Protecting aircraft cabling with fluorosilicones

INTRODUCTION

Fluorosilicones are high-performance silicone materials widely used in aircraft and defense applications because they are formulated to resist mechanical failure caused by exposure to hydrocarbons commonly present in applications such as jet fuels and solvents.

Recently, a leading manufacturer of aircraft cabling faced a problem: the existing coating used to protect the company's cables was failing to pass swell testing, which is required to demonstrate that the cabling resists swell from contact with jet fuel.

When the cabling manufacturer determined the need for an advanced material that could pass the aircraft manufacturer's critical performance requirements, they turned to the experts in silicone: one of the companies that pioneered the development of fluorosilicones for aircraft and defense applications.

DEMANDING PERFORMANCE REQUIREMENTS

The United States Air Force has developed a set of testing specifications (Mil-R-25988) for fluorosilicone elastomers. These specifications outline acceptable changes in mechanical properties after heat exposure and immersion to hydrocarbons, with attention to three specific areas: changes in mechanical properties, weight loss and swell (% volume change).

However, some manufacturers and end users are required to satisfy the performance requirements for their customer's aircraft applications.

"The manufacturer's testing was designed to simulate exposure to this fuel," said Timothy Steckler, Applications Technology Manager, NuSil®. "Unfortunately, they determined that the existing coating could not meet these demanding requirements and had the potential to swell over time to an extent that might jeopardize the integrity of the cabling and lead to unacceptable failure."

The customer had two critical requirements:

- Identify a fluorosilicone with the ability to meet their customer's swell requirements
- Provide the fluorosilicone in a packaging configuration that would enable the cable manufacturer to quickly prototype cabling samples for their customer

One of the principal reasons fluorosilicones were originally developed was that dimethyl silicones swell when exposed to hydrocarbons such as jet fuel and solvents that are typically present where aircraft are operating. Dimethyl silicones are much less polar than fluorosilicones; this is what makes it possible for dimethyl silicones to absorb hydrocarbons and expand.

When the absorbed fuel or solvent evaporates, cracks can develop, resulting in breached seals and gaskets. The polar nature of fluorosilicones results in decreased or very minimal swelling.

Extensive swell testing of fluorosilicones has validated their swell resistance and retention of physical properties and dimensional shape when exposed to hydrocarbons and jet fuels (Fig. 1). The swell test measures the percentage of mass change in samples after being submerged in JP-8 jet fuel for seven days at 60 °C. The cured samples were 1 × 1" (2.54 × 2.54 cm) and 0.07" (1.78 mm) thick.

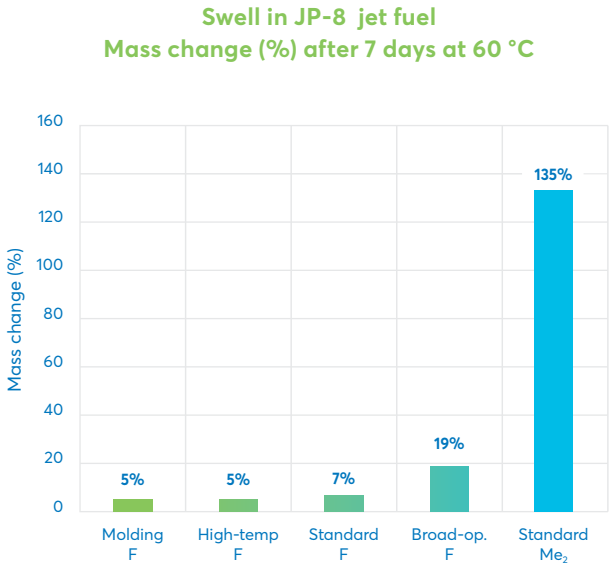

FIGURE 1: Four NuSil fluorosilicones and one dimethyl silicone were subjected to a swell test. All cured samples were submerged in JP-8 jet fuel for seven days at 60 °C.

The results showed that the molding, high-temperature and standard fluorosilicone materials demonstrated less than 10% mass change. When tested in accordance with the Mil-R-25988 requirements, fluorosilicones demonstrate superior stability while resisting degradation under the temperature ranges and exposure to harmful fuels and solvents that aircraft endure.

Based on the results of this swell test, the cable company determined that NuSil's fluorosilicone materials would meet their customer's swell testing and long-term jet fuel resistance criteria.

SPECIALIZED PACKAGING FOR FAST PROTOTYPING

Once the right fluorosilicone was selected, the cable company asked to have the material delivered as soon as possible and align with their prototyping process:

"They wanted to process the fluorosilicone onto cables for their customer to evaluate, but their prototyping process required that the fluorosilicone be efficiently processed onto the cables on a small scale," Steckler said. "Fortunately, NuSil has specialized packaging that addresses this issue, and we were able to meet the cabling company's needs."

This packaging is a one-piece dual-cartridge dispensing system with a specialized static mix tip, available in additional volumes. The fluorosilicone chosen by the cable manufacturer was a two-part 1:1 (A:B) platinum-catalyzed silicone with a paste-like viscosity. The dual-cartridge configuration allows the de-aired silicone to be easily dispensed into the injection system without introducing additional air.

Quickly providing a fluorosilicone with proof of long-term stability and resistance to swelling when exposed to jet fuel, combined with a packaging and application system that worked well with the cable company's prototyping requirements, made it easy for the cable company to provide samples to the aircraft manufacturer for testing to the company's requirements.

MEETING CUSTOMER CHALLENGES WITH FLUOROSILICONES

The cable manufacturer worked with NuSil to rapidly scale up delivery of the fluorosilicone in packaging and quantities that worked efficiently with the company's existing cable fabrication and coating processes. In addition, they have consulted with NuSil on other silicone uses, including applying specialized primers to help improve coating adhesion and to potentially adapt the fluorosilicone to other applications.

> "NuSil's ability to respond to the cable company's needs was built on our flight heritage of more than 40 years, combined with our focus on being agile and responsive to our customer's unique materials performance and processing requirements."
>
> **Tim Steckler**
> Applications Technology Manager

NuSil has a broad portfolio of both custom and standard fluorosilicone solutions, including adhesives, sealants, coatings, molding materials, gels and foams. Manufactured under strict quality control requirements in AS9100- and ISO 9001-certified production systems and facilities, NuSil is always prepared to partner with aircraft and defense component and hardware suppliers to leverage our deep silicone expertise to solve their unique challenges.

"At NuSil, we combine decades of fluorosilicone expertise, proven development processes and our proprietary technology to set the standard for fluorosilicone performance and purity," Steckler said. "So, when we have new and more demanding performance requirements, or the need to provide specialized support for a customer's prototyping needs or existing fabrication processes, our broad portfolio of products and experience creating unique packaging solutions provide NuSil with the resources to meet those needs."

Contact NuSil® to get started

When your advanced applications require customized silicones, we're ready to supply you with the right solution you need.

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