Responsible Manufacturing

The Future of Fluoropolymers

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FLUOROPOLYMERS

What They Are, Why We Need Them, and Misguided Narratives

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Fluoropolymers: An Overview

A fluoropolymer is a fluorocarbon-base polymer with multiple carbon-fluorine bonds, the strongest bond in organic chemistry, making equivalent alternatives impossible across many industries necessary to modern society and the future of more sustainable solutions.

Fluoropolymers are drivers for innovation and sustainability across industries

- Automotive & Electric Vehicle
- Aerospace & Defense
- Advanced Electronics & Semiconductors
- Medical Technology & Pharmaceutical Processing
- Power Generation, Clean Hydrogen & Other Renewables
- Chemical Processing
- Construction & Thermal Management
- Mechanical & Plant Engineering

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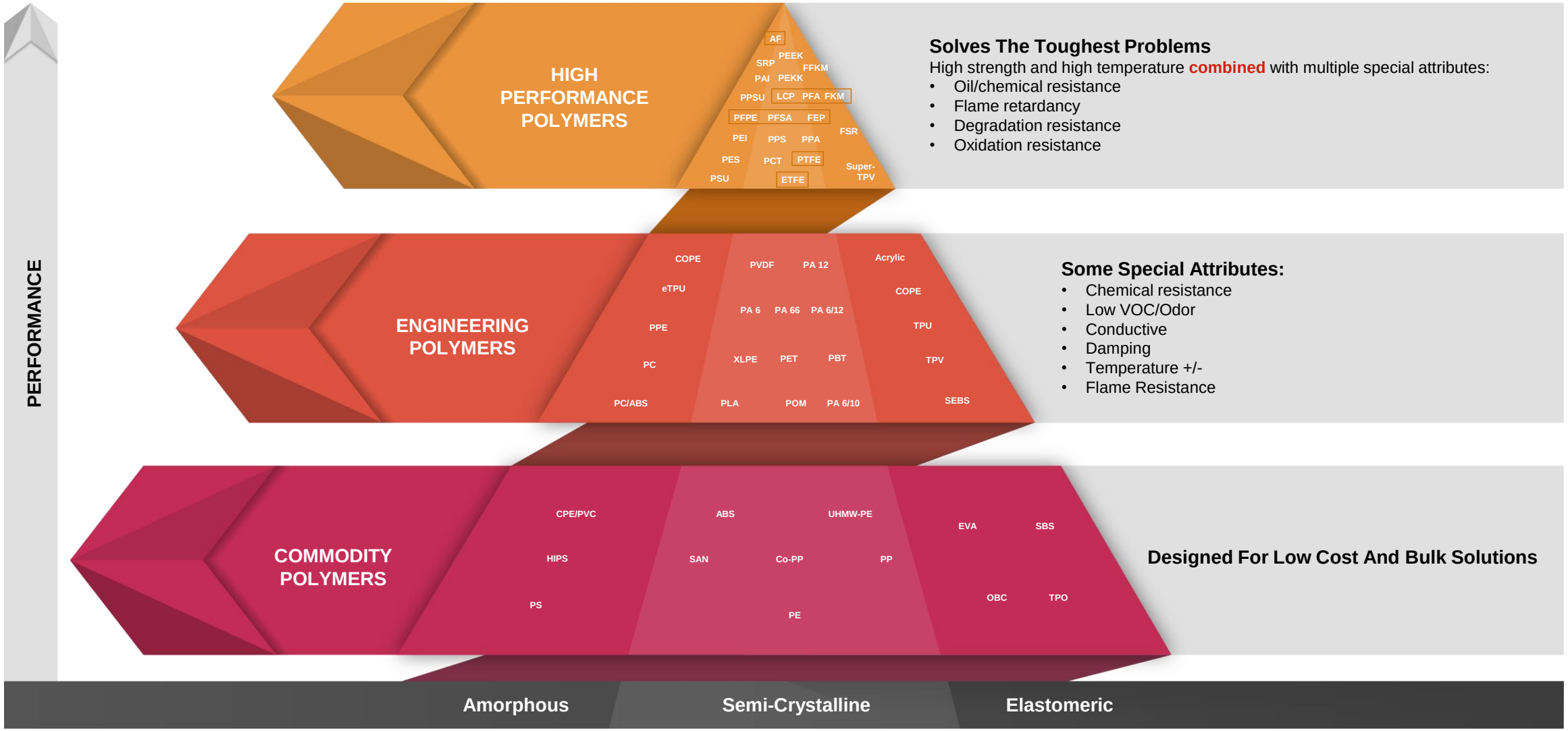
Fluoropolymers: An Overview

