

# *New Secondary Amine Chain Extenders for Aliphatic Polyurea Materials*



*Mark Posey, Ken Hillman and Howard Klein  
Huntsman - Austin Research Labs*

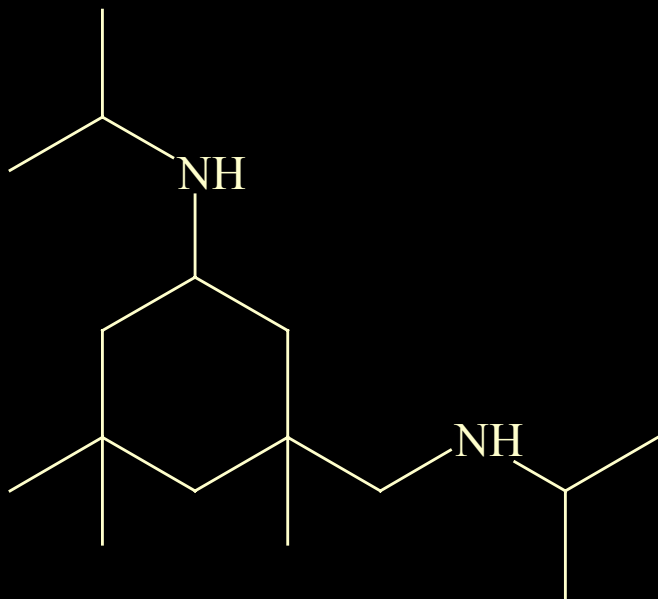
*Polyurea Development Association 2003 Annual Conference  
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# *Objectives of This Presentation*

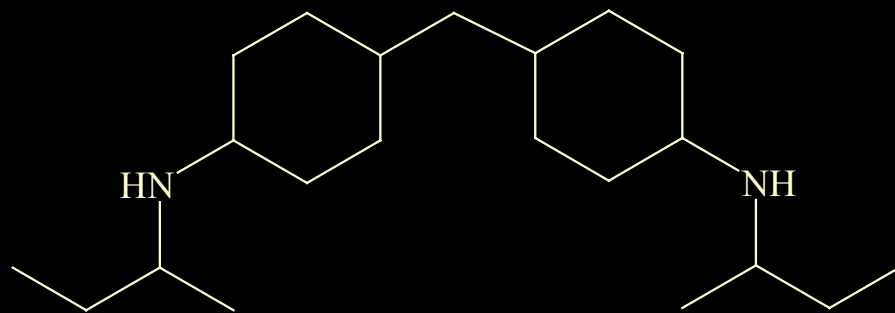


- Introduce JEFFLINK™ 754, Huntsman's cycloaliphatic chain extender.
- Provide formulation assistance to get the most out of the molecule.
- Provide comparisons to CLEARLINK® 1000.
- Demonstrate the conditions at which each product will have superior properties.

# *Molecular Structures*



JEFFLINK™ 754



CLEARLINK® 1000

# *Properties Comparisons*



**JEFFLINK™ 754**

**CLEARLINK® 1000**

|                             |              |                  |
|-----------------------------|--------------|------------------|
| <b>Molecular Weight</b>     | <b>254</b>   | <b>322</b>       |
| <b>Equivalent wt, meq/g</b> | <b>7.87</b>  | <b>6.21</b>      |
| <b>Grams/equivalent</b>     | <b>127</b>   | <b>161</b>       |
| <b>Pvap @ 25°C, mmHg</b>    | <b>0.02</b>  | <b>&lt; 0.02</b> |
| <b>Viscosity @ 25°C, cP</b> | <b>13</b>    | <b>110 @ 16C</b> |
| <b>Density @ 25°C, g/mL</b> | <b>0.855</b> | <b>0.89</b>      |



