



# Novec™

Brand

3M™ Novec™ Engineered Fluids

# Filtration Recommendations

## Introduction

3M™ Novec™ Engineered Fluids are an excellent solvent choice for deposition of lubricants, dilution of coatings and cleaning. They offer smart, safe and sustainable chemistry, protecting your workers, as well as our planet.

With the wide variety of applications Novec fluids are used for, they are filtered immediately before packaging to ensure high quality standards and consistency. Even so, filtration is recommended before or during use in applications that are especially sensitive to particles. Filtering is quick due to easy wetting of the filter membrane and the low pressure drop across the filter thanks to the low surface tension and viscosity of Novec fluids.

Many techniques can be used to filter fluids and the optimal method will depend on the application. This paper provides a filtration starting point and setup examples for neat Novec fluids (including 3M™ Novec™ 7000, 7100, 7100DL, 7200, 7200DL, 7300, 7500 Engineered Fluids) and 3M™ Novec™ 71IPA Engineered Fluid, a solvent blend.

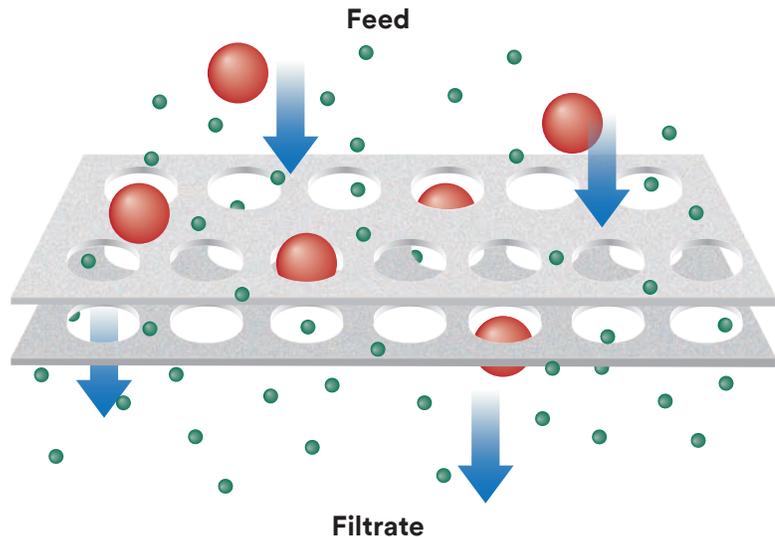


Figure 1. Basic Filtration System

## Basics of Filtration and System Design

A filtration system generally consists of:

- Filter to capture particles
- Filter housing to hold the filter
- Driving force (such as a pump) to push the fluid through the filter
- Supporting equipment such as tubing, o-rings and containers

The best filtration method will depend on the specific needs of the process. Key considerations include:

- Size, type and amount of particles to be removed
- Requirements or specifications for allowable particles and other properties
- Volume of solvent to be filtered and desired flow rate
- Operating temperature
- Integration of the filtration process into manufacturing
- Single pass or recirculation filtration
- Filtration cost
- Material compatibility with the solvent

Ensuring materials in contact with the 3M™ Novec™ Engineered Fluids are compatible is a critical component for all applications.

## Filtration System – Components



Figure 2. Example of cartridge filters

### Filters

Filters capture particles by allowing the fluid, but not the particles, to pass through it. Many filter types

and suppliers are available, including global supply from 3M Company, Pall Corporation and EMD Millipore Inc. Neat Novec fluids and Novec 71IPA fluid can be used with:

- Wound filters: Low cost options for capsule or cartridge filters. They are effective for larger (>0.5 µm), but not smaller, particle sizes. Cotton, polypropylene and glass fiber filters generally work well.
- Polyvinylidene difluoride (PVDF) membrane filters: Offer excellent compatibility and are available as either cartridges or capsules. Effective for treating large volumes of fluid, they can remove both large and small particles. Whereas the filter price can be higher than other options, they generally have long lifetimes, which may result in a low cost per pound of fluid filtered. 3M uses these types of filters.
- Other membrane filters: Other cartridge or capsule filters use membranes that can also be effective for large fluid volumes and both large and small particles. High density polyethylene (HDPE), polypropylene (PP), polytetrafluoroethylene (PTFE), cellulose and polyethersulfone (PES) membranes generally work well.