MANUFACTURED BY CHEMOURS



Solves The Toughest Problems

High strength and high temperature **combined** with multiple special attributes:

- Oil/chemical resistance
- Flame retardancy
- Degradation resistance
- Oxidation resistance

Some Special Attributes:

- Chemical resistance
- Low VOC/Odor
- Conductive
- Damping
- Temperature +/-
- Flame Resistance

Designed For Low Cost And Bulk Solutions

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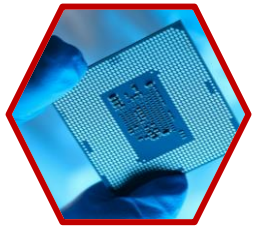
Fluoropolymers: Fundamental Societal Value

Fluoropolymers are fundamental for numerous industries due to a lack of lack of equivalent alternatives. They enable innovative solutions across essential, everyday products and industries, including:



Fluoropolymers in the manufacture of **semiconductors.**

Nafion™ membranes in hydrogen **fuel cells and electrolyzers.**

Teflon™ fluoropolymers & Viton™ elastomers to protect **pipes, vessels and equipment** in the **chemical industry.**

Teflon™ fluoropolymers in manufacturing of **food and medicine** to prevent contamination.

Teflon™ fluoropolymers and Krytox™ lubricants to assure safe and reliable operation of **airplanes.**

Krytox™ as unique lubricant approved for **oxygen medical application** for safety reason.

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Fluoropolymers: Misguided Narratives

When it comes to perceptions of the future of fluoropolymers, there are a number of myths and misconceptions:

Polymerization Aids

MYTH: *Non-fluorinated or in-situ generated surfactant polymerization aids are a more sustainable practice in fluoropolymer manufacturing.*

FACT: Regardless of using a fluorinated, non-fluorinated or in-situ generated surfactant polymerization aids, **fluorinated byproducts are created.** These byproducts may be identified through targeted and non-targeted analysis and then abated responsibly using best-in-class control technologies.

Safety

MYTH: *Fluoropolymers are toxic.*

FACT: A substantial body of scientific data demonstrates fluoropolymers **do not pose a significant risk to human health or the environment**. Fluoropolymers meet the criteria for polymers of low concern (PLC), the definition criteria set by the OECD - OCDE work - who classify the identification of chemical, physical, and biological properties predictive of health and environmental effects which are of low concern.

Which have led to proposed regulations that are based upon misguided definitions of PFAS.

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The OCED Definition of PFAS

"The rationale behind the revision is to have a general PFAS definition that is coherent and consistent across compounds from the chemical structure point of view and is easily implementable for distinguishing between PFASs and non-PFASs, also by non-experts. ***The decision to broaden the definition compared to Buck et al. is not connected to decisions on how PFASs should be grouped in regulatory and voluntary actions****."*

"First, it is strongly recommended that the PFAS terminology be used in a clear, specific and descriptive manner. ***It should be noted that "PFASs" is a broad, general, non-specific term, which should only be used when talking about all the substances included in the PFAS definition described here*** *(or the user should clearly define the scope of which substances are being referred to as PFASs in the documents they prepare).* ***Otherwise, it would introduce ambiguity and even factual error*** *in the statements (as occurred sometimes in past literature)."*

Organisation for Economic Co-operation and Development (OECD), (July 2021). "Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance. Series on Risk Management No. 61."

