

TORONTO WORKSHOP MATERIALS

September 13-14, 2004

Fluorotelomers

What are they?
How are they made?
How are they used?
How do they enter the Environment?
What is their Environmental Fate?

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Fluorotelomers

What are they?



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Terminology

Fluoro-Organics - Fluoropolymers - Fluorochemicals

different chemically & in their uses

Fluoro-Organics

- include Fluorotelomer & ECF chemicals
- "short" fluorine chains attached to organic polymer backbones [F(CF₂)₈-]
- surface modification & protection
- surfactants
- water & oil repellency

Fluoropolymers

- high MW (10⁷) polymers
- PTFE [F(CF₂CF₂)_n F] & Melt Copolymers
- fluorinated "backbone"
- chemical resistance
- cookware, CPI linings, aerospace, automotive, apparel, construction, etc

Fluorochemicals

- small molecules
- 1 - 8 carbons
- refrigerants
- cleaning solvents
- blowing agents
- CFC alternatives

Fluoropolymer Manufacturing Group : 3M / Dyneon, Daikin, Asahi Glass, DuPont
Telomer Research Program : Asahi Glass, Clariant, Daikin, DuPont

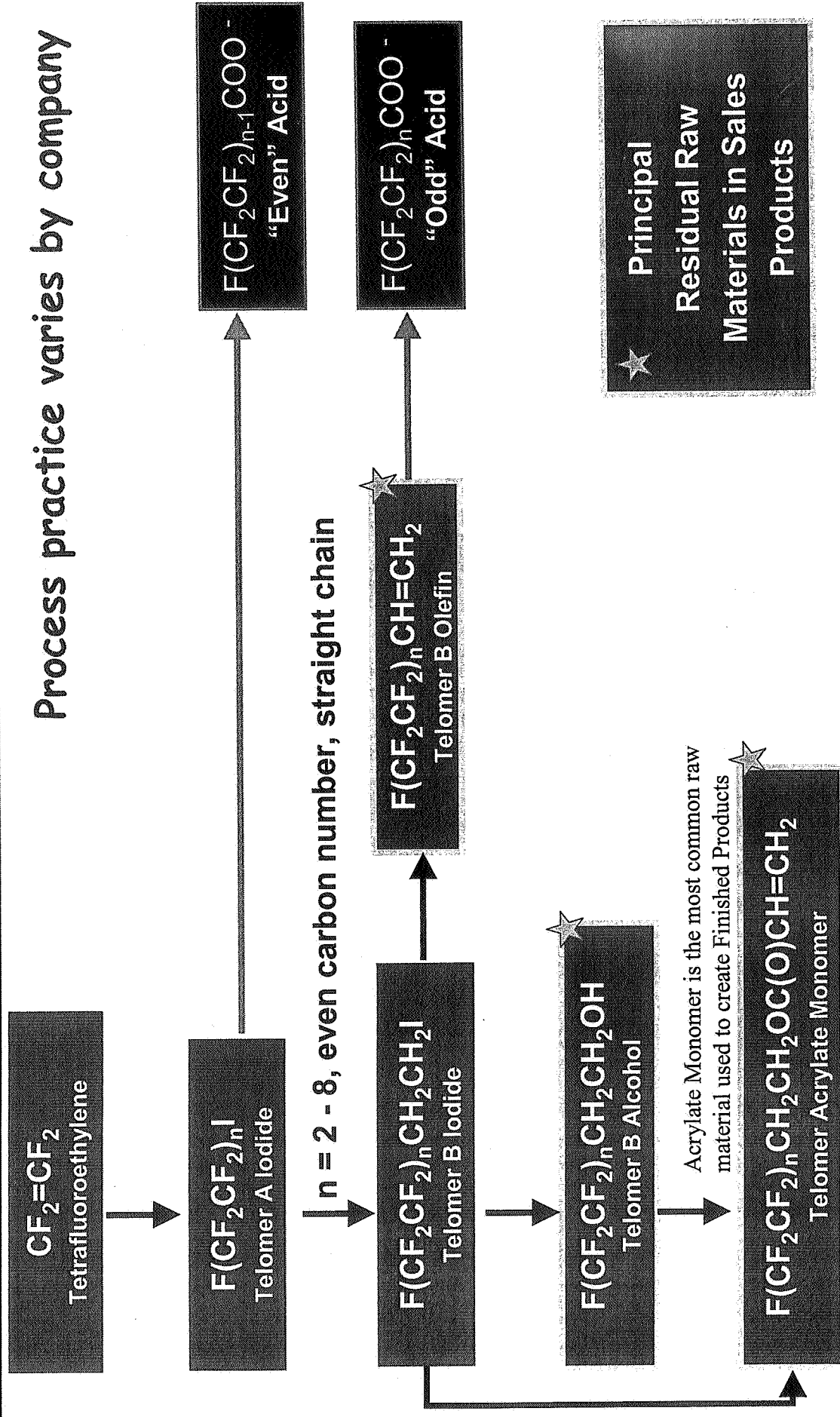


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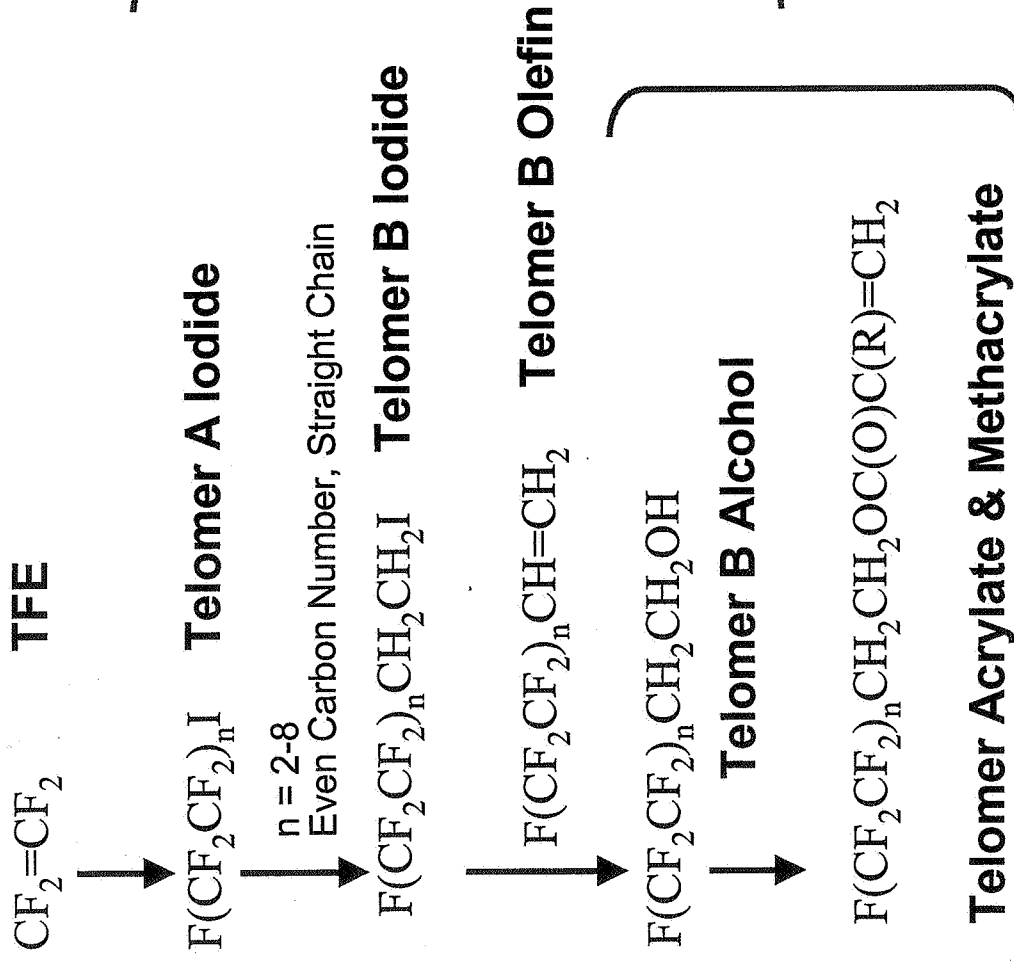
Fluorotelomers

How are they made?

