Onsite Sewage Disposal Of High Strength Wastewater

Don Hammerlund/ Barry Glotfelty
MDE - Water Management Admin.
Onsite Systems Division
High Strength Waste

- A. What is it?
- B. Where is it found?
- C. How do you deal with it?
Purpose of an OSDS

- Treat and dispose of domestic wastewater from a residential or commercial facility.

- Ideally, an on-site sewage disposal system will perform adequately for a long period of time, so long as it is not overloaded hydraulically or organically.
Problem with Onsite Disposal of High Strength Wastewater

• The design, operation and maintenance of an OSDS is based on assumptions about the wastewater:
  1. Volume of Wastewater
  2. Quality of Wastewater

• The ability of an OSDS to effectively treat and safely dispose of effluent is affected by these factors.
Parameters Used to Evaluate the Quality of Effluent: Clogging Factors

- **1. BOD$_5$** - Measures oxygen required for biochemical degradation of organic & inorganic material.
- **2. COD** - Measures oxygen equivalent of the organic content of a sample; samples from a specific source can be related to BOD$_5$. 
3. **TSS** - Total Suspended Solids are a constituent of total solids. It is residue retained on a filter after drying the sample and is a measure of the level of treatment being achieved.

Can be inorganic particles, which are difficult for biological processes to break down, resulting in mechanical clogging.
More Parameters used to Evaluate the Potential for Clogging:

4. **Fats, Oil, and Grease (FOG)** - Measures biological lipids and mineral hydrocarbons.
   - The analytical test does not measure an absolute quantity, but is useful in making comparisons of wastewaters.
Parameters Used to Evaluate the Quality of Effluent: Nutrients

• 5. **Nitrogen** - Of concern due to its impact on groundwater and surface waters.

• Its form can change as it moves through a treatment system and into the receiving environment.

• Acts as a potentially limiting nutrient for photosynthetic autotrophs in surface waters, and as a potential health risk in groundwater.
Parameters used to Evaluate Effluent Quality – Nitrogen (continued):

- Total Nitrogen consists of:
  A. Nitrate (NO3)
  
  B. Nitrite (NO2) and
  
  C. Total Kjeldahl Nitrogen (TKN)
    (which consists of)
    1. Ammonia (NH3) &
    2. Organic Nitrogen
Parameters used to Evaluate Effluent Quality - Nutrients

5. **Phosphorous** - In wastewater, occurs almost entirely as phosphates.
   - Is formed primarily by biological processes on substances contributed by body wastes and food residues.
   - Like Nitrogen, a potentially limiting nutrient in surface waters.
Residential vs. Commercial Wastewater Characteristics

**Residential Wastewater:**

- Quality tends to be less variable than commercial over time.

- In an OSDS, fluctuations in strength and duration of pollutant-generation tend to be dampened by a sedimentation (septic) tank.
Residential vs. Commercial Wastewater Characteristics

Commercial Wastewater:

- Quality tends to be more variable in its quality than from a “typical” residence.
Potential Harm to an OSDS Receiving High Strength W/W

1. High BOD$_5$:
   - Increased biological demand on downstream component.
   - May shorten life of the OSDS

2. High TSS:
   - Inorganics are less easily broken down.
   - Can accelerate mechanical clogging of infiltrative surface.
Potential Harm to an OSDS Receiving High Strength W/W

- 3. High Fats, Oils and Grease (FOG)-
  - Highly increased biological demand on downstream components.
  - May drastically shorten life of the OSDS.
  - Most difficult constituent to control.
Effects of High Strength Wastewater
Commercial Wastewater Characteristics

• Many generate wastewater similar to residential units; However....

• Some generate high strength wastewater:
  - Restaurants
  - Carry-Outs (pizza parlors, sub shops)
  - Medical Facilities
  - Food Processing plants, Slaughterhouses
## Residential Septic Tank Effluent Quality

<table>
<thead>
<tr>
<th></th>
<th>BOD5</th>
<th>COD</th>
<th>TSS</th>
<th>TKN</th>
<th>NO3</th>
<th>TP</th>
<th>FOG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEAN</strong></td>
<td>163</td>
<td>203</td>
<td>81</td>
<td>38</td>
<td>&lt;0.2</td>
<td>6.7</td>
<td>*</td>
</tr>
<tr>
<td><strong>MEDIAN</strong></td>
<td>162</td>
<td>169</td>
<td>41</td>
<td>36</td>
<td>&lt;0.2</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td><strong>MIN.</strong></td>
<td>32</td>
<td>99</td>
<td>3</td>
<td>16</td>
<td>&lt;0.2</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td><strong>MAX.</strong></td>
<td>435</td>
<td>436</td>
<td>720</td>
<td>69</td>
<td>0.2</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>#of Samples</td>
<td>28</td>
<td>12</td>
<td>28</td>
<td>28</td>
<td>4</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