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Proposed Regulations: Using the OCED Definition

The formal OECD definition of PFAS was never meant for regulation as it contains **over 10,000 substances** and **ignores significant differences** between individual substances (manufacturing process, uses, socio-economic benefits, health and environmental profiles).

01 Persistency equates to unmatched performance = durability that drives ongoing contributions to sustainability.

02 **NOT** bioavailable, toxic, or mobile.

03 **NOT** dissolve in water and **CANNOT** enter or accumulate in a person's bloodstream.

04 Meet the **OECD's** criteria for "polymers of low concern"

05 Concerns in manufacturing can be managed by state-of-the art emission controls; concerns for end of life can be managed by end-of-life regulations and circularity programs

The proposed European ban on PFAS uses a definition that wasn't meant for regulation

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THE RACE TO ZERO

An Unachievable Global Emissions Goal

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A Zero Emissions World is Unachievable

Current requirements are moving to testing requirements of emissions levels that are scientifically unmeasurable today.

Inevitable Incompleteness

*Imagine trying to remove every single grain of sand from a bucket. No matter how hard you try, a few tiny grains might always remain. This applies to things like zero emissions in manufacturing - **capturing every single byproduct can be incredibly challenging**.*

Technological Trials

*Developing technologies that get us extremely close to zero emissions can be **expensive and require significant advancements in current technology**.*

Constraints of Quantifying

Our instruments might have limitations in detecting small amounts. For instance, a scale that measures to the gram might not be able to detect a difference of a milligram, making it seem like you have zero of something when there's an undetectable amount present.

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A PROPOSED SOLUTION

Science-Based Regulations & Responsible Manufacturing

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A Better Way to Regulate

The current proposal

- ✗ Would **not address potential risks** as the manufacture and use of fluoropolymers and other substances would continue elsewhere
- ✗ Would have a significant **negative socio-economic impact** on the European economy
- ✗ Would **harm European strategic autonomy** and **global competitiveness**
- ✗ Would create **tremendous administrative efforts** for companies and authorities alike

Industry proposal: targeted, science-based, and coherent approach to regulation

- ✓ **Exempt fluoropolymers** (polymers of low concern) from the restriction
- ✓ Define science-based and most robust and rigorous **standards for chemical manufacturing**

The EU can seize the opportunity to *create a regulatory benchmark* for the safe manufacture and use of chemicals that supports innovation and the sustainable transformation of the economy.

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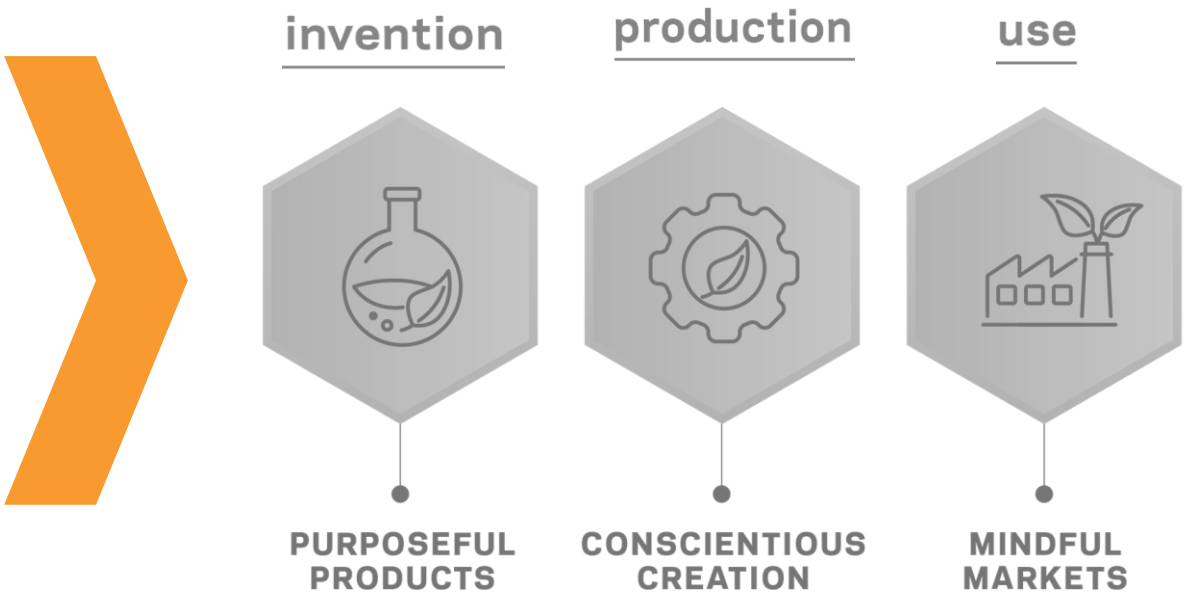
Defining Responsible Manufacturing

