

Bioconcentration Screening of Perfluorinated Compounds Using Fathead Minnows

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Introduction

Perfluorinated compounds have been the focus of increasing scrutiny by regulatory agencies and the industries that manufacture these compounds.

- unique properties
 - potential environmental persistence
 - potential bioconcentration in fish

An initial screening evaluation of potential bioconcentration was conducted using fathead minnows.

- positive control (PFOS), a fluorotelomer alcohol, and a fluorotelomer urethane polymer



Introduction

Acute 96-hr LC₅₀'s

PFOS 7.8 mg/L bluegill, 9.5 mg/L – fathead minnow

Tel. B Alcohol > WS (140 ppb) – zebrafish, 316 mg/L – fathead

U-polymer > 1581, 4000 mg/L – fathead minnow

Test Design

- Continuous flow-through – 14 volume renewals/day
- Negative, positive control (PFOS), 4 test substances
- Single test concentration ~ 10 µg/L as total fluorine
 - nominal test substance conc's from 13 – 100 µg/L
- 1 test chamber/test substance; 70 fish /test chamber
- 16 L : 8 D photoperiod
- 14 d uptake phase, 14 day depuration phase
- Fish fed ~ 2% body weight; frozen brine shrimp
- Loading – 0.2 g/L/day

Sample Analysis

- Analysis of stock solutions from Day 0 and Day 13

- Sacrifice of fish, uptake phase:

 - days 0, 2, 5, 7, 9, 12, 14

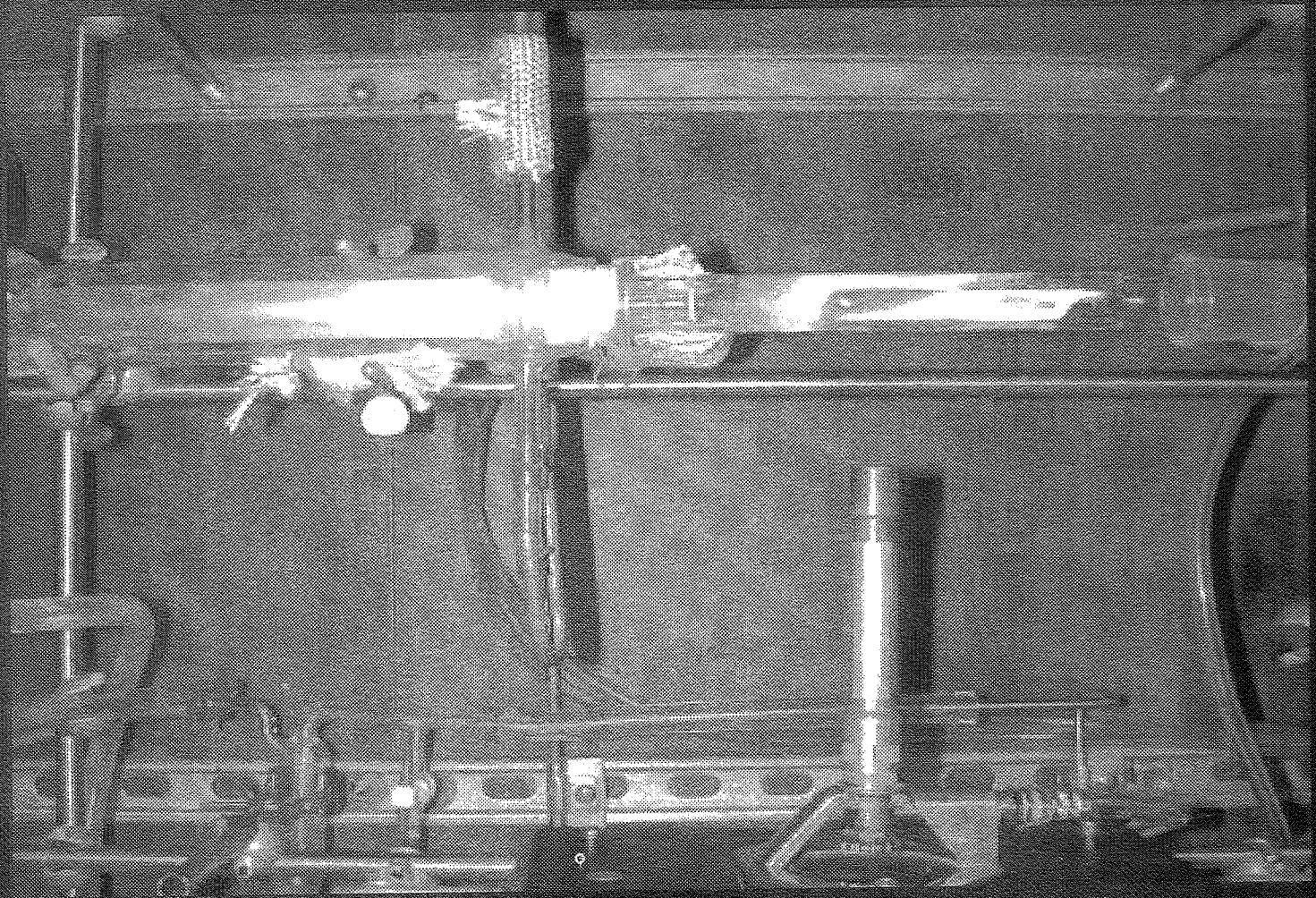
- Sacrifice of fish, depuration phase:

 - days 16, 19, 21, 23, 26, 28

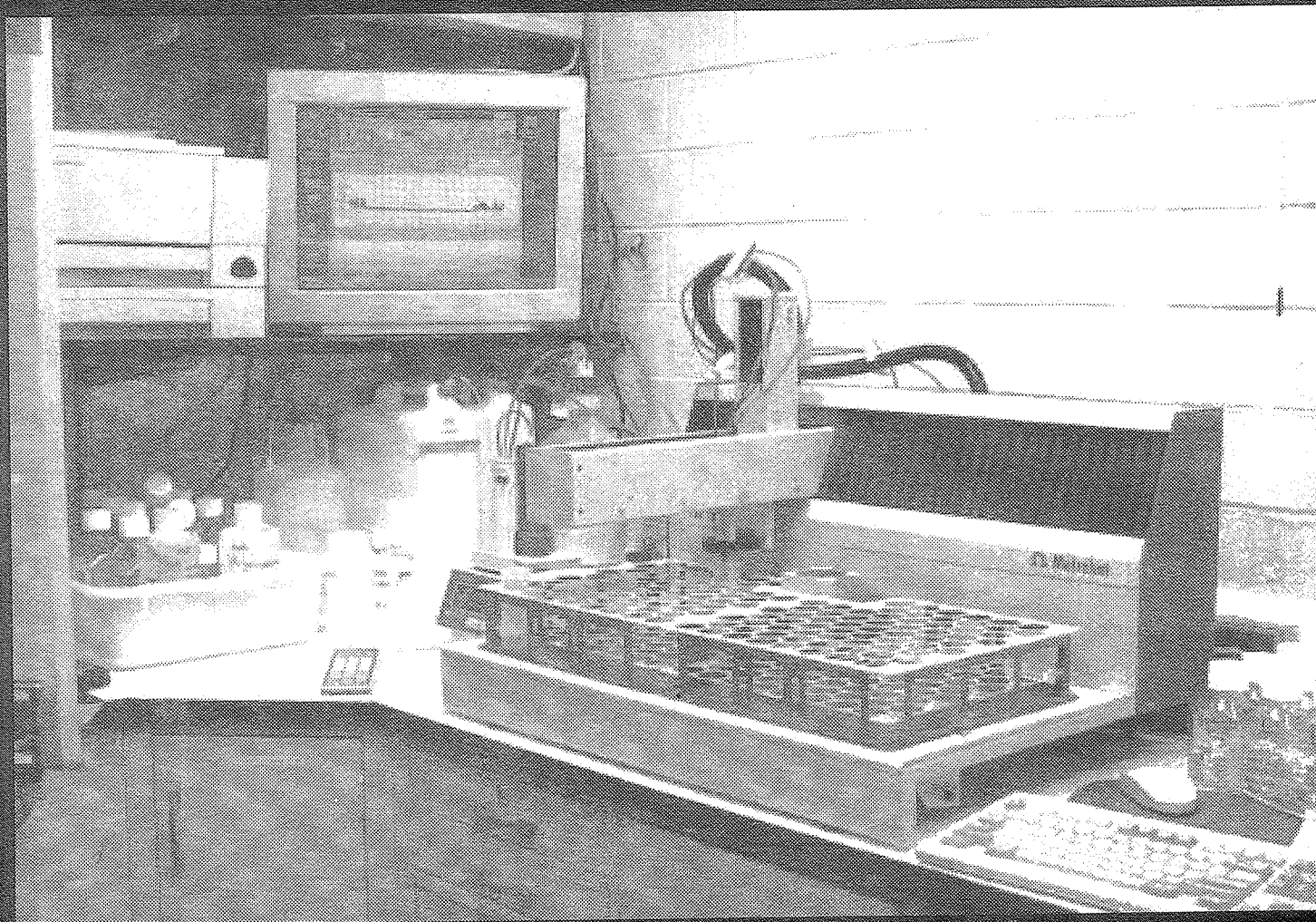
- Fluorine Analysis

 - sample combustion using Wickbold torch; mineralization of sample and conversion of organic F to inorganic fluoride
 - ion selective measurement of fluoride

