1. Advantage of Kuraray’s polyols
   - Low Viscosity
   - Special Foam
   - Soft TPU, Spandex
   - Heat Resistance
   - Confection Molding
   - Hydrolysis Resistance
   - Softness
   - Automotive Interior

2. Kuraray Polyols: all based on MPD*

3. 3-Methyl-1,5-Pentanediol (MPD)
   Unique diol for unique properties
   - Symmetric structure (odd carbon number in a chain)
   - Less hydrolysis
   - Good transparency
   - Less crystallization / Less aggregation
   - Better adhesion

4. Kuraray polyols solve problems

5. Major Application of Kuraray polyols
   - Polyurethane resin for:
     - Printing Ink
     - Paint
     - Adhesive
     - Shoe sole
     - TPU
     - Synthetic leather
     - Polyurethane fiber (spandex)

6. Case Study 1: Printing Ink
   - Gravure ink for food package
   - Solubility
     - [dissolved in wide-range solvents]
     - [transparency: keeping colors bright]
     - Low viscosity: easy for handling
     - UV resistance: [UV light for optimization]

7. Solubility of the polyols in solvents

8. Viscosity of polyols
   - Chart showing viscosity vs. temperature
   - MPD: 3-Methyl-1,5-Pentanediol
   - P-2000: MPD polyester
   - C-2000: MPD/HD carbonate
   - P-2000: MPD carbonate
   - C-2000: MPD/HD carbonate
   - P-2000: MPD/HD carbonate

9. Liquid at low temperature
   - P-2000: MPD adipate
   - C-2000: MPD/HD carbonate

Kuraray Co., Ltd.
Viscosity of Pre-polymer

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Temperature/℃</th>
<th>50</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuraray polyester</td>
<td>10-12</td>
<td>10</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>RBA-2000:TDI = 1/2</td>
<td>Solid</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCU-2000:TDI = 1/2</td>
<td>Solid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For your solvent free pre-polymer

Case study 2 : TPU

<Thermoplastic polyurethane>
Softness
[Soft polyurethane without plasticizer]
Heat resistance: [suitable for car interior]
Transparency: [keeping your products clear]
Abrasion resistance: [good for sportswear]
Low temperature property: [Tg is very low]

Stress-Strain Curve (Polyester polyol)

Elongation Set

<Shoe sole for protective footwear>
Water resistance
[Superior to other polyester polyols]
Softness [ Shock absorbing]
Abrasion resistance [better durability]
Chemical resistance [applicable for industrial use]

Stress-Strain Curve (Polycarbonate polyol)

Adhesion property

Elongation with less tension

Better morphological stability

suitable for co-injection molding (double mold)

Test method: 180 degrees peeling test
Shore A hardness of each TPU 90
Sample preparation: insert molding (laminate structure)
Hydrolysis resistance (polyester polyol)

- Poly(M/W=2000)/MDI/BD = 1/5/4 (molar ratio)
- Kept in water at 70°C, 9% of weight

Hydrolysis resistance (polycarbonate polyol)

- Poly(M/W=2000)/MDI/BD = 1/3/2 (molar ratio)
- Kept in water at 100°C

Acid resistance

<Car seat, Furniture>
- Well balance of softness and toughness
- Is a product with reliability
- Softness (luxurious texture)
- Heat resistance [suitable for car interior]
- Cold resistance [keeping softness in winter]
- Water resistance (easy care)

Case study 4: Synthetic leather

- Polyc (M/W=2000)/MDI/BD = 1/3/2 (molar ratio)
- Kept into 5% H2SO4 aq at 60°C

Water absorption

- Poly(M/W=2000)/MDI/BD = 1/3/2 (molar ratio)
- Kept in water for 4 days
- Sheet of 10×20×1 mm

Alkali resistance

- Poly(M/W=2000)/MDI/BD = 1/3/2 (molar ratio)
- Kept into 5% NaOH aq at 60°C

Abrasion resistance (Taber method)

- Polyc/MDI/BD = 1/3/2 (molar ratio)
- Disk of 120 mm diameter and 2mm thickness
- 9.8N load, 6rpm, 1000 cycles (abrading wheels H-22)
Flexural fatigue strength

Flex cycles until crack length grows 0.5 — 1 mm

<table>
<thead>
<tr>
<th>Polyol</th>
<th>Flex Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-2000</td>
<td>&gt;100,000</td>
</tr>
<tr>
<td>PHC-2000</td>
<td>&lt; 6,000</td>
</tr>
</tbody>
</table>

Polyol/MH=2000/MOH/BD=1/3/2 (molar ratio)
Flex cycle: 300 times per minute

High tolerance against flex fatigue

Recommended Grade

Water Resistance
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD/IPD carbonate)
- P-2050 (MFD IPD carbonate)