Every stage of fluoropolymer manufacturing—from the earliest stages of raw materials and monomers to the creation of polymers—is completed responsibly, with thorough management of raw materials, polymerization aids, and the resulting polymers that are used in various product applications.

Our definition:

Our holistic, environmental approach to the invention, production and use of high-performance materials essential to societal advancement.



Our definition is the most comprehensive in the industry, as it encompasses everything from the invention of our products to their use in application and industry.

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RESPONSIBLE MANUFACTURING

Our Approach: Conscientious Creation

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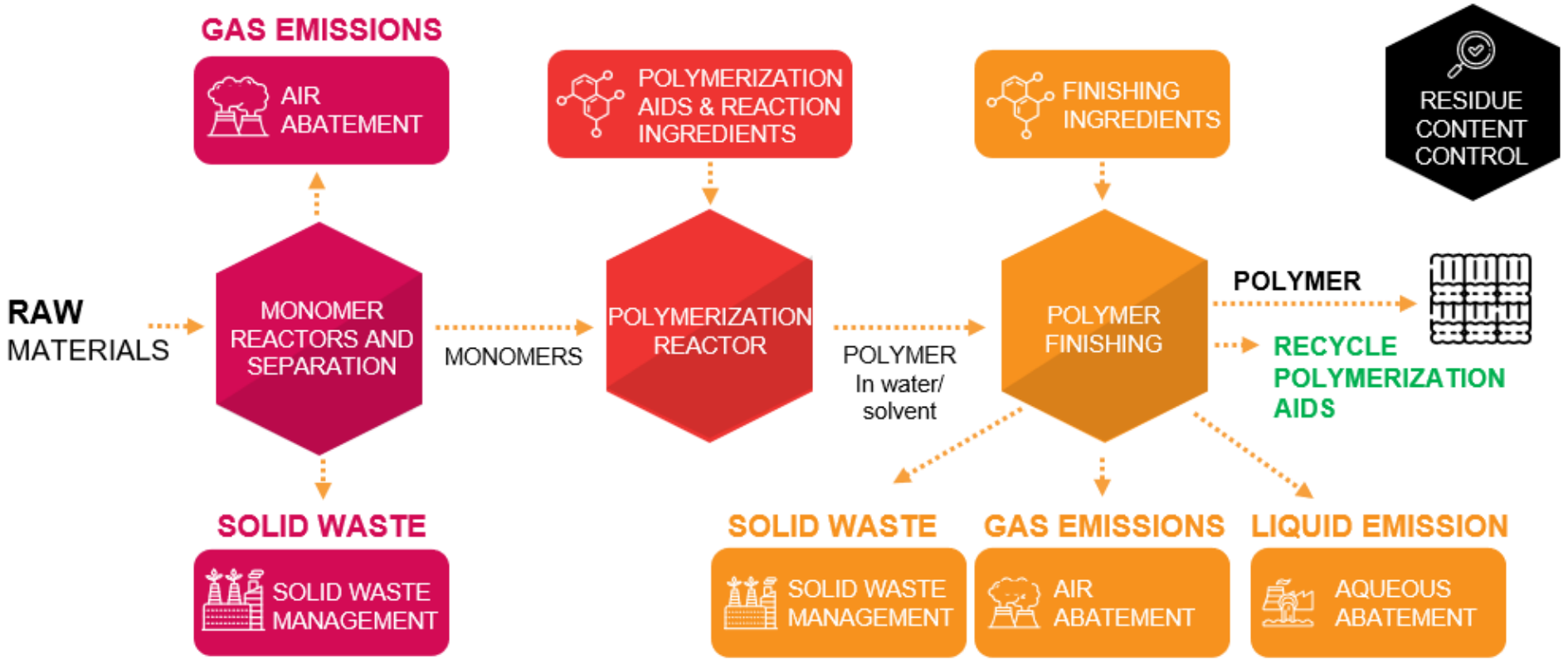
How Fluoropolymers are Made

