Effects of Treatment on Longevity in American Soil Treatment Systems

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Discussion Topics

• Historical Perspective on Onsite Systems
• Issues With Current Effluent Dispersal Systems
• The Case for Pretreatment
• Utilizing the Soil Mantel More Effectively
• Importance of Holdup Time in Removal of Trace Constituents
• Regulatory Issues
• Research Needs for Sustainability
• What to Expect in the Future
**Historical Development of Onsite Systems**

Fosse Mouras (ca. 1860)

No new developments in 150 years

**Dosing Siphon and Subsurface Dispersal**

Dosing Siphon

Subsurface Dispersal
**Effluent Dispersal Trenches**

Recommended shallow (30 mm) dispersal trench for maximum utilization of nutrients in septic tank effluent circa 1900.

Conventional dispersal trench utilizing mechanical excavation techniques. Effluent discharged below active soil horizon, often leading to groundwater contamination.

**Affects of Continuous Application of Effluent on Soils with Varying Initial Permeabilities**

(Orlob and Butler, 1955)
"Progressive Development of Biomat (Kreissl, 1982)"

Infiltration Rate is Controlled by the $d_{10}$ Size:

\[
\text{(a-1)} \quad \text{(b-1)} \\
\text{(a-2)} \quad \text{(b-2)}
\]
**Issues with Current Effluent Dispersal Systems**

- Inappropriate estimate of dispersal area assimilative capacity (both trench or area)
- Solids and grease carryover from septic tank
- Loss of permeability due to the sodium in septic tank effluent
- Discharge of nitrogen and phosphorus (issue: insufficient alkalinity and organic matter)
- Discharge of trace organics
- Actual and presumed groundwater contamination (e.g., use of deep trenches below active region)

**The Case For Pretreatment**

- The percolation (perc) test is hopeless
- Soil variability is beyond description
- All soil absorption systems will eventually reach an equilibrium acceptance rate
- Use of equilibrium rate (e.g., 0.125 gal/ft²•d) is acceptable, but may not be practicable in many situations
Infiltration in Ponded Sand Filters

Sand Filter Response To Aerobic Influent
Title

Conventional Pretreatment

[Diagram showing a failure curve and TSS loading rate, TSSLR, g TSS/m²-d]

[Images of equipment and diagrams related to pretreatment processes]
Impact of Particle Size on Biological Reactions in Reactors and Soil-Consider Grinding Wastewater Solids

Aerobic/Anaerobic Biological Treatment

Textile Filter

Upflow Anaerobic Sludge Blanket (UASB)

Membrane Bioreactor

Baffled Reactor with Fixed Packing
A Strategy for Utilizing the Soil Mantle More Effectively

- Develop a policy for the use of the soil mantle for the treatment of constituents of concern in the 21st century (e.g. pathogens, trace organics, and unknowns), and not BOD, TSS, and/or nutrients
- Eliminate the need for soil characterization for the dispersal of treated effluent
- Develop more effective distribution and dispersal systems

Typical Dispersal Systems

- Conventional trench: Circa late 1800s to present
- Schematic of shallow trench
- Schematic of drip application
Six Way Distribution Valve

Removal of Trace Organics in Soil Treatment: What’s Needed

- Wastewater reduced in organic content and total suspended solids
- Aerobic conditions
- Reduced hydraulic loading rates to achieve adequate hold-up times to allow soil microorganisms to use carbon from trace organics
Importance of Holdup Time in Removal of Trace Organics in Soil Treatment

(赵 in water ~9 mg/L) (赵 in air ~275 mg/L)

Groundwater Accretion Issue

(750 L/home • d)(365 d/yr) = 273,750 L/home • yr
(273,750 L/yr)/(450 m²) = 608 L/m² • yr
= 0.608 m/m² • yr
= 1.67 mm/m² • d

Rainfall = 0.33 m/m² • yr
Evapotranspiration = 1.6 m/m² • yr
Field capacity = 25 % by volume
Conclusion: little or no groundwater accretion
What is important is holdup time
Removal of Coliphage in Soil Filter

> Effluent applied uniformly at 24 dose/d
> Soil filter constructed with Yolo Loam soil
> At low HLRs, no coliphage detected below 12 in

Impacts of Hydraulic Loading Rate on Removal of Virus
Surface Application

Appropriate Spacing for Drip Irrigation Lines
Potential Impacts of Urine Separation On Biological Wastewater Treatment
Consider Partial Urine Separation

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<th>After primary, mg/L</th>
<th>Cell yield, mg/L</th>
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<td>~12</td>
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New Design Concept: Self Cleaning and Flushing Drip Irrigation Reuse System

Drip irrigation lines
Treatment unit
Spin filter
Orifice
Residence
Septic tank
Regulatory Issues

- Existing standards based on limited and, in many cases, poor older science (e.g., the perc test)
- Serious disconnects now exist between research (applied) and regulations
- Relationship between many water quality indicators and public health are unclear or inconsistent
- Must develop uniform standards based on scientific findings and proven field performance

Research Needs For Sustainability

- Need to assess impact of wastewater modification on biological treatment in reactors and the
- Need to understand how to optimize the application of a high quality effluent to the soil to:
  - Control nutrients
  - Reduce pathogens (primarily viruses)
  - Reduce anthropogenic compounds
  - Enhance reuse (e.g., irrigation, recharge)
- Hydraulic model to predict holdup times and actual groundwater accretion
What to Expect in the Future

- Enhanced performance and longevity of dispersal areas through effective pretreatment and pressure application of effluent
- Enhanced utilization of the soil for treatment of viruses and trace organics
- New and improved dispersal systems for source separated waste streams
- Revision of legacy regulations and thinking regarding treatment and effluent reuse or dispersal

THANK YOU
FOR LISTENING