>
<td>1.5-1.7</td>
<td>1.6-1.8</td>
<td>1.6-1.8</td>
</tr>
<tr>
<td>Functionality</td>
<td></td>
<td>~2</td>
<td>~2</td>
<td>~2</td>
<td>~2</td>
<td>~2</td>
</tr>
<tr>
<td>Alkalinity number</td>
<td>meqKOH/30kg</td>
<td>-2.0 to +2.0</td>
<td>-2.0 to +2.0</td>
<td>-2.0 to +2.0</td>
<td>-2.0 to +2.0</td>
<td>-2.0 to +2.0</td>
</tr>
<tr>
<td>Color</td>
<td>APHA</td>
<td>50 max</td>
<td>50 max</td>
<td>50 max</td>
<td>50 max</td>
<td>70 max</td>
</tr>
<tr>
<td>Viscosity @ 40 °C</td>
<td>cP</td>
<td>100-150</td>
<td>190-260</td>
<td>310-420</td>
<td>720-850</td>
<td>1190-1460</td>
</tr>
<tr>
<td>Density @ 40 °C</td>
<td>g/cc</td>
<td>1.019</td>
<td>1.018</td>
<td>1.017</td>
<td>1.016</td>
<td>1.016</td>
</tr>
<tr>
<td>Melting point</td>
<td>°C</td>
<td>9-11</td>
<td>12-14</td>
<td>15-17</td>
<td>16-18</td>
<td>17-19</td>
</tr>
</tbody>
</table>

Customized PO3G grades will be also available in the range of 500-2400g/mol
2) Biobased Polypropanediol PO3G

Bio-Based Polyol

PO3G
Polypropanediol
CAS# 31714-45-1

versus

Petro-Based Polyols

PEG
Polyethyleneglycol
CAS# 25322-68-3

PPG
Polypropyleneglycol
CAS# 25322-69-4

PTMEG
Poly-(tetramethylene ether)-glycol
CAS# 25190-06-1
### 2) Biobased Polypropanediol PO3G

<table>
<thead>
<tr>
<th>Properties</th>
<th>PPG</th>
<th>PO3G</th>
<th>PTMEG</th>
<th>NOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td><img src="image" alt="Structure" /></td>
<td><img src="image" alt="Structure" /></td>
<td><img src="image" alt="Structure" /></td>
<td></td>
</tr>
<tr>
<td>Raw material source</td>
<td>Non-renewable</td>
<td>Renewable</td>
<td>Non-renewable</td>
<td>Renewable</td>
</tr>
<tr>
<td>OH-Type</td>
<td>Secondary</td>
<td>Primary</td>
<td>Primary</td>
<td>Secondary</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Physical state</td>
<td>Liquid</td>
<td>Liquid/Solid</td>
<td>Solid</td>
<td>Liquid</td>
</tr>
<tr>
<td>Crystallinity</td>
<td>Amorphous</td>
<td>Semi-crystalline</td>
<td>Semi-crystalline</td>
<td></td>
</tr>
<tr>
<td>Polydispersity</td>
<td>Narrow</td>
<td>Broad</td>
<td>Narrow</td>
<td></td>
</tr>
<tr>
<td>mp</td>
<td>No melt</td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Tg</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Viscosity</td>
<td>Very low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Oxidative stability</td>
<td>Inferior</td>
<td>Superior</td>
<td>Superior</td>
<td>Inferior</td>
</tr>
<tr>
<td>Properties variability</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

NOP = Natural Oil Polyol

* Dupont findings
2) Biobased Polypropanediol PO3G

**Characteristics of PO3G**

- 100% sustainable content
- Environmental friendly and safe
- Low toxic, Low volatile, biodegradable
- Molecular weight ranging between 500 – 2,400 g/mol
- Clear Liquids with low melting points [9-19 °C], low viscosities [100-1,500 cp]
- Easy to handle, to process and to transport
- High boiling point [>300 °C],
- Low freezing point [down to -50 °C in presence of additives]
- Hydrolysis resistant, High oxidative stability
- Water-soluble/insoluble depending on the mw
2) Biobased Polypropanediol PO3G

