U.S. DEPARTMENT OF ENERGY

Assessment of Fluoropolymer Production and Use With Analysis of Alternative Replacement Materials

The U.S. Department of Energy (DoE) released a report in early 2024 that distinguishes fluoropolymers from other types of per- and polyfluoroalkyl substances (PFAS) and their critical uses in commerce. Conducted by the Savannah River National Laboratory, the report details the importance of fluoropolymers to government and military interests as well as numerous critical U.S. industries. The report also concludes that in many applications, there are no viable alternatives to fluoropolymers that provide the same unique combination of properties.

According to DoE, fluoropolymers are critical for U.S. industry and manufacturing:

> *Throughout various industries, fluoropolymers are often essential to maintaining the effectiveness, safety, and robustness of a wide range of products across many industry sectors. . . . [N]o industrially scaled materials are currently available and viable to fill the role of fluoropolymer plastics if required for multiple performance characteristics.*

> *Due to their molecular structure, fluoropolymer plastics have unique physical and chemical properties that have led to wide-spread integration into many sectors of modern commerce, including aerospace, automotive, chemical processes and storage, infrastructure, solar and wind energies, electronics, and many others.*

> *Fluoropolymers play a vital role in the automotive and aerospace industries, possessing several essential characteristics such as high heat and chemical resistance, low permeability, a low coefficient of friction, and excellent mechanical properties. These attributes are instrumental in ensuring safety, enhancing fuel efficiency, and reducing carbon emissions within these sectors.*

> *Depending on the selected fluoropolymer, the material can be used to extend the lifespan of components, improve fire safety, increase transmission speeds, and enable the creation of smaller, more powerful, and more integrated electronic products.*

> *Fluoropolymers are used in thousands of end-use applications, and potential trade-offs would need to be considered for a significant number of those applications.*

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DoE addresses the inability of fluoropolymer alternatives to provide the same level of benefits, functionality, and enhancements:

> *Their unique characteristics also make replacing fluoropolymers difficult and often cost prohibitive, as fluoropolymers are typically used if alternate polymers or other materials cannot tolerate the stringent conditions required.*

> *Because of the combination of beneficial properties of fluoropolymers, no alternatives have been identified that could replace fluoropolymers in many, or over a broad range, of applications in the sectors considered in this report.*

> *Removing fluoropolymers generally or from specific uses could lead to increased costs, not only in terms of raw material and manufacturing but also from equipment modifications and maintenance and compliance with or revision of industry standards.*

> *A transition to fluoropolymer alternatives may necessitate expensive retrofitting of existing infrastructure and machinery. In addition, restrictions in use of fluoropolymers may result in the loss of technological advances and innovation (e.g., in semi-conductor and microelectronics production, and miniaturization and durability of products).*

> *With fluoropolymers playing an increasingly important role in the clean energy transition, efforts to replace fluoropolymers need to be studied carefully for effectiveness and affordability.*

DoE also spotlights how fluoropolymers are critical to multiple U.S. industries:

- Chemical Processing
- Automotive Industry
- Battery Manufacturing
- Medical Applications
- Renewable Energy
- Building Construction and Infrastructure
- Aerospace Industry
- Electronics and Semiconductor Manufacturing

According to DoE:

Fluoropolymers enhance the durability, safety, and longevity of a wide range of consumer and industrial products. Fluoropolymers are thermally and chemically stable, electrically non-conductive, flame retardant, and water-repellent, making them useful in a wide range of applications. Fluoropolymers are generally not soluble in water.

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