Wickbold Torch



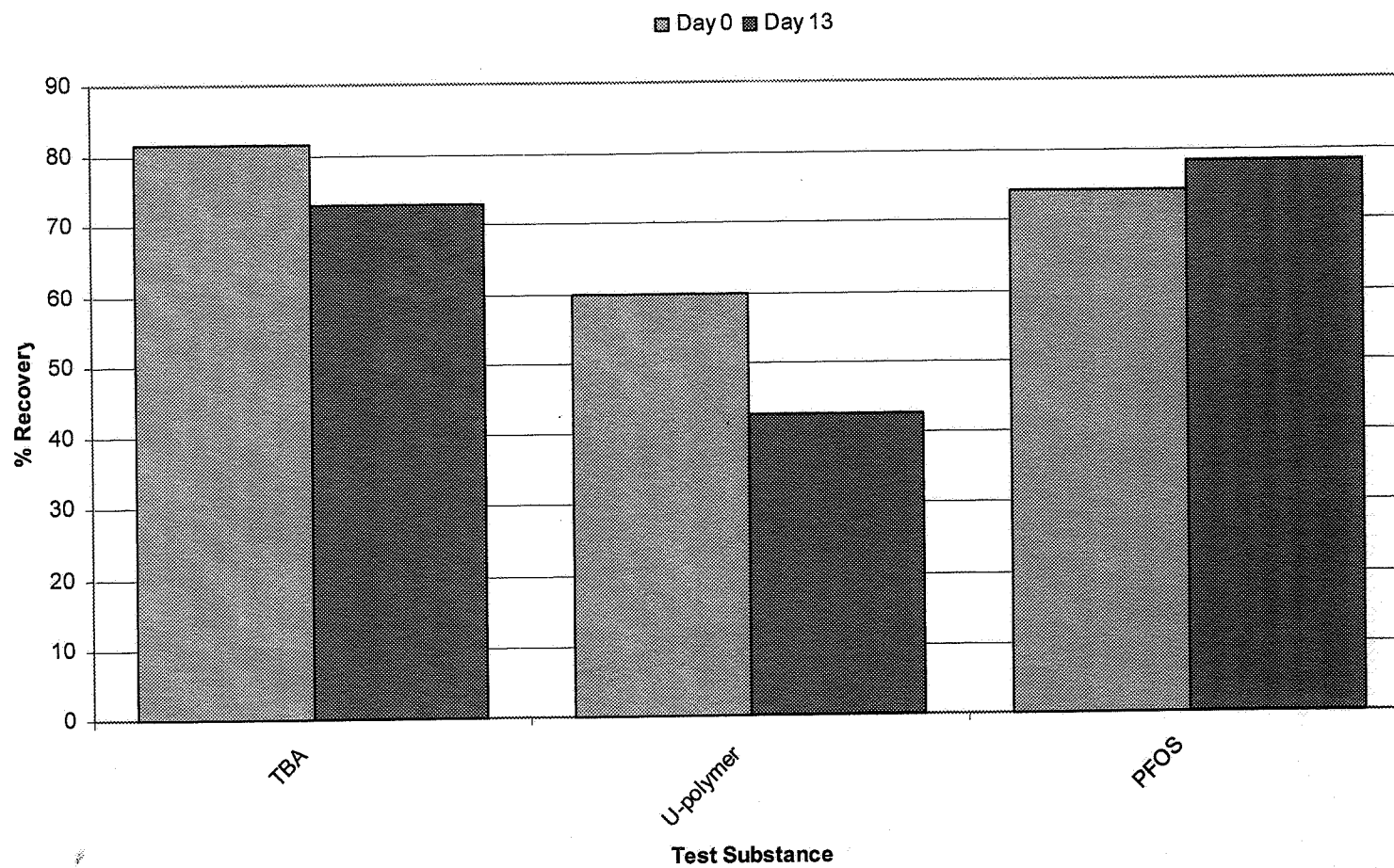
Ion Analysis





Results