Fluorotelomer Manufacture



Fluorotelomer-Based Products



Surfactants

- Anionic - Phosphate, Carboxylate, Sulfonate
- Nonionic - Ethoxylate
- Betaine
- Primarily $\text{F}(\text{CF}_2)_6$ - Based

Polymers

> 80% of all Sales Products

- Acrylic
- Ester
- Amide
- Urethane
- Urea
- Primarily $\text{F}(\text{CF}_2)_8$ - Based



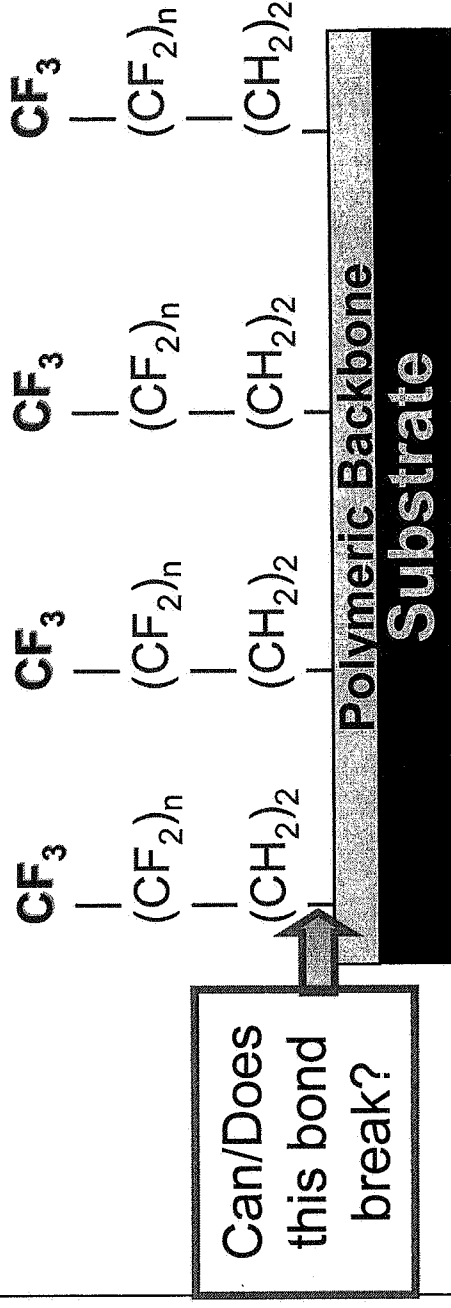
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How do the Polymeric Products Work ?

- The fluorotelomer functionality is attached to a functional backbone which adheres to the substrate surface.

- The fluorocarbon chain orients perpendicular to the surface, at the air interface.

- CF_3 Groups give very low surface tension
- the $-(\text{CF}_2)_n$ chain is rigid



bulk properties are unaffected

Telomer Production Mass Balance

AR226-1141

- Global *Telomer A Iodide* equivalents produced in 2000-2002
 - approximately 5 - 6.5 Million kg/yr **Telomer A Iodide = $F(CF_2CF_2)_nI$**
- Regional Product Distribution : North America - 40%

Europe - 30%

Asia Pacific - 30%
- Polymers : 80% of total product manufacture (acrylate)

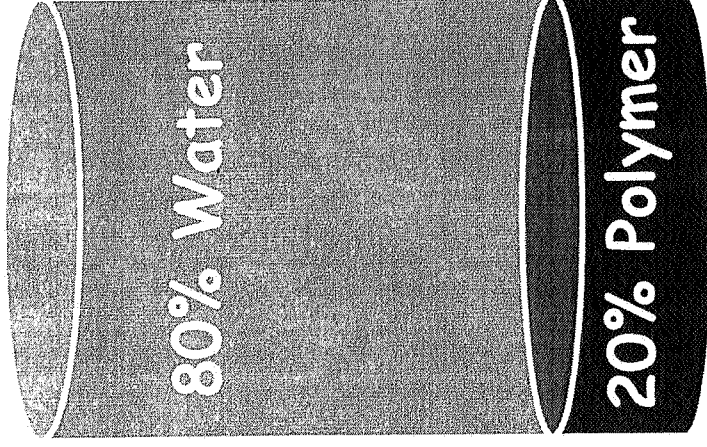
	C4	C6	C8	C ≥ 10	Total
% of Telomer Production	4%	16%	46%	33%	100%
Polymer	99%	45%	85%	88%	80%
Non-Polymer	1%	55%	15%	12%	20%



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Polymeric Product Dispersion

- Aqueous Dispersion of....
- Polymeric Particles 100-200 nm
- Hydrocarbon Surfactant(s)