**PO3G Polyols offer unique added values**

- Linear polyether glycols with odd number of carbons [C3]
- Chemically similar to PTMEG [C4]
- Highly flexible molecules compared to PTMEG
- Good processibility (low mp, low viscosity, slow crystallization rates with a distinctly visible glass transition temperature)
- Crystallization rate is less influenced by the Mw than of PTMEG
- Higher Mw PO3G can be used without losing elasticity
- Pumpable liquids [9-19 °C] versus PTMEG [23-28 °C] (energy savings)
- More resistant against acid and heat compared to PTMEG
- Exhibits excellent thermo-oxidative stability comparable to PTMEG
- Offers long durability in end use applications
- Increases the content of bio-based materials in the end products [more than 80% in elastomers]
2) Biobased Polypropanediol PO3G

PO3G crystallize at much slower rates than PTMEG

- Distinctly visible glass transition temperature (high flexibilty)
- Cold crystallization temperature (Tcc), but no recrystallization from melt
- Low melt temperature and low melt enthalpy

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
2) Biobased Polypropanediol PO3G

**PO3G Polyols offer unique added values**

- Linear polyether glycols with odd number of carbons [C3]
- Chemically similar to PTMEG [C4]
- Highly flexible molecules compared to PTMEG
- Good processibility (low mp, low viscosity, slow crystallization rates with a distinctly visible glass transition temperature)
- Crystallization rate is less influenced by the Mw than of PTMEG
- Higher Mw PO3G can be used without losing elasticity
- Pumpable liquids [9-19 °C] versus PTMEG [23-28 °C] (energy savings)
- More resistant against acid and heat compared to PTMEG
- Exhibits excellent thermo-oxidative stability comparable to PTMEG
- Offers long durability in end use applications
- Increases the content of bio-based materials in the end products [more than 80% in elastomers]
2) Biobased Polypropanediol PO3G

The crystallization rate is less influenced by the MW than of PTMEG

- Higher MW PO3G can be used without losing elasticity

<table>
<thead>
<tr>
<th>Polyol</th>
<th>Number average of MW</th>
<th>Trc/Tcc [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTMEG</td>
<td>650</td>
<td>-5.0</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>1400</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>5.9</td>
</tr>
<tr>
<td>PO3G</td>
<td>650</td>
<td>-38.2</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>-37.8</td>
</tr>
<tr>
<td></td>
<td>1400</td>
<td>-37.7</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>-37.5</td>
</tr>
</tbody>
</table>

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
2) Biobased Polypropanediol PO3G

**PO3G Polyols offer unique added values**

- Linear polyether glycols with odd number of carbons [C3]
- Chemically similar to PTMEG [C4]
- Highly flexible molecules compared to PTMEG
- Good processibility (low mp, low viscosity, slow crystallization rates with a distinctly visible glass transition temperature)
- Crystallization rate is less influenced by the Mw than of PTMEG
- Higher Mw PO3G can be used without losing elasticity
- Pumpable liquids [9-19 °C] versus PTMEG [23-28 °C] (energy savings)
- More resistant against acid and heat compared to PTMEG
- Exhibits excellent thermo-oxidative stability comparable to PTMEG
- Offers long durability in end use applications
- Increases the content of bio-based materials in the end products [more than 80% in elastomers]
2) Biobased Polypropanediol PO3G

**PO3G remains a pumpable liquid at lower temperature than PTMEG**

- Energy can be saved from handling PO3G at 15-20°C lower temperature than PTMEG

<table>
<thead>
<tr>
<th>Temperature [°C]</th>
<th>Viscosity [cp]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO3G H1400</td>
</tr>
<tr>
<td>40</td>
<td>420</td>
</tr>
<tr>
<td>60</td>
<td>185</td>
</tr>
<tr>
<td>80</td>
<td>105</td>
</tr>
</tbody>
</table>

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
2) Biobased Polypropanediol PO3G

**PO3G Polyols offer unique added values**

- Linear polyether glycols with odd number of carbons [C3]
- Chemically similar to PTMEG [C4]
- Highly flexible molecules compared to PTMEG
- Good processibility (low mp, low viscosity, slow crystallization rates with a distinctly visible glass transition temperature)
- Crystallization rate is less influenced by the Mw than of PTMEG
- Higher Mw PO3G can be used without losing elasticity
- Pumpable liquids [9-19 °C] versus PTMEG [23-28 °C] (energy savings)
- More resistant against acid and heat compared to PTMEG
- Exhibits excellent thermo-oxidative stability comparable to PTMEG
- Offers long durability in end use applications
- Increases the content of bio-based materials in the end products [more than 80% in elastomers]
2) Biobased Polypropanediol PO3G