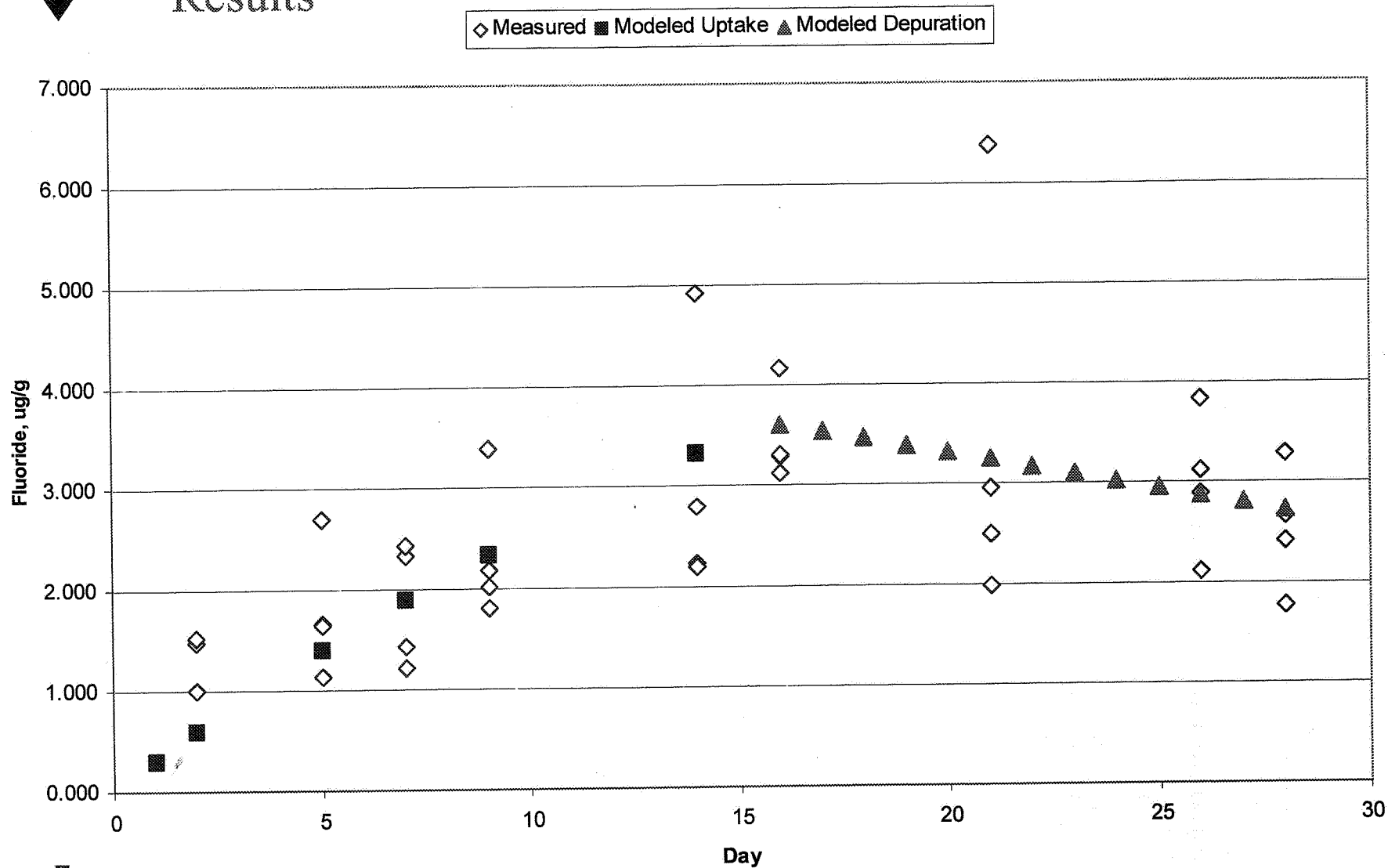
Stock Solutions - % Recovery of Test Substance as Fluoride

