Health Effects of Disinfection Byproducts (DBP) & Strategies to Reduce Exposure

Vance D. Fiegel
Co-Founder and Chief Science & Technology Officer
Creative Water Solutions
OVERVIEW

• Disinfection Byproducts (DBP)

• Toxicity and Health Effects of DBP

• Organic Load and DBP Production

• Strategies to Reduce Organic Load/DBP
Disinfection Byproducts (DBP)

• Disinfection with halides (Cl & Br) create DBP when combined with the organic matter contained in pools and spas

• Two major types
  • Trihalomethanes (from carbon compounds like oils & proteins)
  • Chloramines (from nitrogen containing compounds like urea (from urine))

• Many others now identified
Disinfection Byproducts (DBP)

- Trihalomethanes (THM)
- Halamines (HA)
- Haloacetic acids (HAA)
- Haloacetonitriles (HAN)
- Haloacetaldehyes (HAL)
- Haloketones (HK)
- Halonitromethanes (HNM)
- Haloacetamides (HAAm)
- Chloral hydrate (CH)
- Others
Toxicity and Health Effects of DBP

- Numerous DBP have known toxicity
- Many DBP are volatile - inhalation
- Many can be absorbed through the skin
Toxicity and Health Effects of DBP

• Numerous studies associate exposure to DBP with lung ailments – reactive airway diseases (asthma)

• Can cause epigenetic changes in urinary bladder cells and an increased risk for bladder cancer

• Increased mutagenicity, cytotoxicity, genotoxicity
Organic Load and DBP Production

Organic Contamination

Proteins, sugars, oils, nitrogen and carbon compounds
Organic Load and DBP Production

- Waterborne
- Organic Contamination
- Surface-Bound
Organic Load and DBP Production

Waterborne

- Cells, hair, feces, leaves, etc
- Urine, sweat, lotions, source water
Organic Load and DBP Production

Bacteria/Microbes
Protozoans
Parasites

Surface-bound

Conditioning Film
Extracellular Matrix
Organic Load and DBP Production

DBP Formation: Chlorine + Surface-Bound Organic Contamination

- Filter media obtained from spa sand filter
- Placed into small column and rinsed to remove unbound OC
- Various concentrations of Cl\(^-\) added
- Effluent evaluated for THM content
## Organic Load and DBP Production

**DBP Formation: Chlorine + Surface-Bound Organic Contamination**

<table>
<thead>
<tr>
<th>[Cl] (ppm)</th>
<th>DBP (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>25</td>
<td>230</td>
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<tr>
<td>50</td>
<td>759</td>
</tr>
<tr>
<td>100</td>
<td>1948</td>
</tr>
</tbody>
</table>
Strategies to Reduce Organic Load/DBP

Because

\[ \text{Cl}^- + \text{Organic Load} = \text{DBP} \]

And

[Cl\(^-\)] is required and continuously fed

Then

Less Organic Load = Less DBP
Strategies to Reduce Organic Load/DBP

Reduce Presence of Organic Material in the Pool

- Source water
- Bathers
- Other external sources
- Surface-bound
Strategies to Reduce Organic Load/DBP

Reduce Introduction of Organic Material into the Water

• Require complete showering
• Clean apparel
• No urine in the pool
• Reduce introduction of human-related organics
• Reduce, eliminate and control non-swimming activities
Strategies to Reduce Organic Load/DBP

Maintain and Periodically Flush Spas and Sand Filters
Strategies to Reduce Organic Load/DBP

Removal of Organic Contamination from Filter Media
Strategies to Reduce Organic Load/DBP

Maintain and Periodically Clean Pool/Spa Sand Filters
Strategies to Reduce Organic Load/DBP

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Maintain and Periodically Clean Pool/Spa Sand Filters

Differential Pressures with Air Scour

- Differential Pressure Without Breakaway Air Scour or PoolMoss Pro
- Differential Pressure With Breakaway Air Scour Only
Strategies to Reduce Organic Load/DBP

Reduced Organic Contamination with Sphagnum Moss

w/o SM  
with SM
Strategies to Reduce Organic Load/DBP

Reduced Organic Contamination in Sand Filters with Sphagnum Moss

![Graph showing reduced organic contamination over time in sand filters with Sphagnum Moss. The graph compares data from Competition Pool and Recreation Pool, showing a decrease in organic load from 8/1/07 to 11/1/07.]
Strategies to Reduce Organic Load/DBP

Reduced DBP in Pool Water with Sphagnum Moss

- DBP levels (water) reduced by 75%
- Chloroform levels (air) reduced by 55%
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SUMMARY

Cl⁻ + Organic Load = DBP

[Cl⁻] is required, constant and in excess

Less Organic Load = Less DBP
Questions?

Thank you for attending my session.

Email: vfiegel@cwsnaturally.com
Cell: (612) 275-5824
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