PFAS Level of the Liquid Source in Different Landfills and Leachate Treatment Processes

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Outline

• PFAS Background
• Sampling Method
• PFAS Results in Landfill Leachate
• PFAS Results in Leachate Treatments
Some Facts

- Found in blood of 99.9% of U.S. Americans
- Cannot be degraded during the environmental processes
- Can be inhaled and ingested
- Associated with
  - Kidney, bladder cancer, and other cancers
  - Asthma, impaired lung function
  - Thyroid and immune response diseases
- EPA: Non-enforceable health advisory of 70 ng/L for PFOA+PFOS in drinking water
26 Targeted PFAS Species

Perfluoroalkyl sulfonic acids

\[ \text{PFSA} \]

Targeted PFAS Species

Perfluoroalkyl carboxylic acids

\[ \text{PFCA} \]

Precursors

Fluorotelomer sulfonic acids

\[ \text{FTSA} \]

Precursors

Fluorotelomer carboxylic acids

\[ \text{FTCA} \]

Precursors

Perfluoroalkyl carboxylic acids

\[ \text{PFCA} \]

Precursors

Perfluorooctane sulfonamides

\[ \text{FOSA} \]

Precursors

Fluorotelomer carboxylic acids

\[ \text{FTCA} \]

Precursors

Perfluoroalkyl carboxylic acids

\[ \text{PFCA} \]

Precursors

Perfluoroalkyl sulfonic acids

\[ \text{PFSA} \]

Precursors

Fluorotelomer sulfonic acids

\[ \text{FTSA} \]
<table>
<thead>
<tr>
<th>PFAS Species</th>
<th>Products and Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFCA</td>
<td>In all PFAS products, especially for paper-based food contact materials</td>
</tr>
<tr>
<td>PFSA</td>
<td>Textiles, leather, and carpet</td>
</tr>
<tr>
<td>FTCA</td>
<td>Intermediates degraded from FTOH, usually exist in landfills</td>
</tr>
<tr>
<td>FTSA</td>
<td>Intermediates degraded from firefighting foams</td>
</tr>
</tbody>
</table>
Sampling Method
Sampling Points

<table>
<thead>
<tr>
<th>Sampling Locations</th>
<th>Number of Landfills</th>
<th>Number of Leachate Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFAS Results</td>
<td>27</td>
<td>11</td>
</tr>
</tbody>
</table>

Legend:
- 1-9 sample points
- 10-19 sample points
- Above 20 sample points
<table>
<thead>
<tr>
<th>Name</th>
<th>Sample Type</th>
<th>General Sampling method</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN</td>
<td>Influent of leachate treatment</td>
<td>Spigot/ Bottle on Chain</td>
</tr>
<tr>
<td>OUT</td>
<td>Effluent of leachate treatment</td>
<td>Spigot/ Bottle on Chain</td>
</tr>
<tr>
<td>MS</td>
<td>Leachate of Municipal Solid Waste</td>
<td>Spigot/ Bottle on Chain</td>
</tr>
<tr>
<td>C3</td>
<td>Leachate of C&amp;D Waste</td>
<td>Spigot/ Bottle on Chain</td>
</tr>
<tr>
<td>AH</td>
<td>Leachate of Ash Waste</td>
<td>Spigot/ Bottle on Chain</td>
</tr>
<tr>
<td>GC</td>
<td>Gas Condensate</td>
<td>Spigot/ Bottle on Chain</td>
</tr>
<tr>
<td>ST</td>
<td>Storm Water</td>
<td>Swingarm Sampler</td>
</tr>
<tr>
<td>GW</td>
<td>Groundwater</td>
<td>Peristaltic Pump</td>
</tr>
</tbody>
</table>
Sampling Methods

- Spigot
- Swingarm Sampler
- Peristaltic Pump
- Bottle on Chain
Full Suite of PFAS Samples

- Bottles for PFAS Analysis
  - Field Blank
  - Duplicate
  - Matrix Spike
  - MS Dup
  - PFAS
  - PFAS
  - TOP
  - TOP

- Bottles for Physical Chemical Analysis
  - COD/Ammonia, MS Dup
  - COD/Ammonia, MS
  - COD/Ammonia
  - BOD
  - pH, Alk, Cond, TDS, TS
  - TOC
  - TOC, MS Dup
  - TOC MS
  - Metals
  - Metals, MS
  - Metals, MS Dup
Measurements

PFAS
- 26 Targeted Species – LC-MS/MS (Liquid Chromatography/ Mass Spectrometry)

Physical Chemical
- Field (pH, Temperature, Conductivity)
- Lab
  - pH, Conductivity, Alkalinity
  - COD, BOD, TOC, TDS, TS, Ammonia
  - 23 Metals
PFAS Results in Landfill Leachate
Detected PFAS Concentration

- Source: 27 Landfills & 11 On-Site Leachate Treatments
- Relation to Waste Type
- PFCA: Dominant in Landfill Leachate
- PFSA: Lower Concentration in Leachate
- FTCA: Higher Concentration in MSW
- FOSA: Higher Concentration in GC
- FTSA: Lowest Concentration
EPA issued a non-enforceable health advisory of 70 ppt (ng/L) PFOA+PFOS concentration in drinking water.
Detected PFAS in Ash Leachate

$R^2 = 0.72$
Implications

Incineration:

- Ash% ↑ Detected PFAS ↓
- Destroys some species of PFAS ?

Dilution:

- MSW Leachate PFOA+PFOS: 2000 ng/L
  Q = 1 mgd

- Leachate Treatment

- Diluted Leachate PFOA+PFOS: 70 ng/L
  1:30 Dilution

- Clean Water PFOA+PFOS: 0 ng/L
  Q = ~ 30 mgd
PFAS Results in Leachate Treatments
Treatment Processes

- Evaporation Pond (n=5)
- Aeration (n=2)
- Sand Filtration (n=1)
- Powdered Activated Carbon (n=1)
- Reverse Osmosis (n=2)
Reverse Osmosis

- Volume of Permeate & Concentrate is about 30% & 70% of influent

- PFOA+PFOS in Permeate is less than 30 ng/L
Implications

Conventional Treatment:
• May change the PFAS species during the treatment
• Does not reduce the detected PFAS level in the leachate

Reverse Osmosis:
• Can remove over 90% PFAS in the permeate
• PFAS level become higher in the concentrate
• Concentrate can be recycled back into the landfill
Thank You!