PO3G has much more stable end groups than PTMEG

### Resistance to Heat

<table>
<thead>
<tr>
<th>Polyol</th>
<th>Decomposition %</th>
<th>Activation Energy kJ/mole</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTMEG 1400</td>
<td>0.5</td>
<td>70.9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>69.2</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>73.4</td>
</tr>
<tr>
<td>PO3G H1400</td>
<td>0.5</td>
<td>93.8</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>85.5</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>92.1</td>
</tr>
</tbody>
</table>

<sup>a</sup> Reported activation energy for PTMEG is 62 kJ/mol (J. Appl. Polym. Sci. 77, 1538-1544, 2000)

Activation energy is higher by 20 kJ/mole (Thermal decomposition by TGA)

### Resistance to Acid

A mixture of 500 g of polyol and 5 wt% H<sub>2</sub>SO<sub>4</sub> heated for 4 h at 120 °C

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
2) Biobased Polypropanediol PO3G

**PO3G Polyols offer unique added values**

- Linear polyether glycols with odd number of carbons [C3]
- Chemically similar to PTMEG [C4]
- Highly flexible molecules compared to PTMEG
- Good processibility (low mp, low viscosity, slow crystallization rates with a distinctly visible glass transition temperature)
- Crystallization rate is less influenced by the Mw than of PTMEG
- Higher Mw PO3G can be used without losing elasticity
- Pumpable liquids [9-19 °C] versus PTMEG [23-28 °C ] (energy savings)
- More resistant against acid and heat compared to PTMEG
- Exhibits excellent thermo-oxidative stability comparable to PTMEG
- Offers long durability in end use applications
- Increases the content of bio-based materials in the end products [more than 80% in elastomers]
2) Biobased Polypropanediol PO3G

PO3G exhibit excellent thermo-oxidative stability (comparable to PTMEG)

- When applied as a surface coating, PO3G has virtually no loss of mass due to evaporation until the temperatures approach its bp

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
2) Biobased Polypropanediol PO3G

**PO3G Polyols offer unique added values**

- Linear polyether glycols with odd number of carbons [C3]
- Chemically similar to PTMEG [C4]
- Highly flexible molecules compared to PTMEG
- Good processibility (low mp, low viscosity, slow crystallization rates with a distinctly visible glass transition temperature)
- Crystallization rate is less influenced by the Mw than of PTMEG
- Higher Mw PO3G can be used without losing elasticity
- Pumpable liquids [9-19 °C] versus PTMEG [23-28 °C ] (energy savings)
- More resistant against acid and heat compared to PTMEG
- Exhibits excellent thermo-oxidative stability comparable to PTMEG
- Offers long durability in end use applications
- Increases the content of bio-based materials in the end products [more than 80% in elastomers]
2) Biobased Polypropyleneol PO3G

PO3G Polyols offer unique added values

- Corn-derived PO3G can replace petroleum-based ingredients or finished products without compromising functionality
- In most applications a drop-in replacement is possible so that existing processes, manufacturing systems and equipment might require little or no alteration or retrofitting
- Unique characteristics including good chemical resistance, high mechanical strength and toughness as well as increased softness and elastic recovery
- Enhanced Performance:
  - Automotive coatings – Improved chip resistance and flexibility
  - Thermoplastic elastomers – Improved mechanical strength and toughness
  - Stretch fibers (Spandex) - Improved elongation & stretch recovery
  - Personal care – emollient, dispersant, lubricant, moisturizer, stabilizer
  - Functional heat transfer fluid (radiator coolant) - Thermal conductivity
Overview

1) WeylChem Group of Companies
2) Biobased Polypropanediol PO3G
3) PO3G – Markets, Applications, Benefits
3) PO3G – Markets, Applications, Benefits

- **Functional Fluids**
- **Plasticizer**
- **Inkjet Inks**
- **Automotive Coatings**
- **PO3G**
- **Personal Care**
- **Adhesives & Sealants**
- **Thermoplastic Elastomers**
- **Flexible Fibers**
- **Specialty Polymers**

