



# *E*astman 425 Plasticizer

For Vinyl Plastisols and  
Vinyl Compounds

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**EASTMAN**

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# Eastman 425 Plasticizer for Vinyl Plastics and Vinyl Compounds

## Introduction

*Eastman 425* plasticizer is a terephthalate, higher-solvating, general-purpose plasticizer for use in flexible PVC (polyvinyl chloride). *Eastman 425* plasticizer is compatible with PVC and PVC/VA copolymer resins. *Eastman 425* allows fusing flexible PVC at lower temperatures or in less time. Typical properties are listed in Table 1.

*Eastman 425* provides excellent low temperature flexibility, resistance to extraction, and low volatility. The performance of 425 is equal to or better than other general-purpose plasticizers. It offers excellent physical properties in both flexible PVC compounds and in plastisols.

*Eastman 425* plasticizer was evaluated along with DOP, 79P (mixed C7 and C9 phthalate), and blends of DINP/DIHP (di-isononyl phthalate/di-isoheptyl phthalate), DINP/BBP (butyl benzyl phthalate), and DIDP (di-isodecyl phthalate)/DIHP plasticizers in flexible PVC formulations.

Table 1

### Typical Properties of *Eastman 425* Plasticizer<sup>a</sup>

#### General

|                                |       |
|--------------------------------|-------|
| Molecular Weight (Theoretical) | 371.5 |
|--------------------------------|-------|

#### Physical

|  |               |
|--|---------------|
| Form                                       | Liquid        |
| Color (Pt-Co Scale), ppm                   | 25            |
| Specific Gravity @ 20°C/20°C               | 1.018         |
| Wt/Vol @ 20°C (68°F)                       |               |
| lb/gal (U.S.)                              | 8.44          |
| kg/L                                       | 1.011         |
| lb/gal (Imperial)                          | 10.13         |
| Boiling Point @ 760 mm, °C (°F)            | >300 (>572)   |
| Pour Point (ASTM D97), °C (°F),            | -42 (-43.6)   |
| Solubility in Water @ 20°C, g/L            | Negligible    |
| Viscosity (ASTM D445), cP, 25°C (77°F)     | 99.2          |
| Flash Point, Setaflash Closed Cup, °C (°F) | 194.2 (407.1) |

#### Electrical

|   |     |
|---|-----|
| Dielectric Constant @ 1 MHz (ASTM D150) | 4.5 |
|---|-----|

<sup>a</sup>Properties are reported for information only. Eastman makes no representation that the material in any particular shipment will conform exactly to the values given.

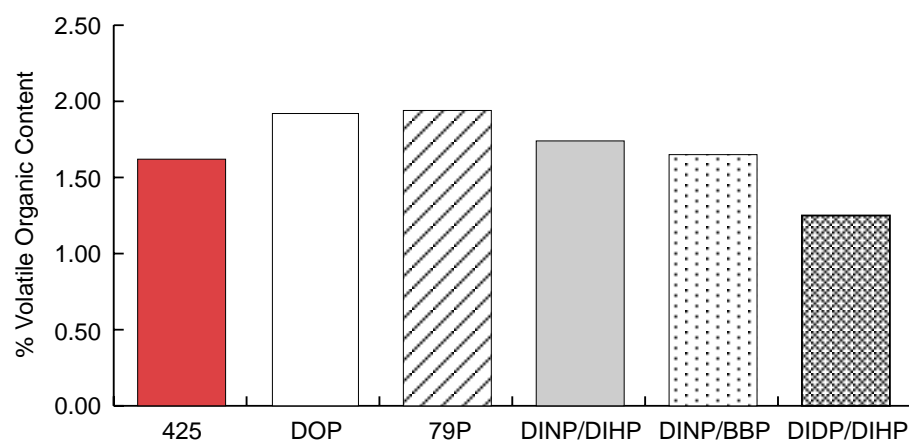
## Plasticizer Volatility

Volatility was determined for each plasticizer and plasticizer blend by heating samples in aluminum weighing pans at 110°C (230°F) for 1 hour.

*Eastman 425* was slightly more volatile than DIDP/DIHP and slightly less volatile than DOP, 79P, and blends of DINP/DIHP and DINP/BBP (see Figure 1).

Figure 1

### Plasticizer Volatility<sup>a</sup>



<sup>a</sup>Heated 1 hour @ 110°C (230°F), ASTM D2369

PVC plastisol formulations were prepared according to the formulas in Table 2. Plastisols were prepared at 40 and 80 phr plasticizer levels.