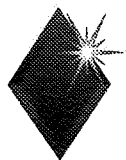




Results

PFOS Uptake and Depuration

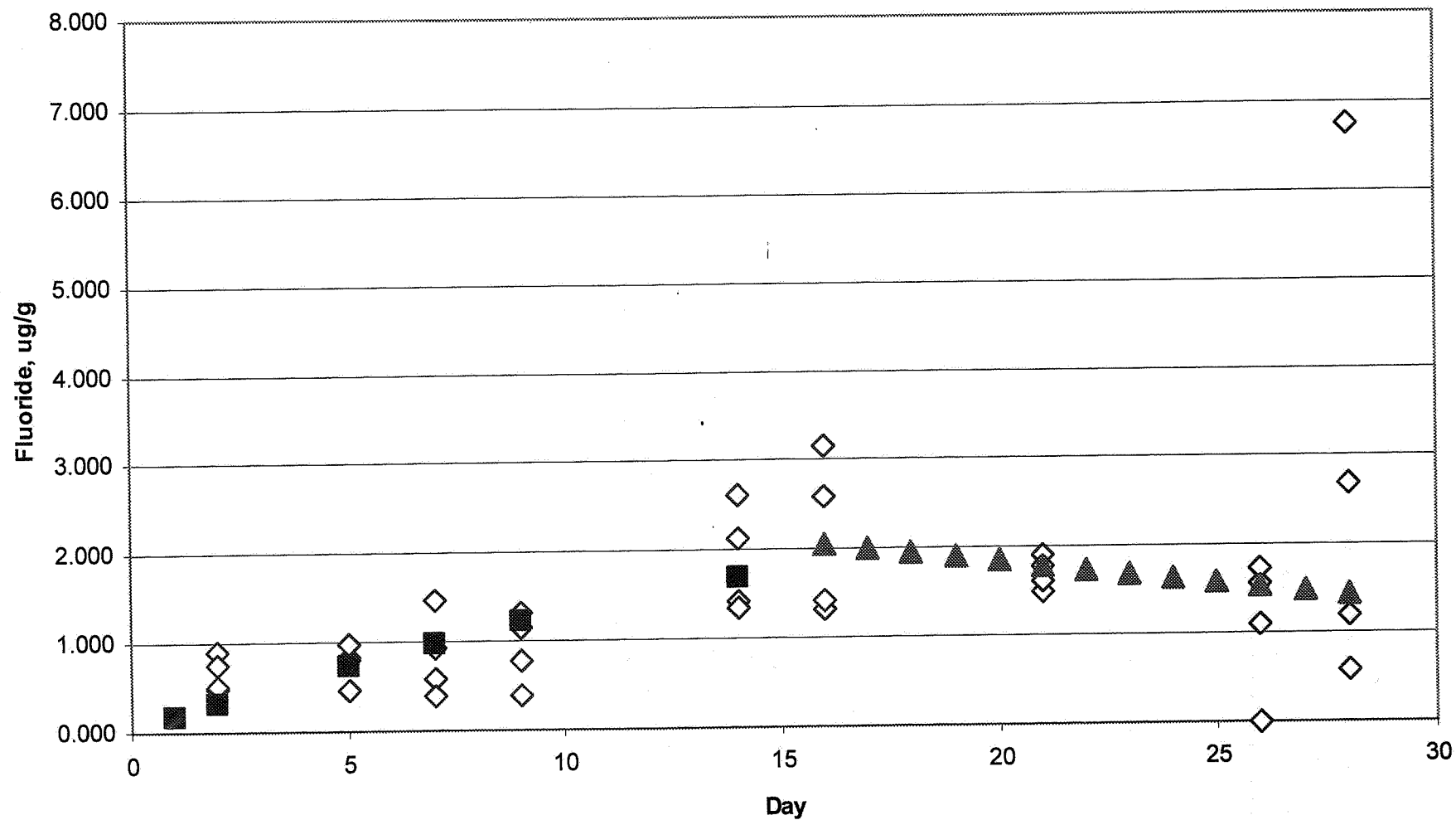


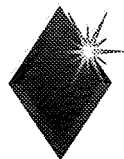


