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Process Usage of 3M Novec™ Fluids at LANL

John Alison, Chris Wetteland

Overview

- LANL is using several 3M Novec™ hydrofluoroether (HFE) fluids in production processes.
- Novec™ HFE fluids currently being used for LANL production processes are: HFE-71IPA, HFE-72DE, HFE-7100, and HFE-7500.
- With the exit of these fluids being sold commercially scheduled for 2025, LANL is researching what about these HFE fluids make them specifically effective for the processes they are used for in hopes of finding adequate replacement.

HFE Critical Characteristics

- Due to LANL's use of plutonium and our operations within a nuclear facility, there are critical characteristics of Novec™ fluids that make them acceptable for our use.
- The first of these critical characteristics is that Novec™ fluids are ***non-flammable***.
- The second critical characteristic is that Novec™ fluids are ***chemically inert***. The liquid and vapor from Novec™ fluids do not interact with the plutonium metal or other process materials.
- These are the two most important chemical characteristics that any fluids used in LANL's plutonium production must follow.
- These HFE's also do not present any industrial health hazards

Novec™ HFE-71IPA

- Novec™ 71IPA is used in LANL processes for Wipe Cleaning.
- Solvent used as a light duty cleaner for removal of smaller stains and fluid residuals on the part from processes that use other HFEs. 71IPA is ideal for use after ultrasonic clean and rinse processes as it does remove the degreasing stabilizer in 72DE.
- The properties of HFE-71IPA that are of interest are its ability to remove the degreasing stabilizer in 72DE, surface tension, viscosity and volatility.
- Non-flammable and chemically inert.

Novec™ HFE-72DE

- Novec™ 72DE is used at LANL for submersion ultrasonic cleaning and rinsing of parts.
- After a plutonium part has been machined, it is submerged into a bath of heavy cleaner HFE-72DE where ultrasonic waves are used to remove particles, soils and oils. The part is also later rinsed again using a gravity fed tube with 72DE.
- HFE-72DE chemical properties of interest to LANL operations is that it is as powerful degreaser as well as its surface tension, viscosity, volatility, and density.
- Non-flammable and chemically inert.

Novec™ HFE-7100

- Novec™ 7100 is used at LANL as a machining fluid.
- The plutonium part is placed into a lathe and is machined to spec where HFE-7100 is used to assist with cutting. HFE-7100 is used as a minimum quantity lubricant (MQL). MQL uses pressurized gas to aerosol the fluid as it's delivered to the part. This adds lubricity and chip evacuation during machining process.
- Novec™ 7100 is used as a lubricant and coolant in the machining process, and the key properties for LANL are heat of vaporization, surface tension, viscosity and volatility.
- Non-flammable and chemically inert.

Novec™ HFE-7500

- HFE-7500 is used at LANL for Density Operations processes.
- Plutonium parts are immersed into a bath of HFE-7500 to determine part density.
- The high density of Novec™ 7500 make it ideal in our density measurement processes.
- Other chemical characteristics of interest to LANL are surface tension, viscosity and volatility.
- Non-flammable and chemically inert.

Tabulated Information of HFE Chemical Characteristics of Interest to LANL

The below fluids have been successfully implemented at LANL. A consideration for originally selecting the suite of HFE fluids is that they exhibited similar physical properties/characteristics, which aided in the safety and storage requirements. When selecting alternatives, we understand that the replacements may have variable physical properties than the HFEs. The below table captures the physical properties used in evaluating the fluids and highlights the LANL specific application/characteristic for each fluid.

Critical Characteristic	HFE-71IPA	HFE-72DE	HFE-7100	HFE-7500
Flammability	Non- Flammable	Non-Flammable	Non-Flammable	Non-Flammable
Inert	Chemically Inert	Chemically Inert	Chemically Inert	Chemically Inert
Surface Tension	Low Surface Tension	Low Surface Tension	Low Surface Tension	Low Surface Tension
Density	High Density	High Density	High Density	Highest Density
Viscosity	Low Viscosity	Low Viscosity	Low Viscosity	Low Viscosity
Volatility	High Volatility	High Volatility	High Volatility	Lower Volatility
Heat of Vaporization	N/A	N/A	High heat of vaporization	N/A
Thermal Conductivity	N/A	N/A	Low Thermal Conductivity	N/A
LANL Application Specific Characteristic	Removes degreaser of 72DE and wipe cleaning	Powerful degreaser for cleaning part	Highest heat of vaporization, volatility and viscosity for machining coolant	Highest Density HFE for Density measurements, Low vapor pressure