**Table 2**

**Plastisol Formulations (phr)**

|                 | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> |
|-----------------|----------|----------|----------|----------|----------|----------|
| PVC Resin       | 100      | 100      | 100      | 100      | 100      | 100      |
| Eastman 425     | 40, 80   | —        | —        | —        | —        | —        |
| DOP             | —        | 40, 80   | —        | —        | —        | —        |
| 79P             | —        | —        | 40, 80   | —        | —        | —        |
| DINP            | —        | —        | —        | 28, 56   | 28, 56   | —        |
| DIDP            | —        | —        | —        | —        | —        | 28, 56   |
| BBP             | —        | —        | —        | —        | 12, 24   | —        |
| DIHP            | —        | —        | —        | 12, 24   | —        | 12, 24   |
| Heat Stabilizer | 3        | 3        | 3        | 3        | 3        | 3        |
| ESO             | 3        | 3        | 3        | 3        | 3        | 3        |

### Plastisol Viscosity

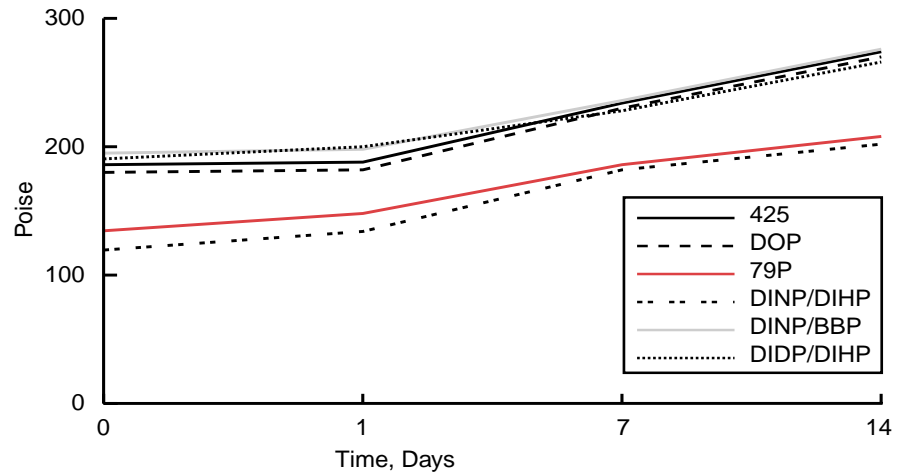
The plastisol formulations in Table 2 were prepared on a low-shear mixer and deaerated. The samples were aged at 23°C (73°F). Brookfield (low-shear) and Severs (high-shear) viscosities were measured.

Brookfield viscosities were measured over a 2-week period (Figures 2 & 3). As shown, 79P and the DINP/DIHP blend imparted slightly lower viscosity than the other general-purpose plasticizers in both the 40 and 80 phr formulations. The viscosities of the other formulations including *Eastman 425* were generally equal.

Figures 4 & 5 show the Severs viscosities of the plastisols. At high shear rates, the 425 plastisol exhibited viscosities very similar to DOP or the DINP/BBP plasticizer blend.

Figure 2

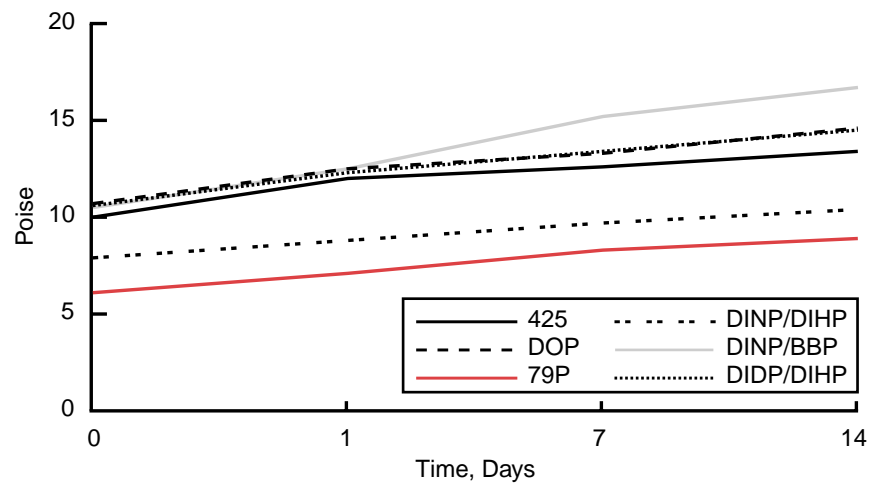
Plastisol Viscosity, Brookfield, 40 phr<sup>a</sup>



