

ANALYSIS OF POLYCARBONATE PLASTIC BOTTLES UNDER HIGH STRESS CONDITIONS

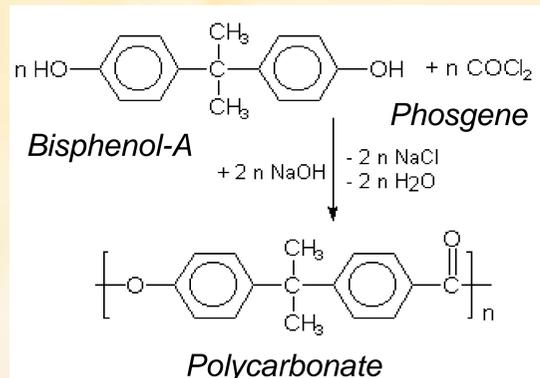
School of Chemical, Biological, and Environmental Engineering

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Subsurface Biosphere Intern 2010

Introduction:

There has been much controversy in recent years over the chemical leaching of Bisphenol-A (BPA) from polycarbonate (Nalgene™, Camelback™) water bottles. This study has been conducted to examine the validity of these claims by exposing polycarbonate bottles to various conditions and analyzing how much (if any) BPA leaches out. New polycarbonate bottles were filled with water and exposed to treatment conditions ranging from 65 to 120 °C. A reverse-phase solid phase extraction process was developed to extract BPA from the water and concentrate it into an organic phase. A Gas Chromatograph (GC) was used to analyze the organic extract. The detection limit of the GC system was 1 part per billion (ppb).

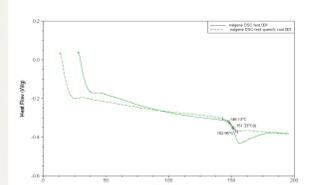
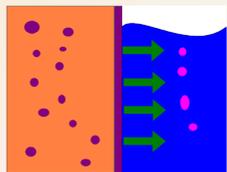
Polycarbonate is produced by the reaction of Bisphenol-A and phosgene (COCl₂), as shown below.



How Leaching Occurs:

Leaching can occur in polycarbonate water bottles in two different ways:

1. Un-reacted Bisphenol-A move through the solid polymer matrix. The un-reacted molecules most likely only travel through the solid polymer matrix at the glass transition temperature (151 C).



2. Surface particles degrading over time.

Objective:

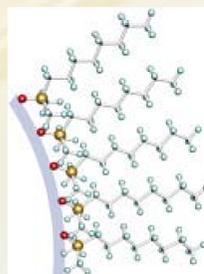
To determine how much Bisphenol-A leaches from polycarbonate water bottles under high stress conditions

Hypothesis:

BPA will leach out of heated polycarbonate water bottles in very small amounts (less than 10 ppb).

Materials:

- Polycarbonate bottles
- Autoclave
- Bisphenol-A (standard)
- Dichloromethane (solvent)
- 1ml, 5 ml, and 10 mL pipettes
- C8 filter



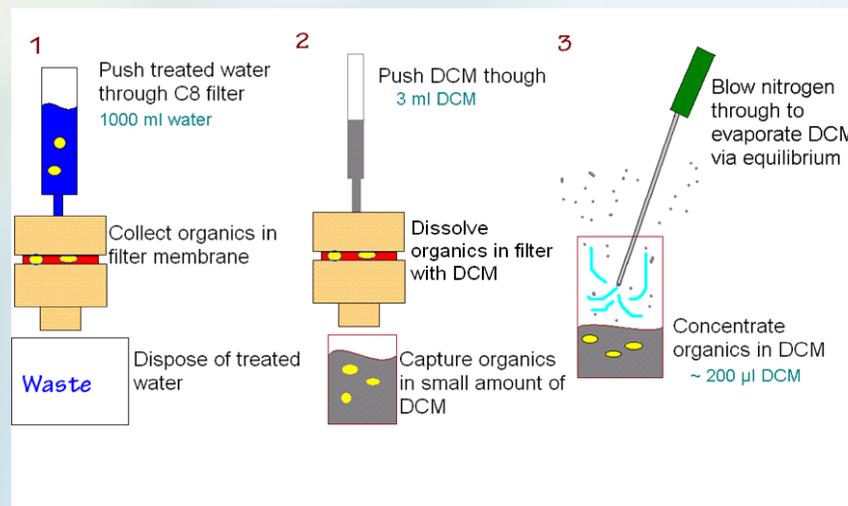
Gas Chromatograph 5890 Series II



• **C8 Filters:** Silica bonded C8 reverse phase solid phase extraction (SPE) filters were used to extract the organic fragments from the water.

Detecting Bisphenol-A:

C8 filters are used in a solid phase extraction process to capture the organic compounds out of the samples. The steps for a reverse solid phase extraction are:

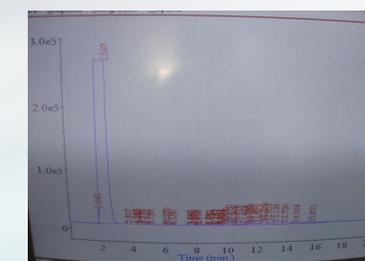
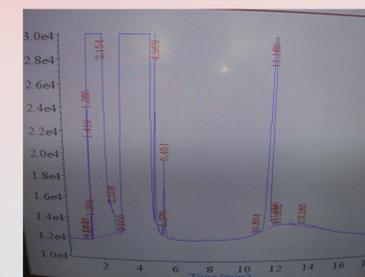


Solid phase extraction process.

- 1) 1000 ml of solution is pushed through the C8 filter.
- 2) The filter is vacuum dried.
- 3) Dichloromethane is pushed through the filter and the organic compounds are extracted.
- 4) Nitrogen is blown over the solution, evaporating away most of DCM and thus further concentrating the organic compounds.

Results:

This first graph (top) shows the peaks from a 100 ppm standard. The first two peaks are DMSO and DCM (solvents), and the third peak at 11.160 seconds is Bisphenol-A. The second graph (bottom) is from a sample of bottles that went through the autoclave at 120°C for two hours and solid phase extraction. The size of the peak of Bisphenol-A is much smaller and can barely be seen in the sample run.



The Environmental Protection Agency (EPA) says that the maximum dose of Bisphenol-A per day is 50 micrograms/kg/day. I found BPA leaching at an average concentration of 1-3 ppb after autoclaving for two hours. This means that a 70 kg human would have to consume **350** liters of this autoclaved water per day in order to achieve the minimum toxic dosage of BPA.

Acknowledgements:

- Oregon State University Chemical Engineering Department
 - Dr. Skip Rochefort: *Associate Professor, Advisor and Mentor*
 - Dr. Mohammad Azizian: *Instrumentation Expert*
- Oregon State University Chemistry Department
 - Kristi Edwards: *Lab Manager*
 - Greg Jones: *Lab Manager*
- Subsurface Biosphere Initiative
 - Dr. Lew Semprini: *Director*
 - Dr. Garret Jones: *Director*