“**TYPICAL**” 140 mg/l  75 mg/l  15 mg/l

(samples collected from 9 Md. sites with 2-compartment septic tanks)
## Commercial Septic Tank Effluent Quality

<table>
<thead>
<tr>
<th></th>
<th>BOD5</th>
<th>COD</th>
<th>TSS</th>
<th>TKN</th>
<th>NO3</th>
<th>TP</th>
<th>FOG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEAN</strong></td>
<td>888</td>
<td>1206</td>
<td>132</td>
<td>69</td>
<td>&lt;0.2</td>
<td>18.5</td>
<td>182</td>
</tr>
<tr>
<td><strong>MEDIAN</strong></td>
<td>626</td>
<td>1090</td>
<td>90</td>
<td>60</td>
<td>&lt;0.2</td>
<td>---</td>
<td>67</td>
</tr>
<tr>
<td><strong>MIN.</strong></td>
<td>155</td>
<td>170</td>
<td>10</td>
<td>29</td>
<td>&lt;0.2</td>
<td>16.9</td>
<td>13</td>
</tr>
<tr>
<td><strong>MAX.</strong></td>
<td>2951</td>
<td>2888</td>
<td>642</td>
<td>127</td>
<td>1.4</td>
<td>20</td>
<td>814</td>
</tr>
<tr>
<td><strong>#of Samples</strong></td>
<td>26</td>
<td>27</td>
<td>27</td>
<td>26</td>
<td>15</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

All Sample Results are in milligrams per liter (mg/l)

(Samples collected from 13 sites in Maryland)
# Septic Tank Effluent Quality:

## Comparison of Means

<table>
<thead>
<tr>
<th>Parameter*</th>
<th>Residential</th>
<th>Commercial</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD$_5$</td>
<td>163</td>
<td>888</td>
<td>545%</td>
</tr>
<tr>
<td>COD</td>
<td>203</td>
<td>1206</td>
<td>594%</td>
</tr>
<tr>
<td>TSS</td>
<td>81</td>
<td>132</td>
<td>163%</td>
</tr>
<tr>
<td>TKN</td>
<td>38</td>
<td>69</td>
<td>182%</td>
</tr>
<tr>
<td>NO$_3$</td>
<td>&lt;0.2</td>
<td>&lt;0.2</td>
<td>-----</td>
</tr>
<tr>
<td>TP</td>
<td>6.7</td>
<td>18.5</td>
<td>276%</td>
</tr>
<tr>
<td>FOG</td>
<td>15</td>
<td>182</td>
<td>1213%</td>
</tr>
</tbody>
</table>

* mg/l
Calculation of Nutrient Loading to an OSDS

LBS. Of BOD₅ = Flow (GPD) x BOD₅ (mg/l) x C (.00000834)

(Residential) 300gpd x 163mg/l x C = 0.41 lbs per day

0.41LBS/Day / 250 sq.ft. = 0.00164 lbs. per sq. ft. per day

(Commercial 1) 350gpd x 1,117 mg/l x C = 3.26 lbs. per day

3.26 lbs./day / 250 sq.ft. = 0.013 lbs per sq. ft. per day (~8x)

(Commercial 2) 3000 gpd x 733 mg/l x C = 18.34 lbs./day BOD

18.34 lbs. per day / 16,200 sq.ft.* = 0.0011 lbs. per sq.ft. per day

* low hydraulic loading rate (0.19 gpd/sq.ft.) still results in ponding
Options for Dealing With High Strength Wastewaters

- A. Control at the Source.
- B. Treat to a Higher Level Before Discharge.
- C. Adjust Loading Rates According to Strength of the Wastewater.
A. Control at the Source

1. Minimize or remove those constituents of the waste load which cause the high strength waste.

2. Treat the waste before it leaves the facility.
B. Treat to a Higher Level

1. Install a proprietary advanced treatment unit (trickling filter, aeration unit).

2. Install a media (i.e., sand, gravel, glass) filter (intermittent, recirculating).
C. Adjust Loading Rates

1. Use Pounds of BOD$_5$ per day/sq.ft. (instead of gallons)

- Effectiveness depends upon which constituent is the major problem. (Oil and grease are very problematic).
- Appears to be the least effective strategy.
Conclusion

- To adequately design an onsite sewage disposal system, you need to know the anticipated volume and strength of the wastewater.
CASE STUDY

Restaurant with failing OSDS

High Flows: 2880 gpd
(weekend avg.)

