# Fluorinert™ Liquids

## For Electronics Manufacturing

## Product Information

### Introduction

3M™ Fluorinert™ liquids are a family of clear, colorless, odorless, inert perfluorinated fluids having a viscosity similar to water but approximately 75% greater density. These non-flammable liquids have set the standard in the electronics industry for 40 years, meeting the demanding and diverse requirements of many heat transfer, manufacturing and testing applications.

Fluorinert liquids are thermally and chemically stable, compatible with sensitive materials, including metals, plastics and elastomers, and are practically non-toxic.

Fluorinert liquids are completely fluorinated, containing no chlorine or hydrogen atoms. The strength of the carbon-fluorine bond contributes to their extreme stability and inertness. This chemical structure also results in very low intermolecular forces, low surface tension and essentially no solvent action on non-fluorinated compounds.

The dielectric strength of perfluorinated liquids is high—in excess of 35,000 volts across a 0.1 inch gap. Water solubility is on the order of a few parts per million. The nominal boiling point of each fluid in this series is determined during their manufacture. Fluorinert liquids are available with boiling points ranging from 30ºC to 215ºC and pour points as low as -101ºC.

## 3M™ Fluorinert™ Liquids Typical Properties

(Not for Specification Purposes)

All values determined at 25°C unless otherwise specified

| Fluorinert Liquid | FC-87 | FC-72 | FC-84 | FC-77 | FC-104 | FC-75 | FC-3283 | FC-40 | FC-5320 | FC-43 | FC-70 | FC-5312 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average Molecular Weight** | 290 | 340 | 388 | 415 | 435 | 420 | 521 | 650 | 650 | 670 | 820 | 820 |
| **Typical Boiling Point,** °C | 30 | 56 | 80 | 97 | 101 | 102 | 128 | 155 | 160 | 174 | 215 | 215 |
| **Pour Point,** °C | -101 | -90 | -95 | -95 | -65 | -88 | -50 | -57 | -65 | -50 | -25 | -25 |
| **Density,** g/cm$^3$ | 1.63 | 1.68 | 1.73 | 1.78 | 1.77 | 1.77 | 1.82 | 1.87 | 1.87 | 1.88 | 1.94 | 1.93 |
| **Density,** -54°C g/cm$^3$ | 1.84 | 1.90 | 1.93 | 1.97 | 1.96 | 1.96 | □ | □ | □ | □ | □ | □ |
| **Kinematic Viscosity,** cs | 0.4 | 0.4 | 0.55 | 0.8 | 0.8 | 0.8 | 0.75 | 2.2 | 2.2 | 2.8 | 14.0 | 12.6 |
| **Kinematic Viscosity,** -54°C cs | 1.1 | 1.9 | 4.0 | 6.9 | 7.3 | 7.4 | □ | □ | □ | □ | □ | □ |
| **Vapor Pressure,** torr | 610 | 232 | 79 | 42 | 29 | 31 | 11 | 3 | 3 | 1.3 | <0.1 | <0.1 |
| **Specific Heat,** cal/g - °C | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Heat of Vaporization @ Boiling Point,** cal/g | 24 | 22 | 19 | 20 | 22 | 21 | 18 | 17 | 17 | 17 | 16 | 16 |
| **Thermal Conductivity,** watts/(cm$^2$) (°C/cm) | 0.00056 | 0.00057 | 0.00060* | 0.00063* | 0.00063* | 0.00063 | 0.00066* | 0.00066* | 0.00066* | 0.00066 | 0.00070* | 0.00070* |
| **Coefficient of Expansion** cm$^3$/(cm$^3$)(°C) | 0.0016 | 0.0016 | 0.0015 | 0.0014 | 0.0014 | 0.0014 | 0.0013 | 0.0012 | 0.0012 | 0.0012 | 0.0010 | 0.0010 |
| **Surface Tension,** dynes/cm | 9.5 | 12 | 13 | 15 | 14 | 15 | 16 | 16 | 16 | 16 | 18 | 18 |
| **Refractive Index** | 1.238 | 1.251 | 1.261 | 1.280 | 1.271 | 1.276 | 1.2813 | 1.290 | 1.290 | 1.291 | 1.303 | 1.303 |
| **Dielectric Strength,** KV(2.54 mm gap) | 42 | 38 | 42 | 40 | 41 | 40 | 43 | 46 | 46 | 42 | 40 | 40 |
| **Dielectric Constant,** (1KHz) | 1.72 | 1.76 | 1.81* | 1.86 | 1.86 | 1.86 | 1.89 | 1.89 | 1.89 | 1.90 | 1.98 | 1.98 |
| **Dissipation Factor,** (1KHz) | <0.0005 | <0.0003 | <0.0003* | <0.0003 | <0.0001 | <0.0001 | <0.0003* | <0.0003 | <0.0003 | <0.0001 | <0.0001 | <0.0001 |
| **Volume Resistivity,** ohm-cm | 5.6x10$^{15}$ | 1.0x10$^{15}$ | 1.0x10$^{15}$ | 1.9x10$^{15}$ | 8.4x10$^{15}$ | 8.0x10$^{15}$ | 5.0x10$^{15}$ * | 4.0x10$^{15}$ | 4.0x10$^{15}$ | 3.4x10$^{15}$ | 2.3x10$^{15}$ | 2.3x10$^{15}$ |
| **Solubility of Water** ppm(wt.) | 7 | 10 | 11* | 13 | 11 | 11 | 7* | 7 | 7 | 7 | 8 | 8 |
| **Solubility of Air** ml gas/100 ml liquid | 54 | 48 | 43* | 41 | 38 | 40 | 30* | 27 | 27 | 26 | 22 | 22 |