Results

Urethane Polymer Uptake and Depuration

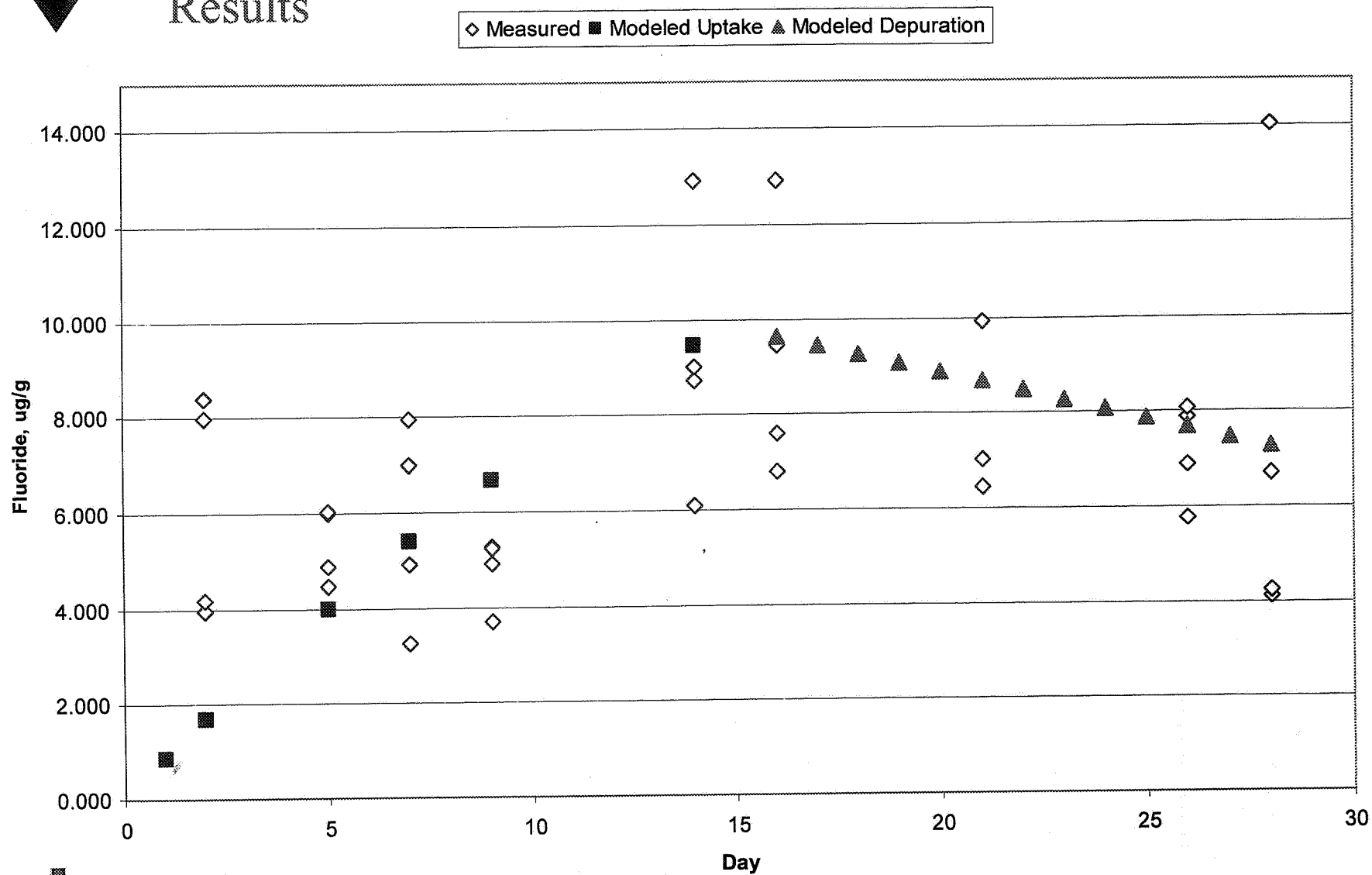
◇ Measured ■ Modeled Uptake ▲ Modeled Depuration