# *Summary of Chemical Sources*



Chemical

Manufacturer

JEFFAMINE<sup>®</sup> D-2000

HUNTSMAN LLC

JEFFAMINE<sup>®</sup> T-5000

HUNTSMAN LLC

TIOXIDE<sup>®</sup> TiO<sub>2</sub>

HUNTSMAN TIOXIDE

JEFFLINK<sup>™</sup> 754

HUNTSMAN LLC

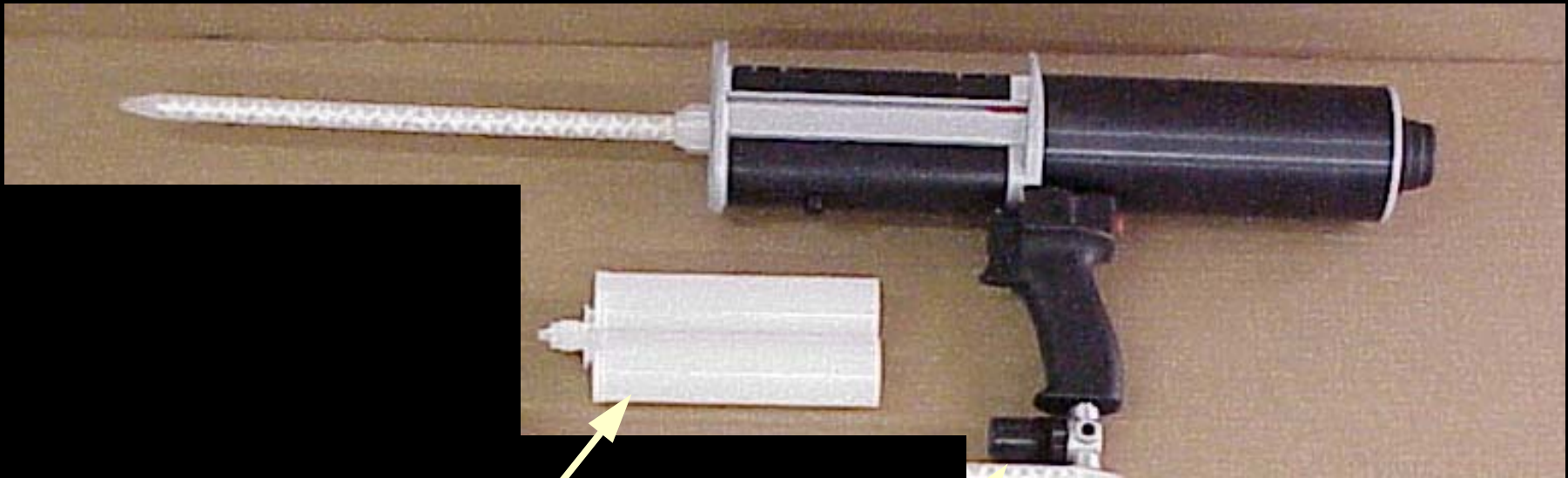
CLEARLINK<sup>®</sup> 1000

UOP

VESTANAT<sup>®</sup> IPDI

CREANOVA

# *Pneumatic Static Mix Equipment*



Dual-Cartridge  
200 mL Each Side

Speed Adjustment

# Comparison of Equal Wt% Formulations

| <u>IPDI/D-2000<br/>Prepolymer</u> | <u>8276-30</u> | <u>8276-48</u> |
|-----------------------------------|----------------|----------------|
| % NCO                             | 16.82          | 14.72          |
| <u>Resin Blend</u>                | Wt%            | Wt%            |
| JEFFAMINE® D-2000                 | 39             | 36.9           |
| JEFFAMINE® T-5000                 | 10             | 8.6            |
| JEFFLINK® 754                     | 44             | 0.0            |
| CLEARLINK® 1000                   | 0              | 47.5           |
| TiO <sub>2</sub>                  | 7              | 7.0            |
| <u>Processing</u>                 |                |                |
| Index                             | 1.06           | 1.062          |
| Iso/Resin Volume Ratio            | 1.0            | 1.0            |
| Iso/Resin Weight Ratio            | 1.036          | 1.021          |

# *Equal Wt% Results (Static-Mix)*

|                        | <u>8276-30</u><br><u>JL754</u> | <u>8276-48</u><br><u>CL1000</u> |
|------------------------|--------------------------------|---------------------------------|
| String Gel Time (sec)  | 35                             | 47                              |
| Tack-Free Time (sec)   | 64                             | 73                              |
| Shore Hardness (0 sec) | 62D                            | 61D                             |
| (10 sec)               | 53D                            | 50D                             |
| Tensile Strength (psi) | 2657                           | 2855                            |
| Elongation (%)         | 819                            | 778                             |
| Modulus (100%) (psi)   | 1229                           | 1159                            |
| Modulus (300%) (psi)   | 1335                           | 1386                            |
| Tear Strength (pli)    | 623                            | 601                             |
| Gloss                  |                                |                                 |
| 20 deg                 | 60                             | 63                              |
| 60 deg                 | 84                             | 84                              |