Filter effectiveness over time depends on how the system is used. If it is primarily used for filtering a Novec fluid out of its container, filters typically last for weeks or months. Placing filters in series helps protect finer filters, extends a filter's life time and can improve filtration of smaller particles. Methods for determining when to change filters include:

- Flow rate – change when the flow rate is too low
- Pressure drop – change when the pressure drop across the filter is too large
- Standard product maintenance cycle – change based on a set time period, volume of fluid filtered or number of production lots filtered



Figure 3. Example of capsule filters

### Filter housing and support materials

Filter support materials are used to hold the membranes in place and are typically made of plastic such as HDPE or PP, although some wound filters may use metal. Cartridge filter housings are typically made of metal or a plastic such as HDPE, PP or perfluoroalkoxy alkanes (PFA). Capsule cases are made of similar materials and are intrinsic to the filter assembly. All of these materials are generally compatible with the neat Novec fluids and Novec 71IPA fluid.

### Pump

Novec fluids' low surface tension and viscosity are effective at penetrating tight geometries but also limit the types of pumps that can be used due to the potential for leaking. Magnetically coupled pumps are preferred as they do not have a shaft seal, the most common location for leaks. Other pump types have been used with Novec fluids but should be tested for potential leaks. Self-priming pumps are generally easier to use than non-self-priming pumps, which need the lines to the pump to be filled with fluid prior to use. Pump priming can be done manually, using gravity feed or a second self-priming pump.

### Holding and Storage Containers/Tanks

Containers or tanks made from glass, epoxy-phenolic-lined steel, stainless steel or hard plastics are generally compatible with neat 3M™ Novec™ Engineered Fluids and 3M™ Novec™ 71IPA Engineered Fluid. Novec fluids have high vapor pressures, particularly the lower boiling point products, so containers and tanks should have a threaded cap to minimize evaporative losses.

Containers and tanks should be free of contaminants, such as oils, fluids, or particles, and may need to be flushed with Novec fluid prior to filling. For sensitive applications, certain materials (e.g. glass, electro-polished stainless steel or hard plastic) and container designs (e.g. seamless construction, externally threaded caps) are better suited for low particle requirements.

Hard plastic (e.g. HDPE or PP) containers or tanks work well with neat Novec fluids and Novec 71IPA fluid at ambient conditions. Containers exposed to elevated temperatures, however, could develop stress cracks due to Novec fluids' high vapor pressure. Containers made of plastic, glass or metal should be tested for suitability. Suitability of the container should be verified prior to use.

### Tubing

Metal (e.g. copper, stainless steel), PFA and most hard plastic tubing work well with neat Novec fluids and Novec 71IPA fluid. Highly plasticized tubing, including most silicones and polyvinyl chloride (PVC), generally are not recommended due to the potential for plasticizer extraction.

### Fittings

Due to the low surface tension and viscosity of Novec fluids, it is important to use higher quality fittings to ensure a good seal and minimize fluid loss due to leaks. Recommended fittings include soldered connections, compression, Swagelok® and Flaretek® brand fittings.

### O-rings and Gaskets

O-rings and gaskets made from polytetrafluoroethylene (PTFE), Viton®, or PTFE encapsulated Viton® are suggested for neat Novec fluids and Novec 71IPA fluid. For PTFE elastomers, high density versions are preferable as they are generally less susceptible to swelling. Other o-ring and gasket materials, including ethylene propylene diene monomer (EPDM) and nitrile rubber (Buna-N), can be used with neat Novec fluids and Novec 71IPA fluid but there is more variability among grades and suppliers so not all types may be compatible. EPDM and Buna-N should be tested for compatibility with the Novec fluid.

### Material Compatibility

Compatibility is critical to minimize Novec fluid loss and contamination while maximizing overall system performance. Neat Novec fluids and Novec 71IPA fluid are generally compatible with a wide range of materials. Compatibility may vary depending upon how long the material is in contact with the fluid, the temperature of the materials, the ratio of fluid volume to the material surface area, variability between material suppliers and other factors. In most filtration applications, the fluid will be at room temperature and the exposure time will be fairly short. Applications with elevated temperatures or with longer exposure times will have more demanding requirements for compatibility, requiring extra testing.