<sup>a</sup>23 °C (73 °F), 20 RPM, #6 Spindle, ASTM D1824

Figure 3

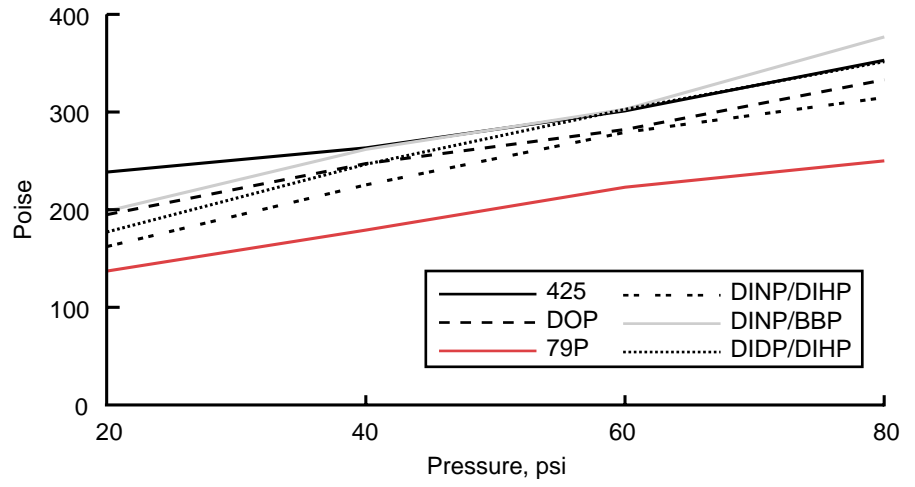
Plastisol Viscosity, Brookfield, 80 phr<sup>a</sup>



<sup>a</sup>23 °C (73 °F), 20 RPM, #6 Spindle, ASTM D1824

Figure 4

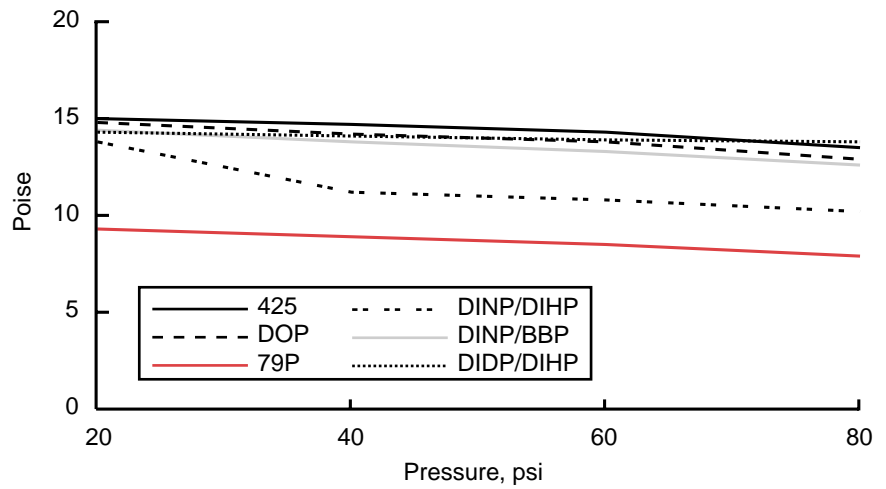
Severs Viscosity, 40 phr<sup>a</sup>



<sup>a</sup>L = 5.00 cm, D = 0.1484 cm, 24-Hours Aging

Figure 5

Severs Viscosity, 80 phr<sup>a</sup>



<sup>a</sup>L = 5.00 cm, D = 0.1484 cm, 24-Hours Aging

## Fusion Properties of Plastisol

Fusion properties were determined on a *Haake* Rheometer using a *Rheomix 600* mixing bowl.

Gel and fusion temperatures are shown in Figures 6 & 7. *Eastman 425* fuses at a lower temperature compared to the other general-purpose plasticizers and plasticizer blends.