# 45/55 Static Mixed Formulations

| <u>IPDI/D-2000</u>              | <u>8276-47</u> | <u>8276-48</u> | <u>8276-63-2</u> |
|---------------------------------|----------------|----------------|------------------|
| 45 / 55 wt% Prepolymer<br>% NCO | 14.72          | 14.72          | 14.72            |
| <u>Resin Blend</u>              | Wt%            | Wt%            | Wt%              |
| JEFFAMINE® D-2000               | 48.4           | 36.9           | 50.4             |
| JEFFAMINE® T-5000               | 8.6            | 8.6            | 8.6              |
| JEFFLINK® 754                   | 36.0           | 0.0            | 34.0             |
| CLEARLINK® 1000                 | 0.0            | 47.5           | 0.0              |
| TiO <sub>2</sub>                | 7.0            | 7.0            | 7.0              |
| <b>Processing</b>               |                |                |                  |
| Index                           | 1.062          | 1.062          | 1.104            |
| Iso/Resin Volume Ratio          | 1.0            | 1.0            | 1.0              |
| Iso/Resin Weight Ratio          | 1.021          | 1.021          | 1.018            |

# 45/55 Static Mix Results

|                        | <u>8276-47</u><br><u>JL754</u> | <u>8276-48</u><br><u>CL1000</u> | <u>8276-63-2</u><br><u>JL754</u> |
|------------------------|--------------------------------|---------------------------------|----------------------------------|
| String Gel Time (sec)  | 42                             | 47                              | 32                               |
| Tack-Free Time (sec)   | 67                             | 73                              | 72                               |
| Shore Hardness (0 sec) | 52D                            | 61D                             | 46D                              |
| (10 sec)               | 41D                            | 50D                             | 33D                              |
| Tensile Strength (psi) | 2700                           | 2855                            | 1997                             |
| Elongation (%)         | 1090                           | 778                             | 953                              |
| Modulus (100%) (psi)   | 770                            | 1159                            | 647                              |
| Modulus (300%) (psi)   | 952                            | 1386                            | 837                              |
| Tear Strength (pli)    | 405                            | 601                             | 385                              |
| Coating Density (g/cc) | 1.031                          | 1.045                           | 0.983                            |

# 50/50 Static Mixed Formulations

| <u>IPDI/D-2000</u>              | <u>8276-30</u> | <u>8276-31</u> | <u>8276-66-2</u> |
|---------------------------------|----------------|----------------|------------------|
| 50 / 50 wt% Prepolymer<br>% NCO | 16.82          | 16.82          | 16.82            |
| <u>Resin Blend</u>              | Wt%            | Wt%            | Wt%              |
| JEFFAMINE® D-2000               | 39             | 25             | 42.8             |
| JEFFAMINE® T-5000               | 10             | 10             | 8.6              |
| JEFFLINK® 754                   | 44             | 0              | 41.6             |
| CLEARLINK® 1000                 | 0              | 58             | 0                |
| TiO <sub>2</sub>                | 7              | 7              | 7                |
| <b>Processing</b>               |                |                |                  |
| Index                           | 1.06           | 1.061          | 1.101            |
| Iso/Resin Volume Ratio          | 1.0            | 1              | 1.0              |
| Iso/Resin Weight Ratio          | 1.036          | 1.036          | 1.032            |

# 50/50 Static Mixed Results

|                        | <u>8276-30</u><br><u>JL754</u> | <u>8276-31</u><br><u>CL1000</u> | <u>8276-66-2</u><br><u>JL754</u> |
|------------------------|--------------------------------|---------------------------------|----------------------------------|
| String Gel Time (sec)  | 35                             | 49                              | 36                               |
| Tack-Free Time (sec)   | 64                             | 75                              | 57                               |
| Shore Hardness (0 sec) | 62D                            | 57D                             | 61D                              |
| (10 sec)               | 53D                            | 45D                             | 50D                              |
| Tensile Strength (psi) | 2657                           | Too                             | 2246                             |
| Elongation (%)         | 819                            | Brittle                         | 721                              |
| Modulus (100%) (psi)   | 1229                           | To get                          | 1096                             |
| Modulus (300%) (psi)   | 1335                           | Data                            | 1239                             |
| Tear Strength (pli)    | 623                            | N/A                             | 566                              |
| Coating Density (g/cc) | 1.039                          | 1.02                            | 1.036                            |

