

## Aerospace Grade Oils and Greases

### Product Information

#### Typical Properties of Krytox™ Aerospace Grade Fluorinated Oils\*

| Property                 | ASTM Test Method | Test Conditions     | Units    | Aerospace Oil Grade  |                      |                      |                      |                       |
|--------------------------|------------------|---------------------|----------|----------------------|----------------------|----------------------|----------------------|-----------------------|
|                          |                  |                     |          | 143AZ                | 143AA                | 143AB                | 143AC                | 143AD                 |
| Average Molecular Weight | NMR              |                     |          | 2060                 | 2210                 | 3800                 | 5940                 | 7480                  |
| Viscosity                | ASTM D445        | -32 °C (-25 °F)     | cSt      | 7480                 | 12,340               | 44,620               | —                    | —                     |
|                          |                  | 0 °C (32 °F)        |          | 228                  | 350                  | 1070                 | 3940                 | 7500                  |
|                          |                  | 20 °C (68 °F)       |          | 60                   | 88                   | 240                  | 800                  | 1540                  |
|                          |                  | 38 °C (100 °F)      |          | 24.7                 | 35                   | 86                   | 270                  | 502                   |
|                          |                  | 40 °C (104 °F)      |          | 22.8                 | 32                   | 78                   | 243                  | 450                   |
|                          |                  | 99 °C (210 °F)      |          | 4.2                  | 5.4                  | 10.5                 | 26                   | 44                    |
|                          |                  | 100 °C (212 °F)     |          | 4.1                  | 5.3                  | 10.2                 | 25.4                 | 42.4                  |
|                          |                  | 204 °C (400 °F)     |          | 1.1                  | 1.3                  | 2.1                  | 4.1                  | 6.0                   |
|                          |                  | 260 °C (500 °F)     |          | —                    | —                    | —                    | 2.4                  | 3.4                   |
| Viscosity Index          | ASTM D2270       |                     |          | 60                   | 96                   | 113                  | 134                  | 146                   |
| Pour Point               | ASTM D97         |                     | °C       | -55                  | -50                  | -40                  | -35                  | -30                   |
|                          |                  |                     | °F       | -70                  | -60                  | -40                  | -30                  | -20                   |
| Distillation Range       | ASTM D1160       | 53 Pa<br>(0.4 torr) | °C       | 140/210              | 170/245              | 215/290              | 260/370              | 300/400+              |
|                          |                  |                     | °F       | 285/410              | 340/475              | 420/555              | 500/700              | 570/750+              |
| Oil Density              |                  | 0 °C (32 °F)        | g/mL     | 1.91                 | 1.92                 | 1.93                 | 1.95                 | 1.95                  |
|                          |                  | 100 °C (212 °F)     |          | 1.72                 | 1.74                 | 1.75                 | 1.77                 | 1.78                  |
| Vapor Pressure           | Knudsen          | 38 °C (100 °F)      | torr     | 4 x 10 <sup>-4</sup> | 1 x 10 <sup>-4</sup> | 5 x 10 <sup>-6</sup> | 8 x 10 <sup>-8</sup> | 6 x 10 <sup>-9</sup>  |
|                          |                  | 260 °C (500 °F)     | torr     | 1.5                  | 0.8                  | 3 x 10 <sup>-2</sup> | 2 x 10 <sup>-3</sup> | 3 x 10 <sup>-3</sup>  |
|                          |                  | 38 °C (100 °F)      | KPa      | 5 x 10 <sup>-5</sup> | 1 x 10 <sup>-5</sup> | 7 x 10 <sup>-7</sup> | 1 x 10 <sup>-8</sup> | 8 x 10 <sup>-10</sup> |
|                          |                  | 260 °C (500 °F)     | KPa      | 0.2                  | 0.1                  | 4 x 10 <sup>-3</sup> | 3 x 10 <sup>-4</sup> | 4 x 10 <sup>-5</sup>  |
| Volatility               | ASTM D2595       | 149 °C (300 °F)     | wt% loss | 18                   | 15                   | 1.9                  | —                    | —                     |
|                          |                  | 204 °C (400 °F)     | in 22 hr | —                    | —                    | 17.3                 | <1                   | —                     |
|                          |                  | 260 °C (500 °F)     |          | —                    | —                    | 76.2                 | 4                    | 2                     |
| Estimated Useful Range   |                  |                     | °C       | -57-149              | -51-177              | -40-232              | -34-288              | -29-316               |
|                          |                  |                     | °F       | -70-300              | -60-350              | -40-450              | -30-550              | -20-600               |

\* This table gives typical properties (not specifications) based on historical production performance. Viscosity may vary within +10%. Chemours does not make any express or implied warranty that these products will continue to have these typical properties.