Figure 6

Fusion Properties of Plastisols, 40 phr<sup>a</sup>

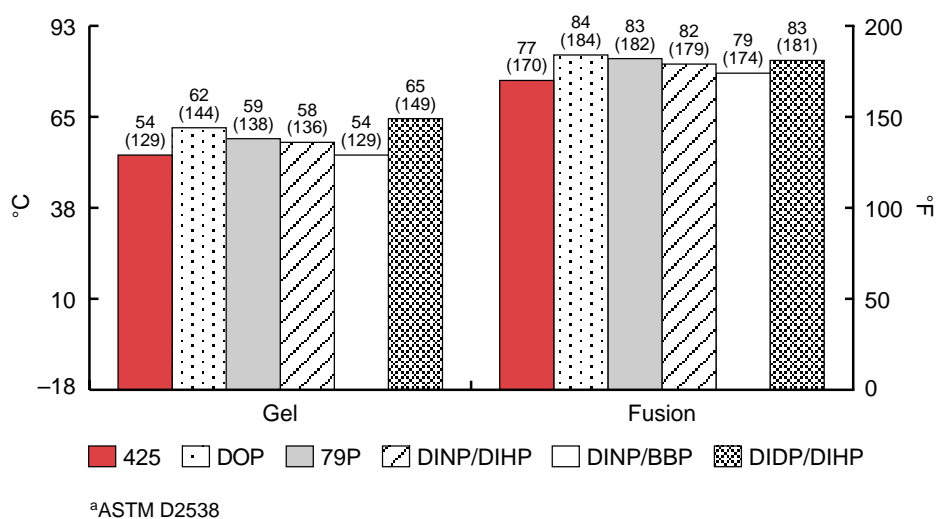
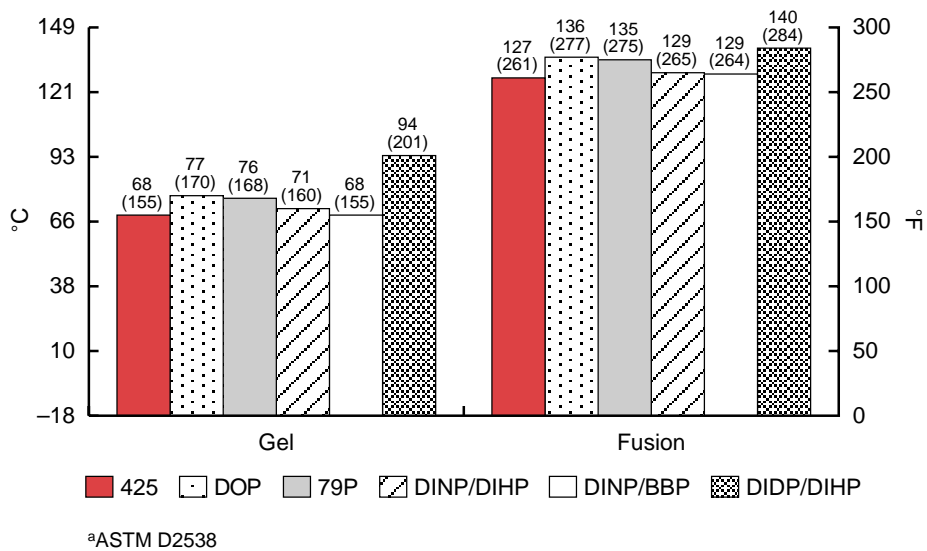


Figure 7

Fusion Properties of Plastisols, 80 phr<sup>a</sup>



## Physical Properties

Plastisol formulations were fused, and samples were used to determine mechanical, permanence, and low-temperature properties. As shown in Table 3, *Eastman* 425 plasticizer imparted comparable mechanical and permanence properties.

