



Alternatives to Long-Chains

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Long-Chain Perfluoroalkyl Acids

From OECD PFC Web Portal:

- Perfluorocarboxylic acids (PFCAs) with carbon chain lengths 8 and higher, including perfluorooctanoic acid (PFOA);
- Perfluoroalkyl sulfonates (PFSAs) with carbon chain lengths 6 and higher, including perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonate (PFOS); and
- Precursors* of these substances that may be produced or present in products.

For definition purposes "precursor" means a substance that has been recognized as having the potential to degrade to perfluorocarboxylic acids with a carbon chain length of 8 and higher (including PFOA) or perfluoroalkyl sulfonates with a carbon chain length of 6 of higher (including PFHxS and PFOS).

Why Transition to Alternatives

Regulatory Direction

- US
- Europe
- Canada

Global Chemicals Management Direction

- Stockholm Convention: Listing of PFOS
- SAICM: Emerging Issue

The Global Business Direction



What are the Alternatives?

Transition Paths

Fluoro-Surfactants (primary path)

- From ≥ 6 -Carbon to 4-Carbon-based Sulfonate chemistry
- From ≥ 8 -Carbon to 6-Carbon Fluorotelomer chemistry
- From 8- and 9-Carbon Perfluorocarboxylate Polymerization Aids (PFOA/PFNA) to certain Mono- and Poly-perfluoroethers or other substances

Fluoro-Surface Property Modification Agents (primary path)

- From ≥ 6 -Carbon to 4-Carbon-based Sulfonate chemistry
- From ≥ 8 -Carbon to 6-Carbon Fluorotelomer chemistry

Non-fluorinated surfactants

e.g., hydrocarbons, siloxanes, and silicone polymers



Do The Alternatives Work?

Effectiveness of Fluoro-Alternatives

- **C-6 and C-4 chemistries meet the criteria for replacement of most current C-8 and higher homologue uses**
- **Requires consideration throughout the value chain**
 - from manufacturers and processors in a wide range of downstream industries
 - from consumer product manufacturers to defense and aerospace industries

Non-Fluorinated Chemistries

“Non-fluorinated alternatives, such as different hydrocarbon surfactants and silicone products, have been identified.... however,... in most cases or at least in larger application areas, other fluorinated compounds are used instead.... **non-fluorinated alternatives do not work as well, especially in situations, where extreme low surface tension is needed**” (Danish EPA, 2006)



Data on Alternatives?

Data on Alternatives

Adequate supporting data on the alternatives have been submitted to obtain regulatory approvals for supported uses

Elimination Half-Life in plasma (alpha-phase) Single Oral Dose

Elimination $t_{1/2}$ (Days)		PFBS	PFHxA		PFOA	PFOS
Rat		0.2	0.2 – 0.05		5	25
Monkey		4	1		21	45
Human		26	no data		1000	1500

- Data taken from multiple references
- C4 sulfonate (PFBS) and C6 carboxylate (PFHxA) have significantly shorter half-lives than PFOS & PFOA

Summary for the Alternatives

- There will likely not be one single replacement but rather several alternatives
- Fluoro-alternatives exist for most but not all current uses
- Non-fluorinated alternatives are available for some applications but may not work as well
- Alternatives with a shorter fluorinated alkyl chain are persistent in the environment but have rapid bioelimination
- Many in the global community are moving quickly to replace uses of C-8 and higher homologues, with obvious future regulatory and business implications



Questions?

Thank You

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