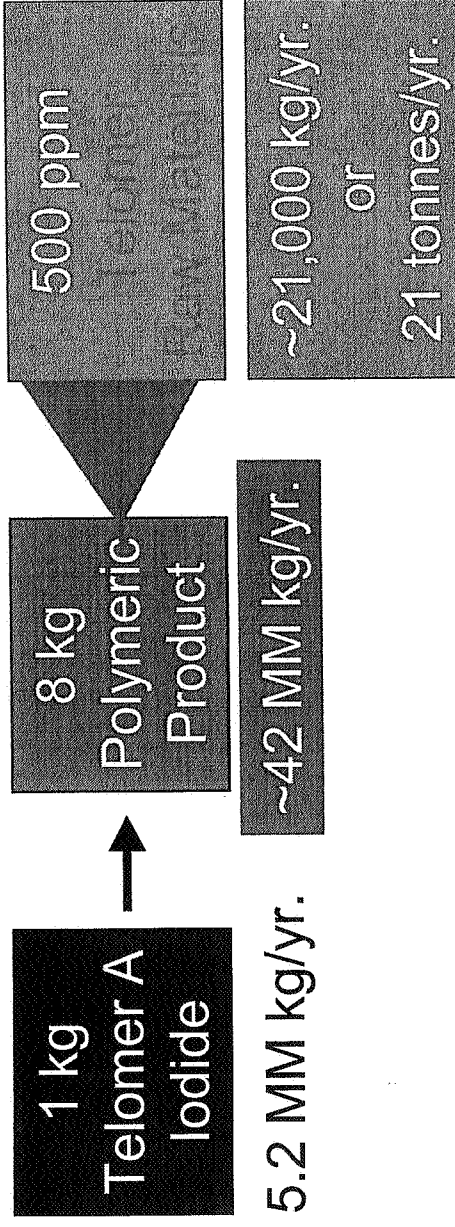
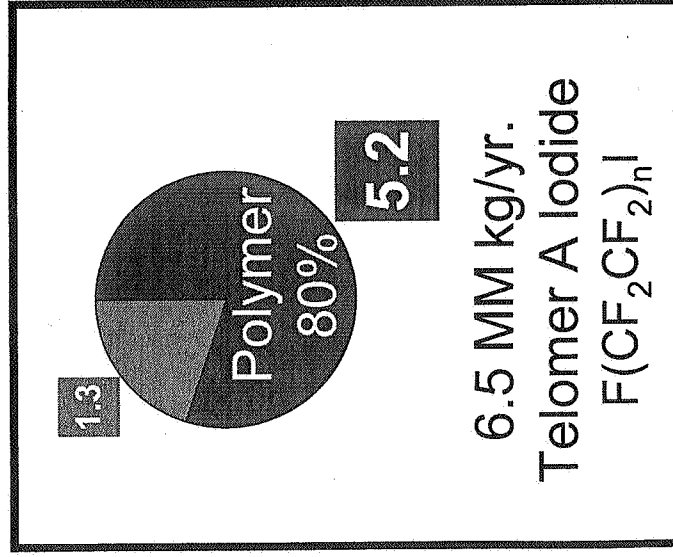


“Typical” Polymeric Product

- wt.% Active Ingredient (~ 20-30 %)
- wt.% Fluorine (~ 6-10%)
- ~500 ppm Residual Raw Materials
 - Telomer B Alcohol
 - Telomer B Olefin
 - Telomer Acrylate Monomer
- Polymer $M_w \geq 10,000$

Fluorotelomer Raw Materials

Environmental Release Estimate



Includes all telomer
raw materials

- 21 tonnes does *not* account for the 100 -1,000 tonnes annual flux computed to be needed to account for reported *Telomer B Alcohol* measured air concentrations
- *Environmental Science and Technology* (2004), 38(4), 991-996.

Fluorotelomers

How are they used?