Table 3

### Physical Properties of Plasticsols, 40 phr

|  | 425                    | DOP                    | 79P                     | DINP/DIHP               | DINP/BBP                | DIDP/DIHP              |
|--|------------------------|------------------------|-------------------------|-------------------------|-------------------------|------------------------|
| <b>Mechanical Properties</b>                 |                        |                        |                         |                         |                         |                        |
| Shore A Hardness, <sup>a</sup> 10 s          | 85                     | 84                     | 83                      | 86                      | 87                      | 87                     |
| Tensile Strength, <sup>b</sup> mPa (psi)     | 16 (2,321)             | 16 (2,321)             | 15 (2,176)              | 17 (2,466)              | 18 (2,611)              | 12 (1,740)             |
| Elongation, <sup>b</sup> %                   | 178                    | 179                    | 167                     | 177                     | 201                     | 184                    |
| Modulus, <sup>b</sup> MPa (psi)              | 12 (1,740)             | 12 (1,740)             | 12 (1,740)              | 13 (1,885)              | 12 (1,740)              | 13 (1,885)             |
| Tear Strength, <sup>c</sup> N/mm (ppi)       | 50 (286)               | 50 (286)               | 47 (268)                | 61 (348)                | 70 (400)                | 36 (206)               |
| <b>Permanence</b>                            |                        |                        |                         |                         |                         |                        |
| Soapy Water, <sup>d</sup> % Loss             | 2.1                    | 0.9                    | 0.8                     | 0.6                     | 1.0                     | 0.3                    |
| Oil Extraction, <sup>d</sup> % Loss          | 6.2                    | 4.7                    | 7.8                     | 5.0                     | 6.4                     | 6.1                    |
| Hexane Extraction, <sup>d</sup> % Loss       | 17.6                   | 20.5                   | 21.2                    | 18.5                    | 18.4                    | 18.5                   |
| Activated Carbon, <sup>e</sup> %             | 6.3                    | 8.7                    | 6.4                     | 6.5                     | 6.5                     | 6.4                    |
| <b>Low-Temperature Flexibility</b>           |                        |                        |                         |                         |                         |                        |
| Torsion Modulus, <sup>f</sup> °C (°F)        |                        |                        |                         |                         |                         |                        |
| 35,000 psi                                   | -21 (-6)               | -22 (-8)               | -19 (-2)                | -27 (-17)               | -16 (3)                 | -22 (-8)               |
| 135,000 psi                                  | -55 (-67)              | -56 (-69)              | -54 (-65)               | -58 (-72)               | -44 (-47)               | -50 (-58)              |
| Low-Temperature Impact, <sup>g</sup> °C (°F) | -24 (-11)              | -28 (-18)              | -34 (-29)               | -31 (-24)               | -28 (-18)               | -24 (-11)              |
| <sup>a</sup> ASTM D1706                      | <sup>b</sup> ASTM D412 | <sup>c</sup> ASTM D624 | <sup>d</sup> ASTM D1239 | <sup>e</sup> ASTM D1203 | <sup>f</sup> ASTM D1043 | <sup>g</sup> ASTM D746 |

Table 4

## Physical Properties of Plastics, 80 phr

|  | 425       | DOP        | 79P          | DINP/DIHP  | DINP/BBP  | DIDP/DIHP  |
|--|-----------|------------|--------------|------------|-----------|------------|
| <b>Mechanical Properties</b>                 |           |            |              |            |           |            |
| Shore A Hardness, <sup>a</sup> 10 s          | 64        | 63         | 62           | 64         | 64        | 65         |
| Tensile Strength, <sup>b</sup> mPa (psi)     | 8 (1,160) | 6 (870)    | 5 (725)      | 5 (725)    | 7 (1,015) | 5 (725)    |
| Elongation, <sup>b</sup> %                   | 202       | 176        | 135          | 135        | 202       | 124        |
| Modulus, <sup>b</sup> MPa (psi)              | 5 (725)   | 4 (580)    | 4 (580)      | 4 (580)    | 4 (580)   | 5 (725)    |
| Tear Strength, <sup>c</sup> N/mm (ppi)       | 26 (148)  | 24 (137)   | 15 (86)      | 16 (91)    | 24 (137)  | 13 (74)    |
| <b>Permanence</b>                            |           |            |              |            |           |            |
| Soapy Water, <sup>d</sup> % Loss             | 2.4       | 0.8        | 0.6          | 0.6        | 0.9       | 0.4        |
| Oil Extraction, <sup>d</sup> % Loss          | 31.3      | 25.3       | 28.5         | 28.3       | 26.9      | 25.1       |
| Hexane Extraction, <sup>d</sup> % Loss       | 26.2      | 31.9       | 35.0         | 35.1       | 42.3      | 42.4       |
| Activated Carbon, <sup>e</sup> %             | 7.4       | 12.1       | 8.7          | 9.3        | 10.3      | 7.9        |
| <b>Low-Temperature Flexibility</b>           |           |            |              |            |           |            |
| Torsion Modulus, <sup>f</sup> °C (°F)        |           |            |              |            |           |            |
| 35,000 psi                                   | -46 (-51) | -50 (-58)  | -54 (-65)    | -51 (-60)  | -45 (-49) | -47 (-53)  |
| 135,000 psi                                  | -60 (-76) | -74 (-101) | <-77 (<-107) | -75 (-103) | -67 (-89) | -74 (-101) |
| Low-Temperature Impact, <sup>g</sup> °C (°F) | -38 (-36) | -43 (-45)  | -48 (-54)    | -45 (-49)  | -37 (-35) | -38 (-36)  |