# *Spray Proportioning System*



# Comparison of Equal Wt% Formulations

| <u>IPDI/D-2000<br/>Prepolymer</u> | <u>8276-66-1</u> | <u>8276-64-1</u> |
|-----------------------------------|------------------|------------------|
| % NCO                             | 16.82            | 14.72            |
| <u>Resin Blend</u>                | Wt%              | Wt%              |
| JEFFAMINE® D-2000                 | 42.8             | 39.4             |
| JEFFAMINE® T-5000                 | 8.6              | 8.6              |
| JEFFLINK® 754                     | 41.6             | 0                |
| CLEARLINK® 1000                   | 0                | 45               |
| TiO <sub>2</sub>                  | 7                | 7                |
| <u>Processing</u>                 |                  |                  |
| Index                             | 1.101            | 1.101            |
| Iso/Resin Volume Ratio            | 1.0              | 1.0              |
| Iso/Resin Weight Ratio            | 1.032            | 1.018            |

# *Equal Wt% Results (Spray)*

|                        | <u>8276-66-1</u> | <u>8276-64-1</u> |
|------------------------|------------------|------------------|
|                        | <u>JL754</u>     | <u>CL1000</u>    |
| Gel Time (sec)         | 7                | 14               |
| Tack-Free Time (sec)   | 21               | 40               |
| Shore Hardness (0 sec) | 58D              | 51D              |
| (10 sec)               | 46D              | 39D              |
| Tensile Strength (psi) | 2236             | 1593             |
| Elongation (%)         | 834              | 737              |
| Modulus (100%)         | 889              | 757              |
| Modulus (300%)         | 1047             | 915              |
| Tear Strength (pli)    | 440              | 397              |
| Abrasion (mg lost)     | 459              | 497              |
| Gloss 20 deg           | 22.2             | 34.2             |
| 60 deg                 | 62.7             | 70.7             |

# 45/55 Sprayed Formulations

| <u>IPDI/D-2000</u><br><u>Prepolymer</u> | <u>8276-62</u> | <u>8276-61</u> | <u>8276-63-1</u> | <u>8276-64-1</u> |
|---|----------------|----------------|------------------|------------------|
| % NCO                                   | 14.72          | 14.72          | 14.72            | 14.72            |
| <u>Resin Blend</u>                      | Wt%            | Wt%            | Wt%              | Wt%              |
| JEFFAMINE® D-2000                       | 48.4           | 36.9           | 50.4             | 39.4             |
| JEFFAMINE® T-5000                       | 8.6            | 8.6            | 8.6              | 8.6              |
| JEFFLINK® 754                           | 36             | 0              | 34               | 0                |
| CLEARLINK® 1000                         | 0              | 47.5           | 0                | 45               |
| TiO <sub>2</sub>                        | 7              | 7              | 7                | 7                |
| <u>Processing</u>                       |                |                |                  |                  |
| Index                                   | 1.062          | 1.062          | 1.104            | 1.101            |
| Iso/Resin Volume Ratio                  | 1.0            | 1.0            | 1.0              | 1.0              |
| Iso/Resin Weight Ratio                  | 1.021          | 1.021          | 1.018            | 1.018            |

