Environmental Fate Studies of Fluorotelomer Intermediates and Fluorotelomer-based Surfactants and Polymers

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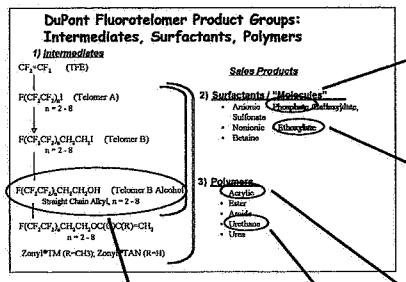
ABSTRACT

Fluorotelomer intermediates are used to manufacture fluorotelomer-based surfactants and polymers, which provide unique properties in a wide variety of consumer products. Fluorotelomer intermediates were initially selected for study because they were expected to be among the possible compounds into which the fluorotelomer-based surfactant and polymer products may potentially degrade. Our environmental fate research has focused primarily on the fluorotelomer intermediate 8-2 Telomer B Alcohol [8-2 TBA; $CF_3(CF_2)_7CH_2CH_2OH$], which we have shown to be hydrolytically stable [half-life ($t_{\frac{1}{2}}$) > one year] and non-toxic to microorganisms at concentrations greater than 100 mg 8-2 TBA L^{-1}. Our research in this area has expanded to include environmental fate studies on the fluorotelomer-based surfactants and polymers. We will summarize the environmental fate studies that we have conducted on the 8-2 TBA, including an air/water/soil partitioning experiment. We will also discuss biotransformation experiments that we performed on the fluorinated surfactants and polymers.

Biodegradation of Telomer surfactants and Polymers

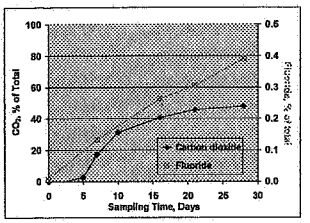
- 28-Day CO_2 Evolution Test
  - Test substance primary C source
  - 20 mg C/L
  - $Ba(OH)_2$ to trap CO_2
  - Fluoride measured with Ion-specific electrode

DuPont Fluorotelomer Product Groups: Intermediates, Surfactants, Polymers



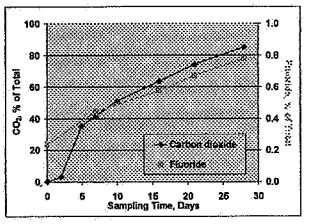
Telomer Phosphate Surfactant

- Water-soluble, anionic
- $(RfCH_2CH_2O)xP(O)(ONH_4)y$
  - where
    - Rf = $F(CF_2CF_2)z$
    - X = 1 or 2
    - Y = 2 or 1
    - X + y = 3
    - Z = 1 to ~ 7

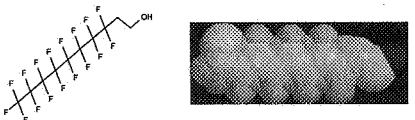


Telomer Ethoxylate Surfactant

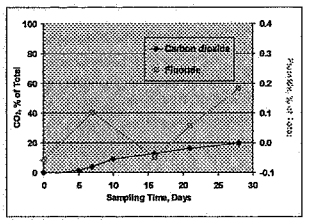
- Water-soluble, nonionic
- $RfCH_2CH_2O(CH_2CH_2O)xH$
  - where
    - Rf = $F(CF_2CF_2)y$
    - X = 0 to ~ 25
    - Y = 1 to ~ 9



8-2 Telomer B Alcohol: 8-2 TBA

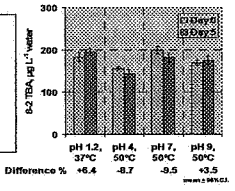


Telomer Acrylic Polymer

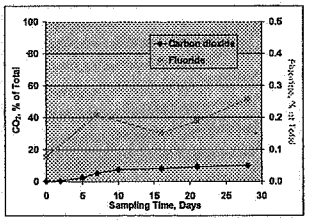


Aqueous Stability

- 150 µg 8-2TBA L^{-1}, sterile conditions
- pH 4, 7, 9 @ 50°C
- pH 1.2 @ 37°C
- Sealed glass vials with Al-foil liners
- 4 replicates at 0 and 5 days
  - Analyzed with GC/MS

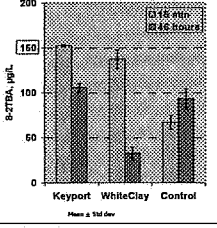


Telomer Urethane Polymer



Soil / Water Partitioning

- Two materials
  - Keyport silt loam
    - Sand 17%, Silt 62%, Clay 21%, pH 5.3, OM 4.0%
  - White Clay Creek sand
    - Sand 98%, Silt 2%, pH 7.2, OM 0.4%
- Mix for 15 m and 46 h, separate phases
- Extracted with hexane from solid and water phases, SPE to clean, analyzed



Summary: Surfactants and Polymers

- Not ready biodegradable
  - Ethoxylate surfactant CO_2 production >60% of total but not within 10-day window after 10% of total
  - Phosphate surfactant and polymers CO_2 production <50% of total
- F^- production <1% of total

Summary: 8-2 TBA

- Hydrolytically stable; half-life > 1 year
- Soil/water partitioning studies may indicate strong adsorption to soils
  - Volatilization is a concern

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