<sup>a</sup>ASTM D1706<sup>b</sup>ASTM D412<sup>c</sup>ASTM D624<sup>d</sup>ASTM D1239<sup>e</sup>ASTM D1203<sup>f</sup>ASTM D1043<sup>g</sup>ASTM D746

## PVC Compounds

Dry blends were prepared at 40 and 80 phr plasticizer levels in a high-intensity mixer using the formulations given in Table 5. Fusion properties were determined on a *Haake* Rheometer using a *Rheomix 600* mixing bowl. Gel and fusion temperatures are shown in Figures 8 & 9. *Eastman 425* fuses at a lower temperature compared to the other general-purpose plasticizers and plasticizer blends.

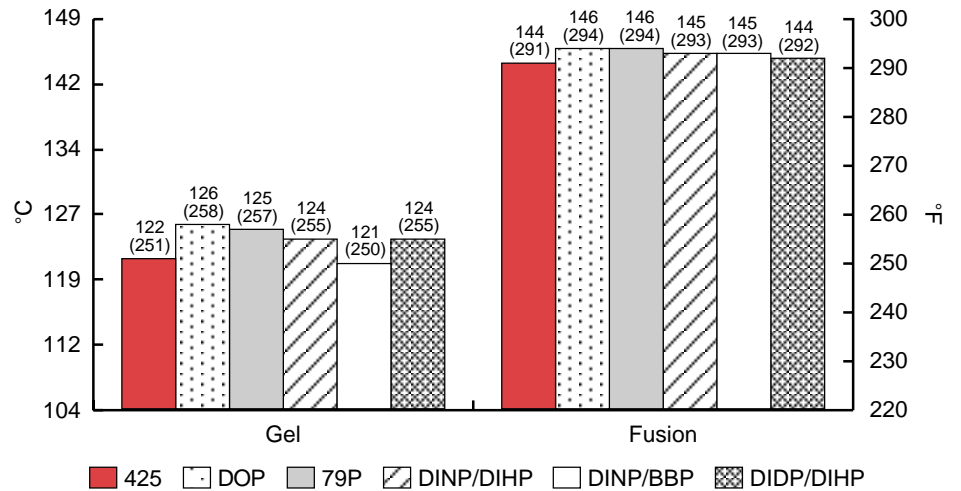
Table 5

Compound Formulations (phr)

|                      | 1      | 2      | 3      | 4      | 5      | 6      |
|----------------------|--------|--------|--------|--------|--------|--------|
| PVC Suspension Resin | 100    | 100    | 100    | 100    | 100    | 100    |
| Eastman 425          | 40, 80 | —      | —      | —      | —      | —      |
| DOP                  | —      | 40, 80 | —      | —      | —      | —      |
| 79P                  | —      | —      | 40, 80 | —      | —      | —      |
| DINP                 | —      | —      | —      | 28, 56 | 28, 56 | —      |
| DIDP                 | —      | —      | —      | —      | —      | 28, 56 |
| BBP                  | —      | —      | —      | —      | 12, 24 | —      |
| DIHP                 | —      | —      | —      | 12, 24 | —      | 12, 24 |
| Heat Stabilizer      | 3      | 3      | 3      | 3      | 3      | 3      |
| ESO                  | 3      | 3      | 3      | 3      | 3      | 3      |

Figure 8

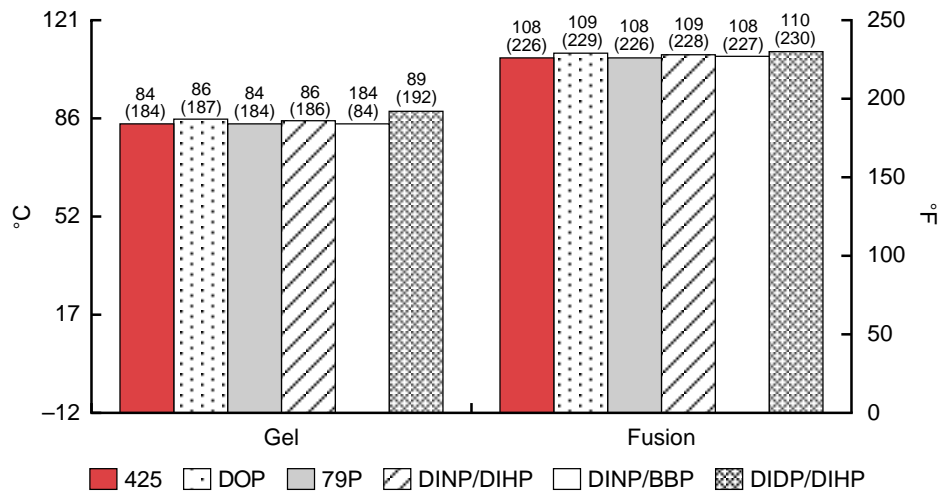
Fusion Properties of Compounds, 40 phr<sup>a</sup>