We live know-how.
3) PO3G – Markets, Applications, Benefits

**Performance coatings and inks (auto refinish, ink jet inks)**

PO3G can be used as ingredient or additive for automotive refinish and industrial metal coatings, as well as for PU dispersions replacing petroleum-based polyols

**Benefits:**

- Suitable for all various kinds of coating layers (top coat, primer, base coat, clear coat, color coat)
- Improved coating flexibility with retaining hardness at the same time (minimize film cracking when exposed to mechanical forces)
- Increased damage resistance to chips and gravels (up to 50% better)
- Improved adhesion to certain substrates, e.g. epoxy primer and metal (adhesion promoter)
- Improved adhesion with remarkable shorter drying time for VOC formulations
- Improved DOI (distinctness of image)
- Improved high gloss of colored topcoat or low gloss (desired for signs, billboards)
As an additive, PO3G provide various benefits to coatings

- PO3G based primers improve chip and flake resistance

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
3) PO3G – Markets, Applications, Benefits

Performance **coatings** and **inks** (*auto refinish, ink jet inks*)

PO3G can be used as ingredient or additive for automotive refinish and industrial metal coatings, as well as for PU dispersions replacing petroleum-based polyols

**Benefits:**

- Suitable for all various kinds of coating layers (top coat, primer, base coat, clear coat, color coat)
- Improved coating flexibility with retaining hardness at the same time (minimize film cracking when exposed to mechanical forces)
- Increased damage resistance to chips and gravels (up to 50% better)
- Improved adhesion to certain substrates, e.g. epoxy primer and metal (adhesion promoter)
- Improved adhesion with remarkable shorter drying time for VOC formulations
- Improved DOI (distinctness of image)
- Improved high gloss of colored topcoat or low gloss (desired for signs, billboards)
3) PO3G – Markets, Applications, Benefits

As an additive, PO3G provide various benefits to **coatings**

- decreased coating drying times

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
3) PO3G – Markets, Applications, Benefits

**Performance coatings and inks (auto refinish, ink jet inks)**

PO3G can be used as ingredient or additive for automotive refinish and industrial metal coatings, as well as for PU dispersions replacing petroleum-based polyols

**Benefits:**

- Suitable for all various kinds of coating layers (top coat, primer, base coat, clear coat, color coat)
- Improved coating flexibility with retaining hardness at the same time (minimize film cracking when exposed to mechanical forces)
- Increased damage resistance to chips and gravels (up to 50% better)
- Improved adhesion to certain substrates, e.g. epoxy primer and metal (adhesion promoter)
- Improved adhesion with remarkable shorter drying time for VOC formulations
- Improved DOI (distinctness of image)
- Improved high gloss of colored topcoat or low gloss (desired for signs, billboards)
3) PO3G – Markets, Applications, Benefits

Speciality Polymers (COPA, COPE, PU)

Benefits:
- Multifunctional - increased softness, flexibility, toughness, elastic recovery, reduced stiffening at low temperatures, low hysteresis and stress decay
- Easier to process and more stable compared to PEG, PTMEG
- H2000, H2400 are ideal soft segments for block copolymers
- The replacement of PTMEG by PO3G as a soft segment does not impact aging despite the increased number of ether linkages
3) PO3G – Markets, Applications, Benefits

Speciality Polymers (COPA, COPE, PU)

- The replacement of PTMEG by PO3G as a soft segment does not impact aging despite the increased number of ether linkages

* Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC
3) PO3G – Markets, Applications, Benefits

PO3G provide various benefits to Cast PU

- new grades of softer, more elastic and tougher CPUs
- new grades of high and low hardness CPUs
- CPUs with superior low temperature performance
- Excellent reactivity and miscibility
- Better homogeneity in one-pot systems (1,4-Butanediol has higher solubility in PO3G compared to PTMEG)
- H650 can replace 1,4-Butanediol as hard segment
- PO3G based prepolymerms are easier to process, both at low and high Mw, compared to PTMEG based prepolymerms (low viscosity, low mp, slow cryst., well control of exothermic heat, reduction of side reactions)
- PO3G allow initiating prepolymer reactions at lower temperatures
- PO3G enable an unique combination of high tensile strength and unusually high elongation
3) PO3G – Markets, Applications, Benefits