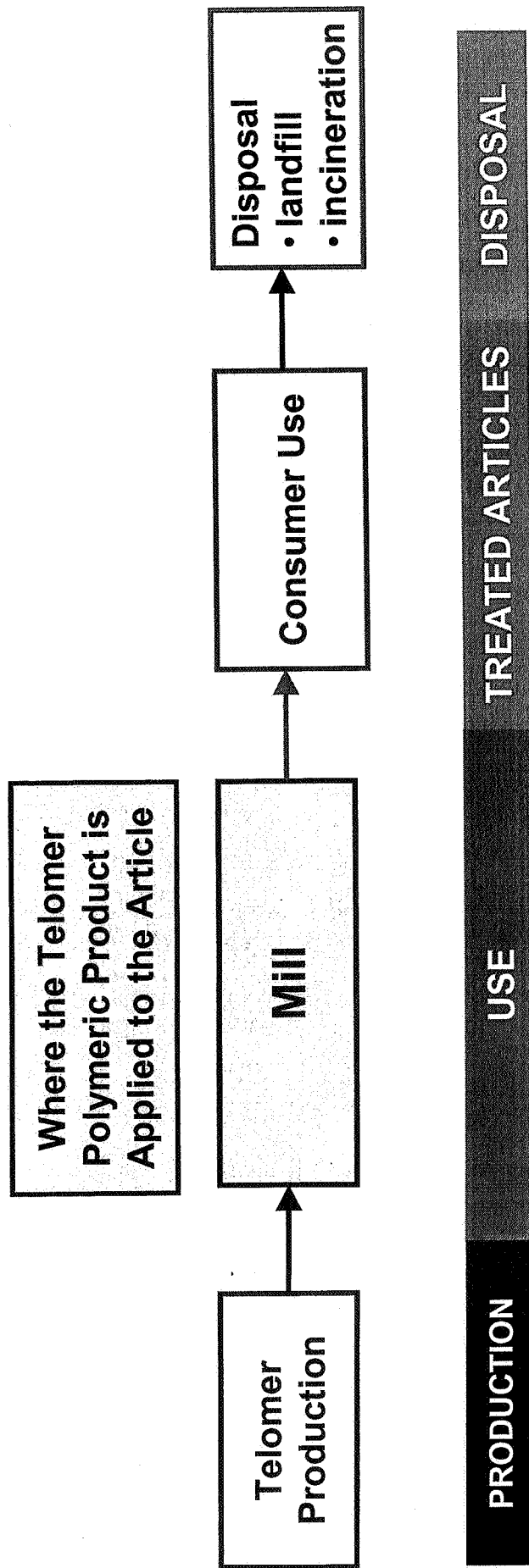
Commercial Uses

- **Functionality**
 - Oil and water repellency
 - Stain and soil resistance
 - Lasts longer, stays looking new
- **Amount**
 - 0.1 - 0.8 wt% polymer
- **Uses**
 - Apparel & Home Furnishings
 - Carpet
 - Paper
 - Stone & Tile
 - Leather

Fluorotelomers

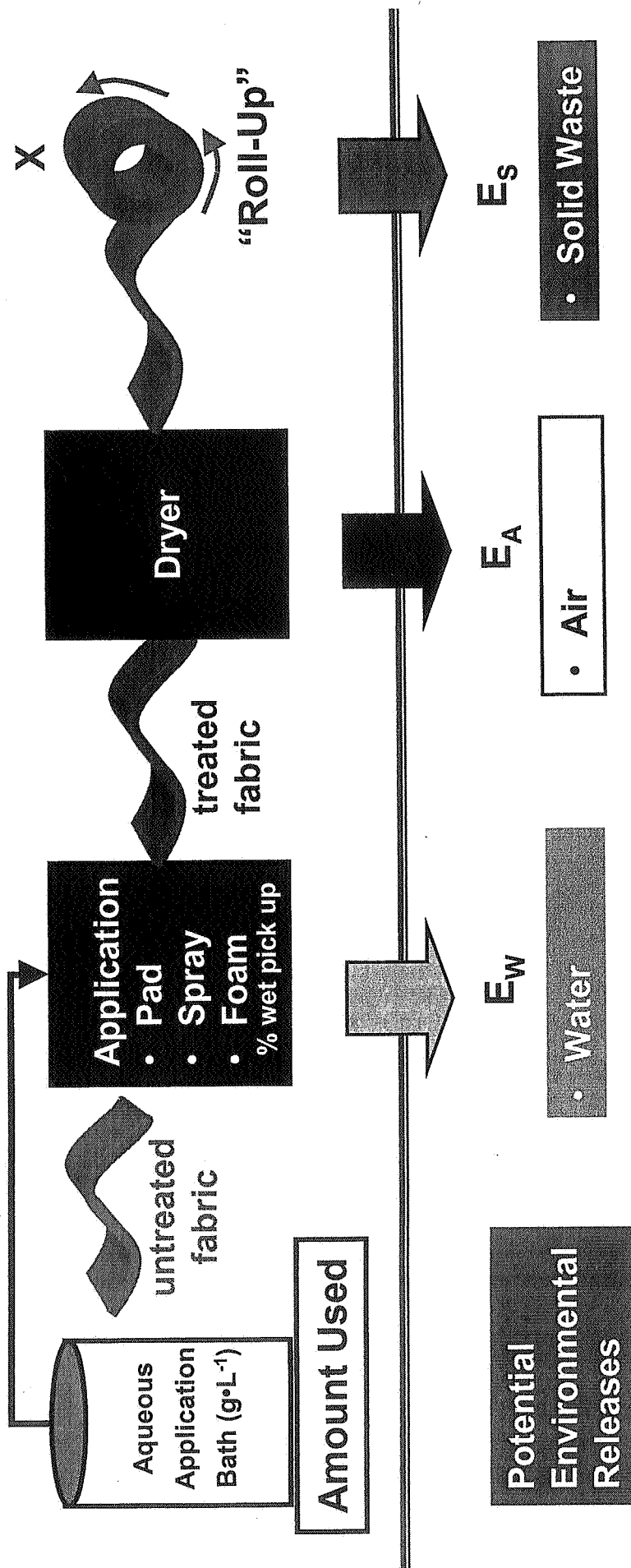
How do polymers enter the
Environment?