# 45/55 Spray Results

|                        | <u>8276-62</u> | <u>8276-61</u> | <u>8276-63-1</u> | <u>8276-64-1</u> |
|------------------------|----------------|----------------|------------------|------------------|
|                        | <u>JL754</u>   | <u>CL1000</u>  | <u>JL754</u>     | <u>CL1000</u>    |
| Gel Time (sec)         | 10             | 10             | 11               | 14               |
| Tack-Free Time (sec)   | 67             | 40             | 47               | 40               |
| Shore Hardness (0 sec) | 40D            | 51D            | 40D              | 51D              |
| (10 sec)               | 27D            | 39D            | 28D              | 39D              |
| Tensile Strength (psi) | 1186           | 1038           | 2157             | 1593             |
| Elongation (%)         | 815            | 419            | 1074             | 737              |
| Modulus (100%) (psi)   | 518            | 786            | 561              | 757              |
| Modulus (300%) (psi)   | 634            | 879            | 740              | 915              |
| Tear Strength (pli)    | 309            | 349            | 291              | 397              |
| Abrasion (mg lost)     | 476            | 569            | 452              | 497              |
| Gloss 20 deg           | 13.5           | 45.3           | 16.8             | 34.2             |
| 60 deg                 | 44.5           | 79.9           | 54.7             | 70.7             |

# 50/50 Sprayed Formulations

| <u>IPDI/D-2000</u><br><u>Prepolymer</u> | <u>8276-66-1</u> | <u>8276-59</u> | <u>8276-60</u> |
|---|------------------|----------------|----------------|
| % NCO                                   | 16.82            | 16.82          | 16.82          |
| <u>Resin Blend</u>                      | Wt%              | Wt%            | Wt%            |
| JEFFAMINE® D-2000                       | 42.8             | 39             | 25             |
| JEFFAMINE® T-5000                       | 8.6              | 10             | 10             |
| JEFFLINK® 754                           | 41.6             | 44             | 0              |
| CLEARLINK® 1000                         | 0                | 0              | 58             |
| TiO <sub>2</sub>                        | 7                | 7              | 7              |
| <b>Processing</b>                       |                  |                |                |
| Index                                   | 1.101            | 1.06           | 1.061          |
| Iso/Resin Volume Ratio                  | 1.0              | 1.0            | 1.0            |
| Iso/Resin Weight Ratio                  | 1.032            | 1.036          | 1.036          |

# 50/50 Spray Results

|                        | <u>8276-66-1</u><br><u>JL754</u> | <u>8276-59</u><br><u>JL754</u> | <u>8276-60</u><br><u>CL1000</u> |
|------------------------|----------------------------------|--------------------------------|---------------------------------|
| Gel Time (sec)         | 7                                | 5                              | 8                               |
| Tack-Free Time (sec)   | 21                               | 22                             | 27                              |
| Shore Hardness (0 sec) | 58D                              | 55D                            | 65D                             |
| (10 sec)               | 46D                              | 45D                            | 55D                             |
| Tensile Strength (psi) | 2236                             | 2672                           | 2121                            |
| Elongation (%)         | 834                              | 875                            | 493                             |
| Modulus (100%) (psi)   | 889                              | 1003                           | 1434                            |
| Modulus (300%) (psi)   | 1047                             | 1120                           | 1550                            |
| Tear Strength (pli)    | 440                              | 526                            | 530                             |
| Abrasion (mg lost)     | 459                              | 514                            | 331                             |
| Gloss 20 deg           | 22.2                             | 47.0                           | 55.7                            |
| 60 deg                 | 62.7                             | 83.0                           | 85.3                            |

# Conclusions



- JEFFLINK™ 754 is faster reacting than CLEARLINK®1000, but not always significantly so.
- Neither chain extender can claim to be better at all sets of conditions.
- JEFFLINK™ 754 can replace CLEARLINK®1000, but reformulation and testing is necessary.
- When high NCO requires high chain extender content, 754 can provide a more flexible, cost effective coating.
- Clearlink®1000 produces coatings that are harder and less flexible than JEFFLINK™ 754 at equivalent conditions.

# *Why Bother to Reformulate?*



- Ability to work with lower viscosity isocyanates in a cost effective coating. (50/50 IPDI/D-2000)
- The potential to save money or gain additional aliphatic business.
- Expand your portfolio with additional product options.
- Recent events demonstrate the need for more than one Chain Extender supplier.

# *Huntsman Commitment*



- Huntsman developed spray polyurea and remains committed to this market segment.
- Huntsman here for the long term. New plant for JEFFLINK™754 up and running with several large customers already placing orders.
- Huntsman is working hard to bring to market new molecules that will further enhance the formulator's "toolbox".
- These new molecules will open up new opportunities not available with today's technology.