**PO3G provide various benefits to Cast PU**

- 1,4-Butanediol has higher solubility in PO3G compared to PTMEG

*Dupont findings: The 12th Annual Green Chemistry and Engineering Conference, June 24-26 2008, Washington DC*
3) PO3G – Markets, Applications, Benefits

PO3G provide various benefits to Cast PU

- new grades of softer, more elastic and tougher CPUs
- new grades of high and low hardness CPUs
- CPUs with superior low temperature performance
- Excellent reactivity and miscibility
- Better homogeneity in one-pot systems (1,4-Butanediol has higher solubility in PO3G compared to PTMEG)
- H650 can replace 1,4-Butanediol as hard segment
- PO3G based prepolymermers are easier to process, both at low and high Mw, compared to PTMEG based prepolymermers (low viscosity, low mp, slow crystallization, well control of exothermic heat, reduction of side reactions)
- PO3G allow initiating prepolymer reactions at lower temperatures
- PO3G enable an unique combination of high tensile strength and unusually high elongation
3) PO3G – Markets, Applications, Benefits

**PO3G provide various benefits to TPE Elastomers**

- Increased bio-content (more than 80%)
- New grades of softer elastomers with improved elasticity and toughness
- H2000 and H2400 are ideal soft segments for thermoplastic elastomers
- Easy processability (low viscosity, slow crystallization rates)
- Superior low temperature performance
3) PO3G – Markets, Applications, Benefits

**Personal Care**

PO3G can be used as less toxic, non-skin-irritating and odorless additives or base fluids for hand and skin care formulations providing enhanced sensorial properties. Low PO3G grades (≤H650) are also well suited to extract flavors and fragrances from plant materials.

**Benefits:**

- 100% renewable-sourced
- Petroleum and silicon free
- Non skin irritant
- Multifunctional - viscosity building, moisturizing, lubricity and stabilizing effects
- Simplified formulations, reducing the use of chemical additives
- H650 is medium water soluble - useful for spreading, dispersion and solubilization (broad solvency for essential oils)
- H1000-2400 are not water soluble – useful for W/O emulsions
3) PO3G – Markets, Applications, Benefits

**Personal Care**

**Benefits:**
- Solubility promoter
- Viscosity promoter
- Increase the stability of the formulations (stable for at least 3 months under harsh conditions: +50 °C, freeze/thaw-cycle -18 °C)
- H650 and H1000 significantly increase skin hydration after a single application
- H650 and H1000 have an 8 hours moisturizing effect
- Blends of various polyol grades is useful to get the desired solubility
### 3) PO3G – Markets, Applications, Benefits

#### Personal Care

<table>
<thead>
<tr>
<th>Application</th>
<th>PO3G Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-based systems</td>
<td>H500, H650</td>
</tr>
<tr>
<td>Solvent-based systems</td>
<td>H650 - H2400</td>
</tr>
<tr>
<td>Humectant/Moisturizer</td>
<td>H500, H650</td>
</tr>
<tr>
<td>Emollient</td>
<td>H650 - 2400</td>
</tr>
<tr>
<td>Dispersant</td>
<td>H500, H650</td>
</tr>
<tr>
<td>Essential oil solvent/extractant</td>
<td>H500, H650</td>
</tr>
<tr>
<td>Lubricant</td>
<td>H500 - 2400</td>
</tr>
<tr>
<td>O/W emulsion</td>
<td>H500, H650</td>
</tr>
<tr>
<td>W/O emulsion</td>
<td>H1000 - H2400</td>
</tr>
<tr>
<td>Gelation/thickening</td>
<td>H650</td>
</tr>
</tbody>
</table>
3) PO3G – Markets, Applications, Benefits

Personal Care

Health and Environmental Data

Health:

- PO3G has low potential for skin irritation and sensitization (Patch test) as well as eye irritation
- PO3G is not mutagenic in bacteria (Ames test)

Environment:

- PO3G is low in acute aquatic toxicity based on studies in fish, invertebrate and algae
- PO3G is not readily biodegradable but will ultimately degrade under certain conditions
IT'S ALWAYS WORTH ASKING!

Thank you for your attention

peter.talbiersky@weylchem.com