Figure 1. Viscosity vs. Temperature of Krytox™ Aerospace Grade Fluorinated Oils

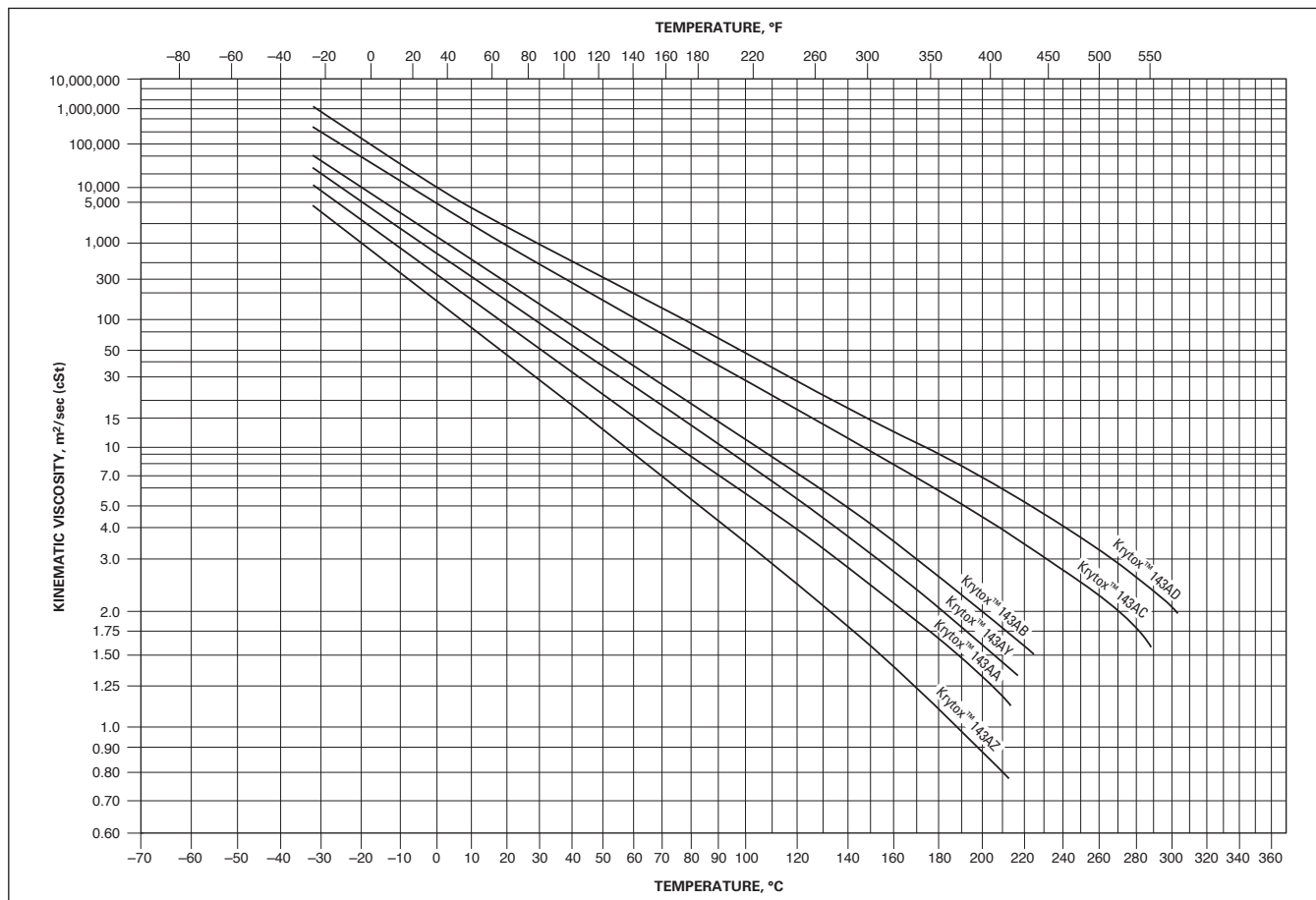
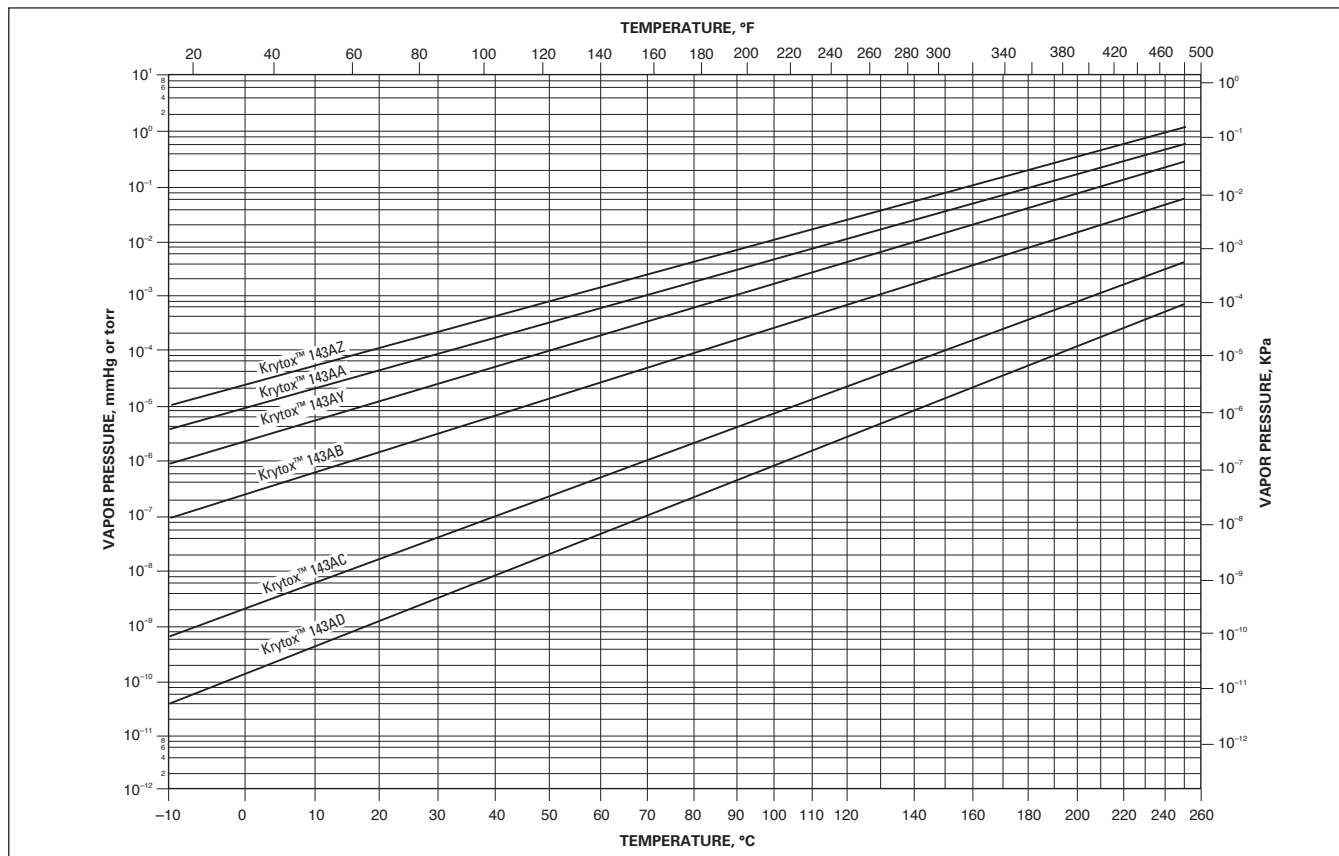