* Estimated values  □ Not measured due to relative proximity to pour point

## Thermal Shock Testing Liquid 3M™ FC-6003 Typical Properties
(Not for Specification Purposes)
Low Temperature Reservoir

| | |
|---|---|
| Density @ 25°C, gm/ml | >1.76 |
| Dielectric Strength, volts/mil | >350 |
| Viscosity @ -75°C | <50 |
| Residue, micrograms/ml | <10 |
| Appearance | Clear/colorless liquid |

## 3M™ SF-2 Secondary Fluid Typical Properties
(Not for Specification Purposes)

| | | Test Number |
|---|---|---|
| Boiling Point, °C | 46.0°C ± 8.0° | 66.1 |
| Density @ 25°C, gm/ml | 1.600 - 1.900 | 14.5 |
| Residue, micrograms/ml | 10 Max | 1.13.5.2 |
| Appearance | Clear/colorless liquid | Visual |

## Typical Applications
Boiling Points

**MIL. STD. Tests:**

| | | | |
|---|---|---|---|
| Gross Leak | Detector Fluids (Bombing) | FC-72 | 56°C |
| | Bubble Tank or NID | FC-84 | 80°C |
| | Indicator Fluids (Bubble Tank) | FC-40 | 155°C or |
| | | FC-43 | 174°C |
| Thermal Shock | Cold Side | FC-77 or FC-6003 | |
| | Hot Side | FC-40 or FC-43 | |

**Liquid Burn In & ESS (Environmental Stress Screening):**

| | |
|---|---|
| FC-40 | 155°C |
| FC-5320 | 160°C "Thermally Stabilized" |
| FC-43 | 174°C |

**VPS Vapor Phase Soldering:**

| | | |
|---|---|---|
| Primary | FC-70 | 215°C |
| | FC-5312 | 215°C "Thermally Stabilized" |
| Secondary | SF-2 | 46°C |

**Cooling/Thermal Management:**

| | |
|---|---|
| FC-77 | 97°C |
| FC-3283 | 128°C |
| FC-43 | 174°C |
| FC-70 | 215°C |

**High Voltage/Dielectric Testing:** All 3M™ Fluorinert™ Liquids have high dielectric strength

**Constant Temperature Baths/Calibration:** Match the Boiling Point and Pour Point

## Materials Compatibility

3M™ Fluorinert™ Liquids are compatible with most metals, plastics and elastomers.

## Toxicity Profile

Fluorinert liquids are non-irritating to the eyes and skin, and are practically non-toxic orally. They also demonstrate very low acute and sub-chronic inhalation toxicity. These products are not mutagens or cardiac sensitizers.

## Safety and Handling

Fluorinert liquids are nonflammable, and are highly resistant to thermal breakdown and hydrolysis in storage and during use. Recommended handling procedures are given in the Material Safety Data Sheets, which are available upon request.

## Environmental

Fluorinert liquids have zero ozone depletion potential. These materials are not defined by the U.S. EPA, nor regulated, as volatile organic compounds (VOCs) and do not contribute to ground-level smog formation.

Fluorinert liquids, which are perfluorocarbon (PFC) materials, have high global warming potentials and long atmospheric lifetimes. As such, they should be carefully managed to minimize emissions.

3M recommends that users of Fluorinert liquids further limit emissions by employing good conservation practices, and by implementing recovery, recycling and/or proper disposal procedures. 3M offers a program for used fluid return. Specific guidelines for the safe handling and use of 3M products are provided in the Material Safety Data Sheets.

## Resources

For additional technical information on Fluorinert liquids, contact

**3M Specialty Materials**
3M Center, Bldg. 223-6S-04
St. Paul, MN 55144-1000
800 810 8513
800 810 8514 (Fax)

Or visit our web site at **www.3m.com/electronicmaterials**



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