Product Trail Example



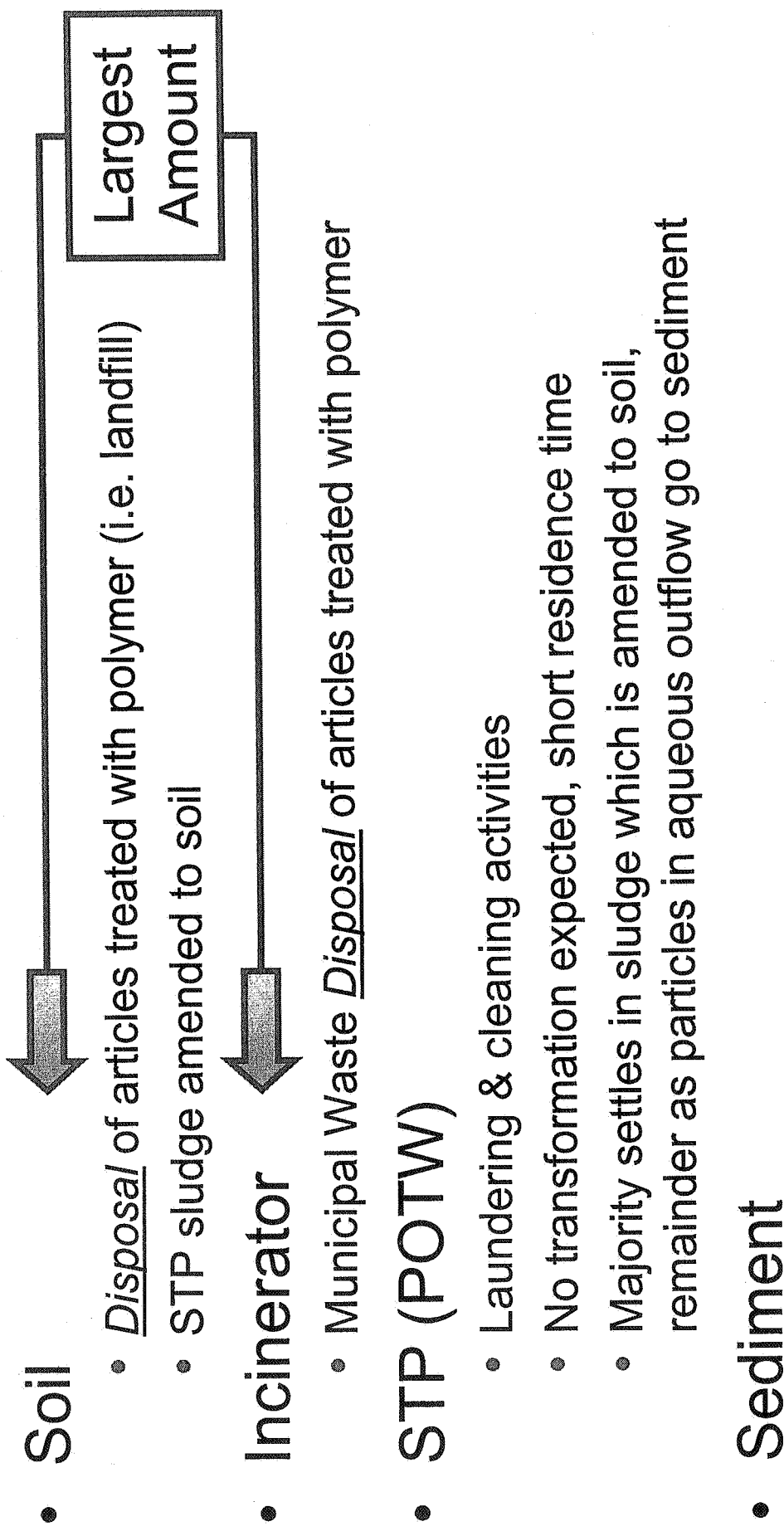
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Mill Application