<sup>a</sup>ASTM D2538

Figure 9

Fusion Properties of Compounds, 80 phr<sup>a</sup>



<sup>a</sup>ASTM D2538

### Physical Properties

After dry blend preparation, samples were fused on a two-roll mill and pressed into 70-mil sheets. A calender was used to prepare 10-mil samples for permanence testing. *Eastman* 425 imparted comparable mechanical and permanence properties to the other general-purpose plasticizers.

Table 6

## Physical Properties of Compounds, 40 phr

|  | 425                    | DOP                    | 79P                     | DINP/DIHP               | DINP/BBP                | DIDP/DIHP              |
|--|------------------------|------------------------|-------------------------|-------------------------|-------------------------|------------------------|
| <b>Mechanical Properties</b>                 |                        |                        |                         |                         |                         |                        |
| Shore A Hardness, <sup>a</sup> 10 s          | 90                     | 87                     | 87                      | 89                      | 90                      | 92                     |
| Tensile Strength, <sup>b</sup> MPa (psi)     | 22 (3,191)             | 20 (2,901)             | 21 (3,046)              | 21 (3,046)              | 21 (3,046)              | 21 (3,046)             |
| Elongation, <sup>b</sup> %                   | 188                    | 191                    | 172                     | 194                     | 224                     | 213                    |
| Modulus, <sup>b</sup> MPa (psi)              | 17 (2,466)             | 18 (2,611)             | 16 (2,321)              | 16 (2,321)              | 16 (2,321)              | 17 (2,466)             |
| Tear Strength, <sup>c</sup> N/mm (ppi)       | 105 (600)              | 97 (554)               | 95 (542)                | 109 (622)               | 113 (645)               | 103 (588)              |
| <b>Permanence</b>                            |                        |                        |                         |                         |                         |                        |
| Soapy Water, <sup>d</sup> % Loss             | 0.9                    | 2.1                    | 0.5                     | 0.8                     | 0.7                     | 0.2                    |
| Oil Extraction, <sup>d</sup> % Loss          | 3.8                    | 12.7                   | 12.6                    | 20.7                    | 17.5                    | 4.6                    |
| Hexane Extraction, <sup>d</sup> % Loss       | 18.5                   | 18.0                   | 27.7                    | 24.4                    | 17.1                    | 16.5                   |
| Activated Carbon, <sup>e</sup> %             | 4.5                    | 7.0                    | 7.3                     | 6.1                     | 5.9                     | 5.0                    |
| <b>Low-Temperature Flexibility</b>           |                        |                        |                         |                         |                         |                        |
| Torsion Modulus, <sup>f</sup> °C (°F)        |                        |                        |                         |                         |                         |                        |
| 35,000 psi                                   | -14 (7)                | -16 (3)                | -22 (-8)                | -17 (1)                 | -13 (9)                 | -15 (5)                |
| 135,000 psi                                  | -46 (-51)              | -49 (-56)              | -50 (-58)               | -45 (-49)               | -42 (-44)               | -46 (-51)              |
| Low-Temperature Impact, <sup>g</sup> °C (°F) | -18 (0)                | -23 (-9)               | -29 (-20)               | -21 (-6)                | -18 (0)                 | -23 (-9)               |
| <sup>a</sup> ASTM D1706                      | <sup>b</sup> ASTM D412 | <sup>c</sup> ASTM D624 | <sup>d</sup> ASTM D1239 | <sup>e</sup> ASTM D1203 | <sup>f</sup> ASTM D1043 | <sup>g</sup> ASTM D746 |