Results

Zonyl BA (Telomer B Alcohol) Uptake and Depuration



Results

No SS for PFOS, Polymer or TB Alcohol in 14 days

<u>Test Substance</u>	<u>14-d BCF</u>	<u>k_1</u>	<u>k_2</u>	<u>BCF-K</u>
PFOS	250	0.031	0.04	775
U-Polymer	157	0.0165	0.047	351
Tel B Alcohol	1025	0.0883	0.0401	2202

Comparative Results – PFOS

WLI, Inc., 2002

Bluegill Sunfish – 0.087, 0.87 mg/L; 62 d uptake, 56 d dep

- 0.87 mg/L terminated @ 35 d; 55/90 fish dead

- 0.086 mg/L – BCF-K; Whole Fish = 2796

Martin et al. (2003 a, b) – ETC 22: 189-195, 196-204

Rainbow Trout - carcass BCF-K = 1100 (~ whole body BCF-K)

This Study

Fathead Minnow - BCF-K = 775



Comparative Results – Tel B Alcohol

(METI 2002)

Carp – 0.844, 9.22 $\mu\text{g/L}$; 60 d uptake, 7 d dep.

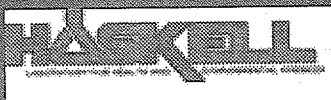
- 9.22 $\mu\text{g/L}$ – mean whole fish BCF, max BCF = 1100

- <u>7 d</u>	<u>14d</u>	<u>21d</u>	<u>28d</u>	<u>42d</u>	<u>60d</u>
380	550	420	950	780	640

- Depuration - < LOD of 26 ng/g within 7 d

This Study

Fathead Minnow - BCF-K = 2202



Uncertainties in Approach

- variability in stock preparation, sample collection,
- variability in sample combustion, fluoride analysis,
- extrapolation from measured F ion in stock solutions to concentrations in test solutions,
- assumption that fish residue is entirely parent compound
- data analysis and model fitting

Conclusions:

- screening BCF test approach; reasonable estimates of BCFs based on values from GLP guideline studies,
 - e.g., PFOS, 775 vs 2796 (fathead minnow, bluegill)
 - Telomer B Alcohol, 2202 vs 950 (fathead, carp)
- the potential bioconcentration of the Telomer B Alcohol is unlikely to be a significant environmental issue based on observed BCF values and its phys-chem properties (low WS, high VP, tendency to sorb).
- the potential bioconcentration of the urethane polymer is also unlikely to be a significant environmental issue based on observed BCF values.