$$\text{Mass Balance : Amount Used} = X + E_w + E_a + E_s$$

Polymers: Route(s) to the Environment



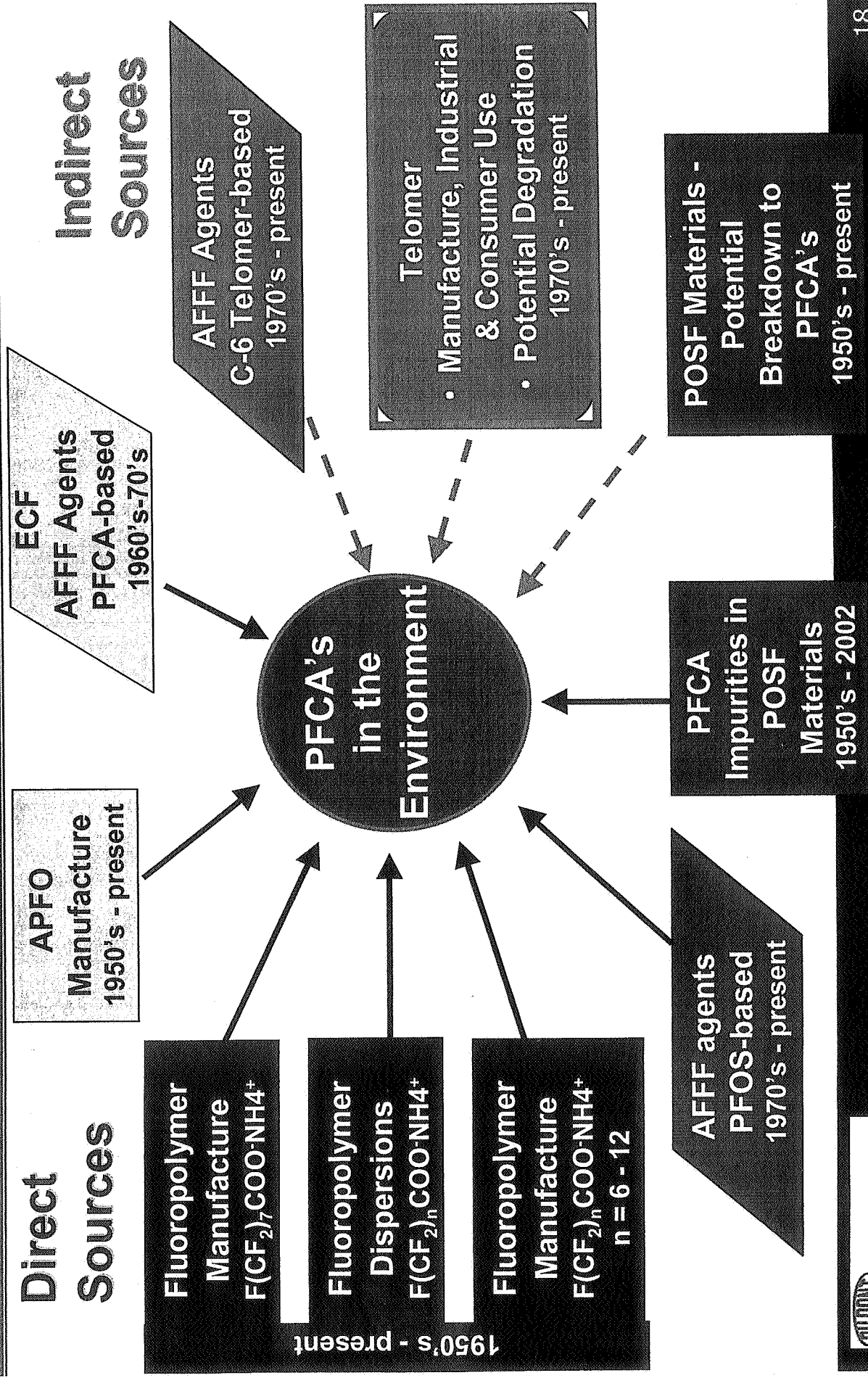
~75% of Polymer remains on the article at Disposal

Fluorotelomers

What is their Environmental Fate?