High Strength Wastewater
1200 mg/l BOD
450 mg/l TSS
124 mg/l FOG

Limited Area for Repair
(trench loading = 0.9gpd/ft²)

Soil Limitations
Improved Kitchen Practices to Attempt to Control FOG

- Scrape plates and cookware before rinsing.
- Reduce surge flows through water conservation measures.
- Use low temperature sanitizing rinse dishwashers.
- Use dishwashing and general cleaning agents that promote oil & water separation.
Improved Kitchen Practices to Attempt to Control FOG

- Use proper concentrations of solvents and cleaners (some cleansers can emulsify grease).
- Use proper concentrations of disinfectants (excess use reduces bacterial action in septic system).
- Use shortening in place of vegetable oil.
How big is big enough? That’s the question NCS sought to answer in a study of six restaurant sites with grease tanks sized from less than a half-day average flow to more than seven days average retention time. The answer may surprise many of you. We found that after two days retention time there was limited value to adding more grease tank capacity. Kitchen habits appear to have the greatest impact on grease tank effectiveness. With increased use of vegetable oils, which tend to remain emulsified, and chemical washes and degreasers, which further emulsify fats, oils and grease, there is a limit to what grease tanks can remove.

Following is a summary of study results:

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Retention Time (Days)</th>
<th>pH</th>
<th>FOG (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>0.4</td>
<td>3.94</td>
<td>12,802</td>
</tr>
<tr>
<td>#2</td>
<td>0.7</td>
<td>4.57</td>
<td>1,270</td>
</tr>
<tr>
<td>#3</td>
<td>2.6</td>
<td>4.97</td>
<td>193</td>
</tr>
<tr>
<td>#4</td>
<td>2.8</td>
<td>4.46</td>
<td>323</td>
</tr>
<tr>
<td>#5</td>
<td>3.9</td>
<td>4.04</td>
<td>395</td>
</tr>
<tr>
<td>#6</td>
<td>7.2</td>
<td>4.75</td>
<td>2,487</td>
</tr>
</tbody>
</table>

Based on this study conducted in Washington State and our experience across the rest of the country, NCS sizes grease tanks using a design standard of the greatest between two days average flow and one and a half days peak flow, whichever is higher.

For a complete copy of this study regarding the performance of grease tanks, give us a call or email your request.

Existing grease trap is only 1000 gallon capacity. An effluent filter was installed on the outlet baffle to facilitate grease retention.
Pretreating to reduce BOD, TSS and FOG can allow higher loading rates.

Table 1. Typical wastewater effluent composition and loading rates.

<table>
<thead>
<tr>
<th>Effluent Type</th>
<th>Typical Concentrations</th>
<th>Mass Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BOD₅ (mg/L)</td>
<td>TKN (mg/L)</td>
</tr>
<tr>
<td>Restaurant STE</td>
<td>500</td>
<td>65</td>
</tr>
<tr>
<td>Domestic STE</td>
<td>150</td>
<td>55</td>
</tr>
<tr>
<td>Graywater STE</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>Domestic Aerobic Unit</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>Domestic Sand Filter</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Restaurant STE          | 500          | 65         | 1300         | 180        | 5           | 25.0         | 3.25         | 65.0          | 9.0          |
| Domestic STE            | 150          | 55         | 550          | 80         | 5           | 7.5          | 2.75         | 27.5          | 4.0          |
| Graywater STE           | 150          | 15         | 370          | 40         | 5           | 7.5          | 0.75         | 18.5          | 2.0          |
| Domestic Aerobic Unit   | 35           | 10         | 116          | 40         | 5           | 1.75         | 0.5          | 5.8           | 2.0          |
| Domestic Sand Filter    | 5            | 2          | 19           | 10         | 5           | 0.25         | 0.1          | 0.95          | 0.50         |

1. Based on data reported by Siegrist and Boyle, 1982; Siegrist et al., 1985; 1986; Ronayne et al., 1982; SSWMP, 1978; Minor, 1985; and Effert et al., 1985.

2. tBOD = ultimate carbonaceous BOD (cBOD₅) plus nitrogenous BOD with cBOD₅ based on BOD₅ and K₁₀ = 0.06 days⁻¹ and nBOD = 4.57 * TKN.
Aerobic Pretreatment
More complex controls and increased maintenance required.
Irrigation Control Valve Facilitates Uniform Distribution
Characterize soil

Determine flow and effluent quality

Determine treatment requirement

Determine trench loading rate

Maximize design

Incorporate maintenance
Managing High Strength Wastewater

Pretreatment

Controls

Maintenance

Uniform Distribution