Even with high compatibility with most materials, Novec fluids can extract plasticizers and additives from certain plastics, changing physical properties and possibly reducing performance or adding contamination. This can result in the contamination of parts to be cleaned or coated, clogging filters or small fluid passages, or creating static voltage or static discharge.

General information on material compatibility with Novec fluids can be provided by 3M. However, plasticizers and additives in plastics and elastomers vary by supplier and within material grades so it is difficult to recommend specific options. Testing is required to verify compatibility of specific plastics or elastomers and 3M can assist in this.

### Material suggestions

For a filtration process at ambient conditions for a short exposure time such as hours, the materials listed below are generally compatible with the neat Novec fluids and Novec 71IPA fluid. For elevated temperatures, longer exposure time or sensitive applications, additional testing may be needed to determine plastic and elastomer compatibility.

- **Metals:** Neat Novec fluids and Novec 71IPA fluid are compatible with nearly all metals including aluminum, brass, copper, carbon steel and stainless steel.
- **Plastics:** Neat Novec fluids and Novec 71IPA fluid are compatible with most hard plastics such as acrylonitrile butadiene styrene (ABS), acrylic (PMMA), epoxy, nylon, polyethylene terephthalate (PET), PFA, phenolic, polycarbonate (PC), polyester, PE, PP and polyvinylidene fluoride (PVDF). For applications at elevated temperatures, some injection molded plastics such as PMMA and PC are not recommended as they may experience stress cracking due to the higher temperatures.

- **Elastomers:** Neat Novec fluids and Novec 71IPA fluid are compatible with PTFE, Viton®, or PTFE encapsulated Viton®. Contact of Novec fluids with certain grades of PTFE and other fluorochemical elastomers may exhibit swelling. EPDM and Buna-N can be used, but due to variability in the plasticizer and additive loading, testing will be required to verify compatibility. Silicones and fluorosilicones are generally not recommended for use with Novec fluids.

- **Others:** Novec fluids are generally compatible with glass and ceramic materials.

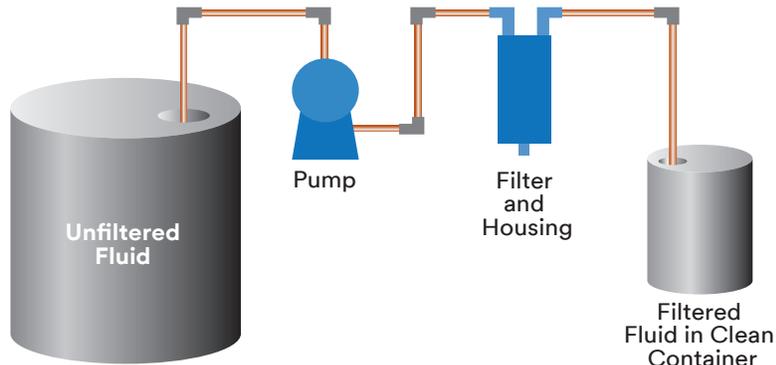
## Filtration System Examples

### Basic Application

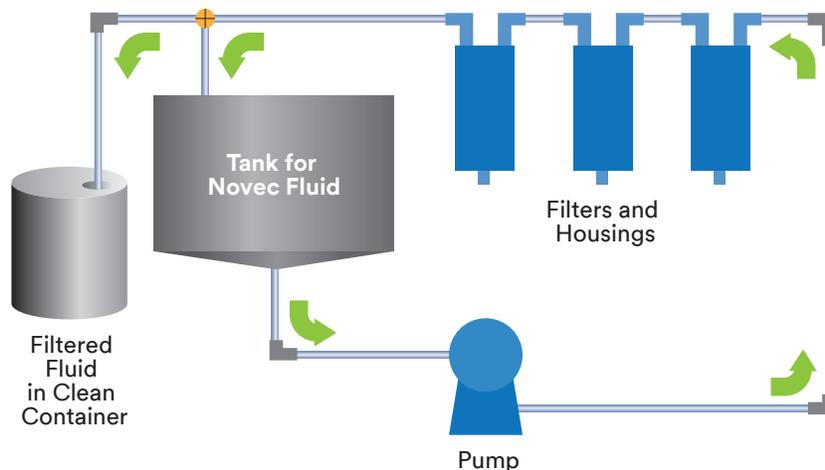
This is an example of removing large (>0.5 µm) particles from a neat Novec fluid in a 55-gallon drum and transferring the fluid into smaller, clean containers. Single pass filtration is sufficient and components of the system might consist of:

- **Filter:** Cotton wound filter in stainless steel housing and high-density PTFE gaskets
- **Pump:** Self-priming magnetically coupled pump
- **Tubing:** Copper with compression fittings

A copper dip tube is placed in the 55 gallon drum of fluid and connected to the self-priming, magnetically coupled pump. The pump would then drive the Novec fluid through the copper tubing from the drum through the pump, filter and housing components, ending into a small, clean container.



Schematic of Basic Filtration System



Schematic of Recirculating Filtration System

### Sensitive Applications

This is an example of removing fine (<0.5 µm) particles. The fluid is recirculated through a series of filters and clean fluid is obtained by pulling off a small portion of the recirculating flow. This system is well suited for applications sensitive to trace contaminants including particles, metals, ions and organics.

- **Filter:** PVDF membrane filters with PFA filter housings and high-density PTFE gaskets
- **Pump:** Self-priming magnetically coupled pump
- **Tubing:** PFA lines with Flaretek® fittings

Novec fluid should be placed in a plastic (preferably HDPE, PP or PFA) tank with a bottom drain. PFA tubing then connects the bottom drain to a self-priming, magnetically-coupled pump which is then connected to a series of filter housings. PFA tubing from the filter housing is connected to a sampling valve. In recirculation mode, all the solvent returns to the tank. When filtered fluid is needed, the sample valve is opened and a small portion (e.g. 10%) of the tank return flow is sent to the clean container. Using this method minimizes particle generation in the system.

Please note that it is possible for a non-conductive fluid moving through

a non-conductive system to create static charging issues. The reason for this is not well understood in the industry but static charging tends to occur more often at low temperatures (below ambient) and in systems with high Reynolds numbers (high flow rates and/or small pipe diameters). The risk of static charging can be reduced by using antistatic or conductive PFA tubing but this also has the potential to introduce a contamination source.

#### **Simple Filtration for Small Scale Work**

Filter paper, supported with either a glass, ceramic or plastic funnel, can be used to remove larger particles from fluids. Positive pressure before the filter, or negative (vacuum) pressure after the filter, can assist the process. Due to their high vapor pressure, care needs to be taken to minimize the evaporative loss of the Novec fluids. Another small scale option is to use glass or plastic syringes to push the fluid through one or more syringe filters.

#### **Summary**

3M™ Novec™ Engineered Fluids are used in many sensitive applications. Some of these applications are sensitive to particles and filtration immediately before or during use is recommended. The low surface tension and viscosity of Novec fluids facilitates filtration, allowing tight particle control. There are many filtration options depending on your process needs.

We are here to help and can work with you to determine the most appropriate filtration system for your application. Please give us a call.

## For additional information

For information on additional 3M fluids, coatings and other chemical products, visit our web site at:  
[www.3m.com/Novec](http://www.3m.com/Novec)

### Smart. Safe. Sustainable.

#### The 3M™ Novec™ Brand Family

The Novec brand is the hallmark for a variety of proprietary 3M products. Although each has its own unique formula and performance properties, all Novec products are designed in common to address the need for smart, safe and sustainable solutions in industry-specific applications. These include precision and electronics cleaning, heat transfer, fire protection, protective coatings, immersion cooling, advanced insulation media replacement solutions and several specialty chemical applications.

3M™ Novec™ Engineered Fluids ■ 3M™ Novec™ Aerosol Cleaners ■ 3M™ Novec™ 1230 Fire Protection Fluid ■ 3M™ Novec™ Electronic Grade Coatings ■ 3M™ Novec™ Insulating Gases

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