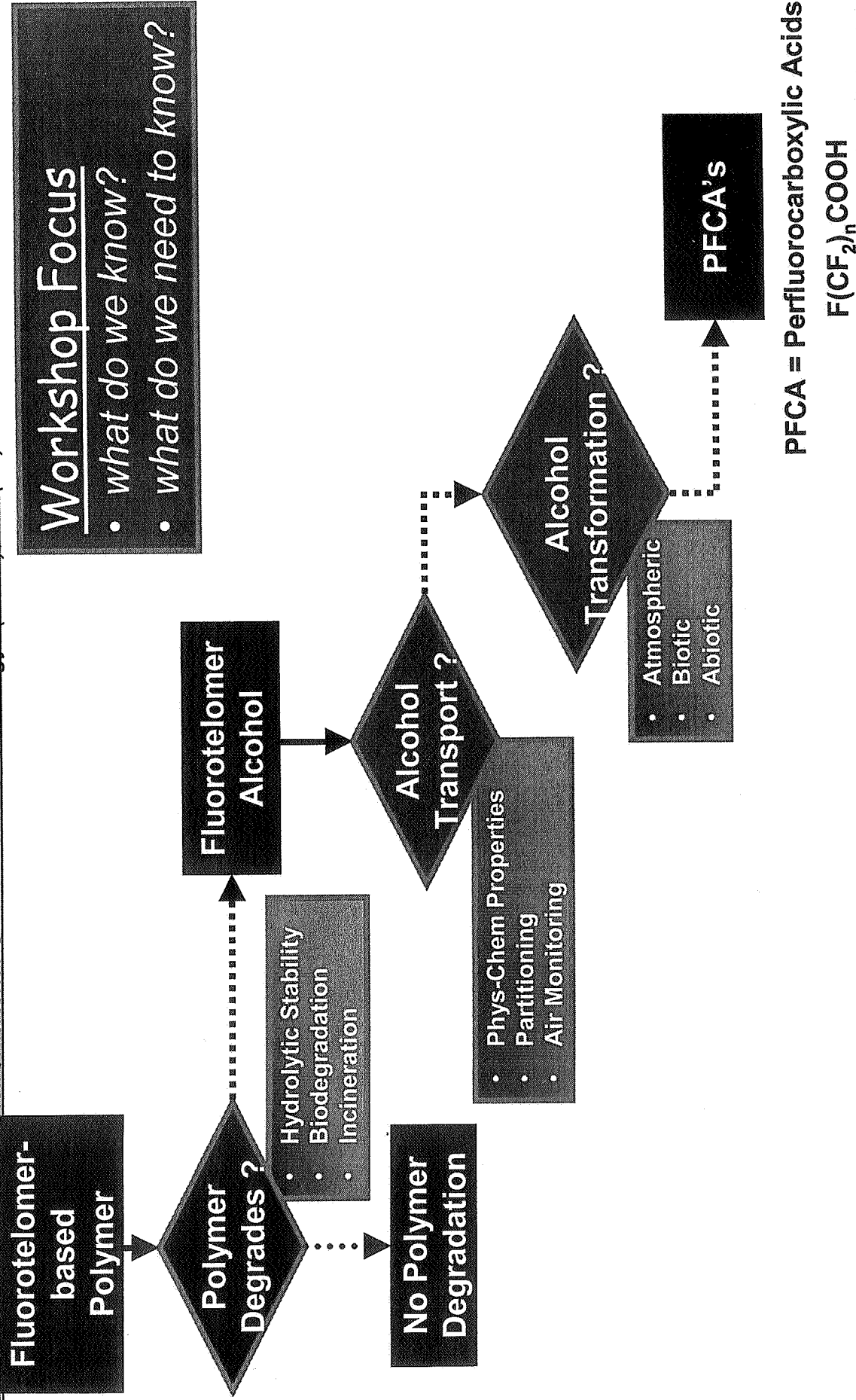
Are they a source of
perfluorocarboxylic acids (PFCAs)?

Potential PFCA Sources : $F(CF_2)_n COO^-$



Environmental Fate Hypothesis

Environmental Science and Technology (2004) 38(12) 3316-3321



Thank You !



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Release, Fate and Effects Compartments