Table 7

## Physical Properties of Compounds, 80 phr

|  | 425                    | DOP                    | 79P                     | DINP/DIHP               | DINP/BBP                | DIDP/DIHP              |
|--|------------------------|------------------------|-------------------------|-------------------------|-------------------------|------------------------|
| <b>Mechanical Properties</b>                 |                        |                        |                         |                         |                         |                        |
| Shore A Hardness, <sup>a</sup> 10 s          | 69                     | 67                     | 65                      | 68                      | 69                      | 70                     |
| Tensile Strength, <sup>b</sup> MPa (psi)     | 13 (1,885)             | 12 (1,740)             | 12 (1,740)              | 12 (1,740)              | 12 (1,740)              | 13 (1,885)             |
| Elongation, <sup>b</sup> %                   | 369                    | 356                    | 406                     | 333                     | 317                     | 362                    |
| Modulus, <sup>b</sup> MPa (psi)              | 5 (725)                | 5 (725)                | 5 (725)                 | 5 (725)                 | 5 (725)                 | 5 (725)                |
| Tear Strength, <sup>c</sup> N/mm (ppi)       | 46 (263)               | 44 (251)               | 41 (234)                | 47 (268)                | 39 (223)                | 42 (240)               |
| <b>Permanence</b>                            |                        |                        |                         |                         |                         |                        |
| Soapy Water, <sup>d</sup> % Loss             | 2.3                    | 1.0                    | 0.3                     | 0.2                     | 0.7                     | 0.5                    |
| Oil Extraction, <sup>d</sup> % Loss          | 27.4                   | 27.6                   | 25.6                    | 21.1                    | 19.4                    | 25.3                   |
| Hexane Extraction, <sup>d</sup> % Loss       | 36.6                   | 40.3                   | 41.2                    | 37.7                    | 30.0                    | 37.3                   |
| Activated Carbon, <sup>e</sup> %             | 5.6                    | 12.0                   | 5.9                     | 6.4                     | 7.6                     | 7.2                    |
| <b>Low-Temperature Flexibility</b>           |                        |                        |                         |                         |                         |                        |
| Torsion Modulus, <sup>f</sup> °C (°F)        |                        |                        |                         |                         |                         |                        |
| 35,000 psi                                   | -42 (-44)              | -46 (-51)              | -53 (-63)               | -43 (-45)               | -42 (-44)               | -44 (-47)              |
| 135,000 psi                                  | -68 (-90)              | -72 (-98)              | -79 (-110)              | -65 (-85)               | -66 (-87)               | -68 (-90)              |
| Low-Temperature Impact, <sup>g</sup> °C (°F) | -40 (-40)              | -42 (-44)              | -49 (-56)               | -42 (-44)               | -41 (-42)               | -41 (-42)              |
| <sup>a</sup> ASTM D1706                      | <sup>b</sup> ASTM D412 | <sup>c</sup> ASTM D624 | <sup>d</sup> ASTM D1239 | <sup>e</sup> ASTM D1203 | <sup>f</sup> ASTM D1043 | <sup>g</sup> ASTM D746 |





■ **NORTH AMERICA**

**Eastman Chemical Company  
Corporate Headquarters**

P.O. Box 431  
Kingsport, TN 37662-5280 U.S.A.

Telephone:  
U.S.A. and Canada, 800-EASTMAN (800-327-8626)  
Other Locations (1) 423-229-2000  
Fax: (1) 423-229-1673  
<http://www.eastman.com>

■ **LATIN AMERICA**

**Eastman Chemical Latin America**

2333 Ponce de Leon Blvd.  
Suite R-20  
Coral Gables, FL 33134 U.S.A.

Telephone: (1) 305-461-8240  
Fax: (1) 305-461-8254

■ **EUROPE / MIDDLE EAST / AFRICA**

**Eastman Chemical B.V.**

Customer Service Center  
Weena 159-161  
3013 CK Rotterdam  
NETHERLANDS

Telephone: (31) 10 2402 111  
Fax: (31) 10 2402 100

■ **ASIA PACIFIC**

**Eastman Chemical Japan Ltd.**

Yebisu Garden Place Tower, 32F  
4-20-3 Ebisu  
Shibuya-ku, Tokyo 150-6032 JAPAN

Telephone: (81) 3-5424-1551  
Fax: (81) 3-5424-1590

**Eastman Chemical Asia Pacific Pte. Ltd.**

#05-04 Winsland House  
3 Killiney Road  
Singapore 239519 SINGAPORE

Telephone: (65) 738-4877  
Fax: (65) 732-4930

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Publication L-230  
November 2001