Figure 2. Vapor Pressure vs. Temperature of Krytox™ Aerospace Grade Fluorinated Oils

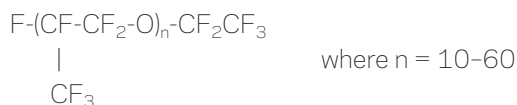


### Typical Properties of Krytox™ Aerospace Grade Fluorinated Greases\*

| Property                   | ASTM Test Method           | Test Conditions            | Units             | Aerospace Grade                                  |                    |                    |                    |                    |
|----------------------------|----------------------------|----------------------------|-------------------|--------------------------------------------------|--------------------|--------------------|--------------------|--------------------|
| Aerospace Grease Grade     |                            |                            |                   | 240AZ (H-1)                                      | 240AA              | 240AB (H-1)        | 240AC (H-1)        | 240AD              |
| Extreme Pressure Grade     |                            |                            |                   | 250AZ                                            | —                  | —                  | 250AC              | 250AD              |
| Rust Inhibited Grade       |                            |                            |                   | —                                                | —                  | 280AB              | 280AC              | —                  |
| Rust Inhibited Grade       |                            |                            |                   | 283AZ                                            | 283AA              | 283AB              | 283AC              | 283AD              |
| Viscosity of Base Oil      | ASTM D445                  | 20 °C (68 °F)              | cSt               | 60                                               | 88                 | 240                | 800                | 1540               |
|                            |                            | 38 °C (100 °F)             |                   | 24.7                                             | 35                 | 86                 | 270                | 502                |
|                            |                            | 99 °C (210 °F)             |                   | 4.2                                              | 5.4                | 10.5               | 26                 | 44                 |
|                            |                            | 204 °C (400 °F)            |                   | 1.08                                             | 1.3                | 2.1                | 4.1                | 6.0                |
| Vapor Pressure of Base Oil | Knudsen                    | 38 °C (100 °F)             | torr              | $4 \times 10^{-4}$                               | $1 \times 10^{-4}$ | $5 \times 10^{-6}$ | $8 \times 10^{-8}$ | $6 \times 10^{-9}$ |
|                            |                            | 260 °C (500 °F)            | torr              | 1.5                                              | 0.8                | $3 \times 10^{-2}$ | $2 \times 10^{-3}$ | $3 \times 10^{-4}$ |
| Volatility of Base Oil     | ASTM D2595                 | 149 °C (300 °F)            | wt% loss in 22 hr | 18                                               | 15                 | 1.9                | —                  | —                  |
|                            |                            | 204 °C (400 °F)            |                   | —                                                | —                  | 17.3               | <1                 | —                  |
|                            |                            | 260 °C (500 °F)            |                   | —                                                | —                  | 76.2               | 4                  | 2                  |
| Pour Point of Base Oil     | ASTM D97                   |                            | °C                | -55                                              | -50                | -40                | -35                | -30                |
|                            |                            |                            | °F                | -70                                              | -60                | -40                | -30                | -20                |
| Texture                    |                            |                            |                   | Buttery                                          |                    |                    |                    |                    |
| Penetration                | ASTM D217                  | 60 Strokes                 |                   | 265–295                                          |                    |                    |                    |                    |
| Mechanical Stability       | ASTM D217                  | 10,000 and 100,000 Strokes |                   | No change from original grade                    |                    |                    |                    |                    |
| Oxidation Stability        | ASTM D942                  | 99 °C (210 °F)             |                   | 0 psig O <sub>2</sub> pressure drop after 600 hr |                    |                    |                    |                    |
| Liquid Oxygen Impact       | ASTM D2512, NASA MSFC 106B |                            |                   | Pass                                             |                    |                    |                    |                    |
| Grease Density             |                            | 25 °C (77 °F)              | g/mL              | 1.89                                             | 1.91               | 1.92               | 1.93               | 1.93               |
| Oil Separation             | ASTM D6184                 | 99 °C (210 °F)             | wt% loss in 30 hr | 6                                                | 5                  | 4                  | 3                  | 3                  |
|                            |                            | 204 °C (400 °F)            |                   | —                                                | 20                 | 12                 | 11                 | 10                 |
| Estimated Useful Range     |                            |                            | °C                | -57–149                                          | -51–177            | -40–232            | -34–288            | -29–316            |
|                            |                            |                            | °F                | -70–300                                          | -60–350            | -40–450            | -30–550            | -20–550+           |

\* This table gives typical properties (not specifications) based on historical production performance. Viscosity may vary within +10%. Chemours does not make any express or implied warranty that these products will continue to have these typical properties.

Krytox™ 143 series oils are clear, colorless, fluorinated synthetic oils that are non-reactive, nonflammable, safe in chemical and oxygen service, and are long-lasting. Krytox™ is a perfluoropolyether (PFPE)—also called perfluoroalkylether (PFAE) or perfluoropolyalkylether (PFPAE)—with the following chemical structure:



The polymer chain is completely saturated and contains only carbon, oxygen, and fluorine. On a weight basis, a typical Krytox™ oil contains 21.6% carbon, 9.4% oxygen, and 69.0% fluorine.

All standard grades of grease are thickened with high efficiency PTFE, whose formula is  $(\text{CF}_2-\text{CF}_2)_n$ . This special high efficiency thickener has a melting point of 325 °C (617 °F), and has low molecular weight and submicron (0.2 µ) particle size for higher performance in bearings.

Krytox™ 240 series greases are white buttery greases with all of the same properties as our 143 series oils that they are made from, but they are in grease form.

Krytox™ 250 series EP greases are black greases that contain molybdenum disulfide added as an extreme pressure additive for highly loaded gears and bearings.

Krytox™ 283 series anticorrosion greases are white greases that contain sodium nitrite. These grades provide rust protection at ambient temperatures, corrosion protection at high temperatures, and antiwear protection.

**Krytox™ 240 AC, 240 AB, and 240 AZ Grade 1 greases now have NSF approval for incidental food contact (H-1) in and around food processing areas. These three products meet the requirements of Mil Spec PRF 27617, Types 1, 2, and 3.**

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