PFAS, or poly-fluoroalkyl substances, are a large and diverse family of chemistries that contain carbon-fluorine bonds, the strongest chemical bonds in organic chemistry. **Fluoropolymers, a specific class of PFAS, possess a unique and vital combination of properties** that allow them to withstand the most challenging and high-stress conditions.



Fluoropolymers can be manufactured using specialty ingredients called **polymerization aids**, which help reduce surface tension to make polymers grow larger. **Whatever polymerization technology is being used, state-of-the-art emissions control technologies are required because fluorinated byproducts will be created regardless of the process or surfactant used.**

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We Know Water Abatement

State-of-the-art technologies for Fluorinated Organic Compound (FOC) reduction are used to process millions of gallons of water each day

Fayetteville – Cape Fear River Barrier Wall

WHAT

$400+M invested in an underground barrier wall adjacent to the Cape Fear River for groundwater abatement that spans over one mile (≈1.6 km), extending as deep as 100 feet (≈ 30.5 m) sub-surface

HOW

The barrier wall works in conjunction with a state-of-the-art groundwater extraction and treatment system

RESULT

99+% of captured PFAS compounds removed, significantly reducing the amount of PFAS compounds reaching the river

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We Know Waste Abatement

Waste reduction strategies include solid waste disposal, waste incineration plants, waste minimization strategies, and recycling fluorinated surfactants

Washington Works – Optical Sorter

WHAT

Nearly three-quarters of a million dollars spent on an optical sorter

HOW

Defective material detected and removed from produced product by scanning with > 100 cameras and using puffs of air, directed by AI, to remove the defective material, saving the otherwise lost batch of 99.9% in-specification material

RESULT

Increased yields of first-quality PFA and more than 100 MT of waste reduced in 2023

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We Know Air Abatement

State-of-the-art abatement technologies, including thermal oxidizers, adsorption, fugitive emission detection and controls, and treatment of dilute vapor streams containing low-boiling compounds, reduce FOC and greenhouse gas emissions.