Acid Resistance
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD/IPD carbonate)
- P-2050 (MFD IPD carbonate)

Alkali Resistance
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD/IPD carbonate)
- P-2050 (MFD IPD carbonate)

Oleic acid Resistance
- P-2020 (MFD terphthalate)
- P-2050 (MFD sebacate)
- P-2010 (MFD adipate/terphthalate)

Low Viscosity
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD terphthalate)
- P-2010 (MFD adipate)

Abrasion Resistance
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD IPD carbonate)
- P-2010 (MFD adipate)

Compare to other polyols

- P-2010 (MFD adipate)
- P-2050 (MFD sebacate)
- P-2010 (MFD adipate)
- P-1050 (MFD adipate)

Softness, toughness
- F-2010 (TDI/MFD adipate)
- P-2010 (MFD adipate/terphthalate)
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD terphthalate)

Adhesiveness
- P-2010 (MFD adipate)
- P-2010 (MFD adipate/terphthalate)
- C-2000 (MFD/HD carbonate)
- P-2020 (MFD terphthalate)
### Product List

<table>
<thead>
<tr>
<th>CAS Nr.</th>
<th>M.W.</th>
<th>Functional Number</th>
<th>Appearance</th>
<th>Viscosity (cP) at 25°C</th>
<th>Melting point (°C)</th>
<th>NET volume (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4457-71-6</td>
<td>118</td>
<td>2</td>
<td>Liquid</td>
<td>173</td>
<td>&lt;50</td>
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<tr>
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<td>160</td>
<td>2</td>
<td>White Solid</td>
<td>33</td>
<td>46</td>
<td>175</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>CAS Nr.</th>
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<th>Melting point (°C)</th>
<th>NET volume (%)</th>
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</thead>
<tbody>
<tr>
<td>26751-34-3</td>
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<td>Liquid</td>
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<td>26751-34-3</td>
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<td>68,000</td>
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</tbody>
</table>

**<Polyester Polyols>**

- Kuraray Polyester P-350
- Kuraray Polyester P-1010
- Kuraray Polyester P-2020
- Kuraray Polyester P-3030
- Kuraray Polyester P-4020
- Kuraray Polyester P-5030
- Kuraray Polyester P-6030

**<Polyols>**

- MDI (Methyl Isocyanate)
- TDI (Toluene Diisocyanate)
- IPDI (Isophorone Diisocyanate)
- HDI (Hexamethylene Diisocyanate)
- HDI-30 (Hexamethylene Diisocyanate 30)
- HDI-40 (Hexamethylene Diisocyanate 40)
- HDI-50 (Hexamethylene Diisocyanate 50)

### Registration

<table>
<thead>
<tr>
<th>EFAH (mg/kg)</th>
<th>TSCA (mg/kg)</th>
<th>RNC (mg/kg)</th>
<th>ECOC (mg/kg)</th>
<th>ECO (mg/kg)</th>
<th>NNL (mg/kg)</th>
<th>EPA (mg/kg)</th>
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<td>MPO</td>
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<tr>
<td>ND</td>
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<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

*1: Registered by Kuraray, Kuraray Europe GmbH is appointed as OR.
*2: Pre-registered by Kuraray Europe GmbH as an importer.
*3: SNF = 0.05 mg/kg.
*4: All monomers are listed on EFSA positive list.

To the best of our knowledge, information contained herein is accurate. It is the sole responsibility of the customer to determine whether the product is appropriate and suitable for customer’s specific use. Specific end use may require approval by appropriate regulatory agencies. All chemicals may present unknown health hazards and should be used with caution. Although certain hazards may be described in this publication, we cannot guarantee that these are the only hazards that exist. Kuraray makes no warranties, express or implied, regarding products on information contained here in. Kuraray disclaims any liability for infringement of any patent by means of customer’s use of any Kuraray products in combination with other materials or in any process.

**Reference**

**Abbreviations**

- MPO: 3-Methyl-1,5-Pentanediol
- ND: 1,6-Nonanediol
- Asb: Adipic Acid
- TPA: Terephthalic Acid
- IPA: Isophthalic Acid
- SA: Salicic Acid
- TIP: Trimethylol Propane
- HD: 1,6-Hexanediol
- BD: 1,4-Butanediol
- EGI: Ethylene Glycol
- DEG: Diethylene Glycol
- PBA: Poly Butanediol Adipate
- PCL: Poly(caprolactone)
- PMA: Poly Hexanediol Adipate
- PHC: Poly Hexanediol Carbonate
- PTMG: Poly Tetramethylene ether Glycol
- MDI: 4,4'-Diphenylmethane Diisocyanate

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**Kuraray Polyurethane Polyl**

Kuraray Co., Ltd.