Dordrecht – Sequoia

WHAT

$75 million invested in abatement technologies including air abatement

HOW

Air streams are captured and routed to activated carbon filtration

RESULT

Reduces emission of HFPO-DA and its salts to the air by more than 99%

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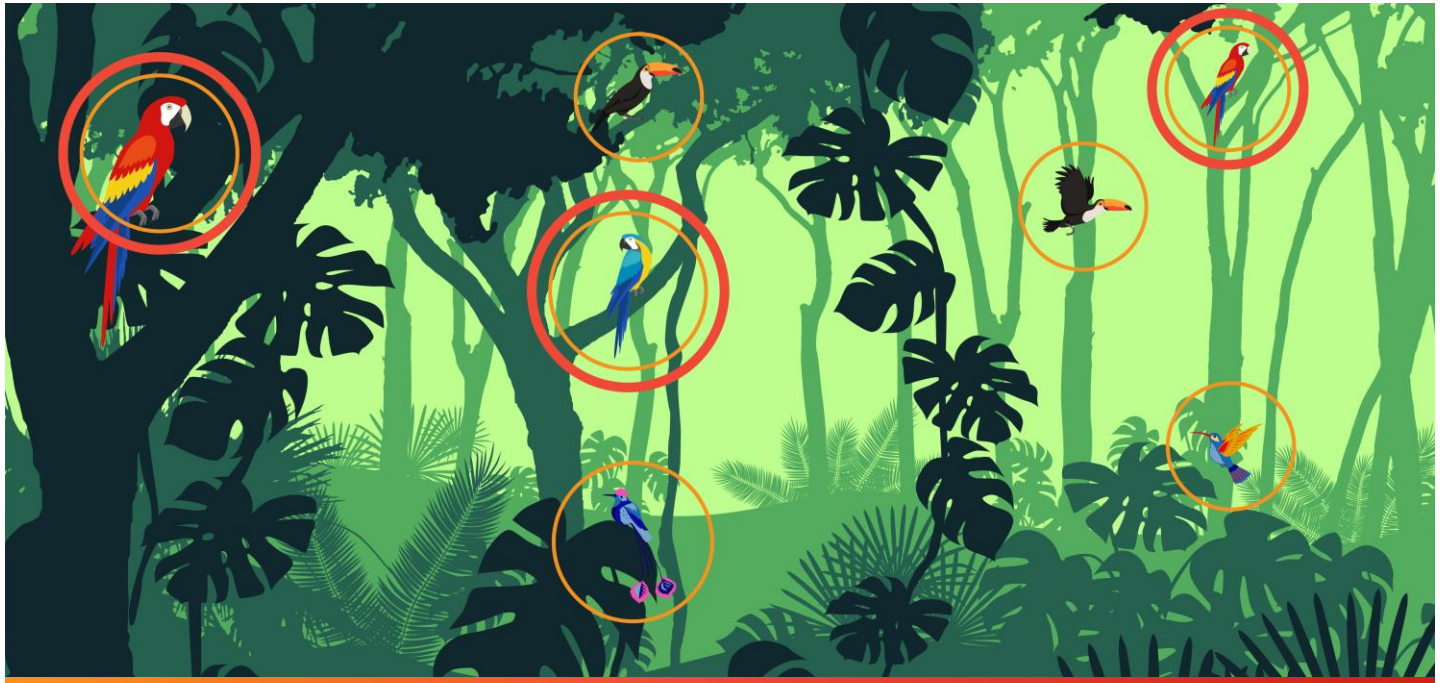
A Different Kind of Measurement Standard



You are asked to count how many birds are in the jungle. Targeted analysis is searching for parrots in the jungle: no parrots means no birds. Non-targeted is searching for birds: so even if you find no parrots, you may still find other birds.

This is how fluorinated byproducts from use of non-fluorinated polymerization aids are measured today.

Targeted

Only searches for known substances, about 70 PFAS substances, missing potentially countless other unknown byproducts.

Measures exact quantities of those targeted substances.

Non-Targeted

Identifies all potential byproducts.

With this information, a targeted analysis may be developed to determine exact quantities of an identified compound.

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We Know Polymerization Aids & Surfactants

Non-fluorinated polymerization aids/surfactants (NFPA/NFS) are not the solution to sustainability needs—nor is removing NFPA/NFS from the process altogether. This is because regardless of what surfactant or process is used in the manufacture of fluoropolymers, fluorinated byproducts are created and need to be abated.

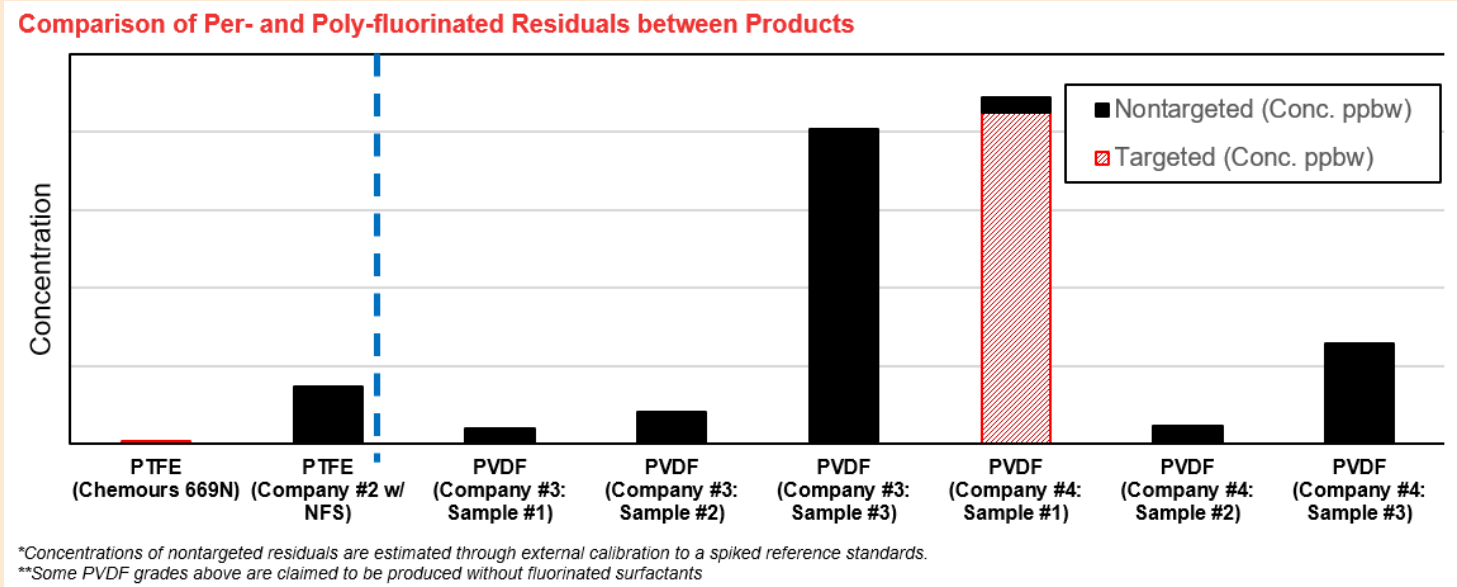
PTFE with fluorinated and non-fluorinated surfactants

Using fluorinated polymerization aids:

Less than 150 ppb of detectable emissions & residues, mainly from FPA itself

Using NFS:

Generates several other sub-families of non-polymeric PFAS due to interaction between the NFS and the monomers, leading to 2,600-2,700 ppb of residue – significantly higher than when using FPA.



A Different Kind of Approach to Polymerization Aids

Chemours is driven by innovation and that includes **actively researching** and testing alternative polymerization aids.

Considered Factors of Alternatives

- ✓ Improvement in environmental footprint
- ✓ Residuals generated in polymerization
- ✓ Product processing and performance requirements
- ✓ Customer and application performance needs
- ✓ Technical feasibility at commercial scale

Key Achievements

200+
alternative surfactants investigated

120+
alternative surfactants tested

9
alternative surfactants in performance/plant scale

Launched
NFS Viton™ 20+ years ago

Launched
Viton™ FWRD APA 2023

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We’re proud and being recognized…

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RECAP & SUMMARY

Fluoropolymer Safety, Regulatory Considerations, Responsible Manufacturing

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Recap & Summary

Fluoropolymers are **safe** and **necessary** for societal advancement.

Current regulatory proposals and narratives are **inconsiderate of key scientific realities**.

A better way to regulate:

- ✓ Exempt fluoropolymers (polymers of low concern) from the restriction.
- ✓ Define science-based and most robust and rigorous standards for chemical manufacturing.
- ✓ Create a regulatory benchmark for the safe manufacture and use of chemicals that drives innovation and the sustainable transformation of the economy.

Chemours already employs a holistic, scientific approach to responsible manufacturing and can help lead the industry toward cleaner, safer fluoropolymer production.

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