Septic Tank Overview

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People Caring About Water

Yowa
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NOWRA
National Onsite Wastewater Recycling Association
Tank Functions

- Solids removal by settling & floatation
  - 60-80% solids removal
- Anaerobic digestion
- Storage of solids
### Average Removal of BOD, TSS, and Grease in Septic Tank

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average Raw Sewage Influent</th>
<th>Average Septic Tank Effluent</th>
<th>% Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD (mg/L)</td>
<td>308</td>
<td>122</td>
<td>60</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>316</td>
<td>72</td>
<td>77</td>
</tr>
<tr>
<td>Grease (mg/L)</td>
<td>102</td>
<td>21</td>
<td>79</td>
</tr>
</tbody>
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The Septic Tank
Tank Materials

- Fiberglass-reinforced plastic (FRP)
- Polyethylene/Polypropylene
- Reinforced concrete
Biological Activity in the Septic Tank

• Anaerobic (without Oxygen)
  – Incomplete
  – Cheap and easy
  – Reliable

• Gases produced are odoriferous

• Not all solids in tank are biodegradable
The Physical Process

- Flow Attenuator
- Temperature Equalizer
- Separator
The Physical Process

- Floatables (Scum Layer)
- Clear Zone
- Settling (Sludge Layer)
The Biological Process

This is where bacteria comes in...

Important in breaking down biodegradable material
The Biological Process

- Bacteria break down biodegradable material in anaerobic environment.
The Chemical Process

- Precipitation
- Adsorption
- Ion Exchange
Septic Tank Design

- Sizing
- Geometry
- Compartments
- Vehicular traffic
- Appurtenances
Effective Volume (new tank)
Tank Sizing

• Generally prescribed for individual homes based on home size
• Criteria: Hydraulic detention time plus solids storage
  – 1 to 2 days detention of design flow
  – Add solids storage volume equal to 1/3 – 1/2 of the above hydraulic detention
Septic Tank Sizing Example

• Consider a 3-bedroom home
• Design flow: 3 br, 2 people/br, 75 gpd/person
  – Flow = 3 \times 2 \times 75 \text{ gpd} = 450 \text{ gpd}
  – Provide for 2 day detention \Rightarrow 2 \times 450 = 900 \text{ gal}
Septic Tank Sizing Example

• Add solids storage
  – 1/3 of the above = 1/3 \times 900 = 300 \text{ gal}

• Total tank volume = 900 + 300 = 1200 \text{ gal}
Septic Tank Sizing Example

- This is the minimum recommended tank size
  - The tank should have two compartments
- Many regulatory agencies now require 1,500 gal tank for a 3-br home, but sizing starts with a procedure like this.
Goal: Near Zero Velocity for Optimum Solids Removal

- Maximize distance between inlet and outlet
- Length:Width ratio at least 3:1
- Inlet to outlet drop ~ 2"
Other Factors that Affect Tank Size

• Garbage grinders
  – Add to solids accumulation rate and organic load
  – May add grease and oil
  – Increase hydraulic load some

• Though not recommended with septic systems
  – they will be used in many homes.
Other Factors that Affect Tank Size

• Sewage (grinder) lift pumps
  – Increase turbulence in the septic tank
  – Should discharge into sewer line – not directly to tank
  – Two compartment tanks highly recommended with pumps
  – Set pumps for minimum discharge volumes
Surface area

- **Rectangle: 4’ x 7’ tank**
  - L x W = Area
  - 7’ x 4’ = 28 ft²

- **Circle: 4’ diameter**
  - Radius is half of diameter 4’ ÷ 2 = 2’
  - \(\pi \times [\text{radius}]^2 = 3.14 \times r \times r\)
  - 3.14 x 2’ x 2’ = 12.5 ft²
Calculating capacity

Using INSIDE tank dimensions

- 4’ x 7’ x 60”
- 4’ x 7’ x [60” ÷ 12] = 140 ft³
- 140 ft³ x 7.5 gal/ft³ = 1050 gal
- 1050 gal ÷ 60 inches = 17.5 gpi
Tank Compartments

• Advantages of multiple compartments
  – More complete solids removal
  – Improved effluent quality
  – Protect against solids discharge due to lack of maintenance
Two Compartment Septic Tank

Two Compartment Septic Tank

2/3 total volume

1/3 total volume

Scum

Clear Zone

Sludge

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Vehicular Traffic

• Standard concrete tanks are not designed to handle traffic loads
  – ASTM Standard C-857 provides information on these design issues

• Use other tanks in areas subject to traffic only with manufacturer guidance and engineer approval
Tank Appurtenances

- Tees and baffles
- Effluent screens
- Access risers
Inlet and Outlet Baffles/Tees

• Inlet baffle
  – Directs flow
  – Minimizes turbulence and short circuiting

• Outlet baffle
  – Assures outflow comes from clear zone
  – Holds floating scum in tank
Inlet and Outlet Baffles/Tees

Dual Chamber Septic Tank

Sludge
Clear Zone
Scum
Tee-Type Outlet Baffle

- Baffle made from sanitary tee and 4-in pipe nipples
- Positioned directly under tank opening for access
Curtain Baffle

- Penetrates into clear zone
- Groove at top allows gas transfer across tank and up sewer to roof vent
Baffle Fastened to Tank Wall
Effluent Screens

• Designed to keep larger suspended solids in the tank
• Control outflow rate
• Protect downstream components
• Typically replace the outlet baffle
• Require riser to grade for access to screen
Effluent Screen Installation

Issues

• Location
  – Tank
  – Sump
  – Pump vault

• Can be equipped with alarm

• Screen in second compartment of a two-compartment tank requires less service
Effluent Screen Installation Issues

- Must be secure in place
- No bypass flow if clogging occurs
- Housing should not interfere with normal tank cleaning
Proprietary Effluent Screens
Access Risers

- Provide easy access to tank & components
- A must for tanks with effluent screens or pumps
- Shallow tanks and short risers preferred
Riser Design
More Risers

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Common Lid Safety Attachment Methods

- ASTM requires lids to weigh 59 LBS or be provided with a locking system
- Double safety of heavy concrete lid with mechanical attachment of plastic lid
Common Lid Safety Attachment Methods

- Several manufacturers have created an interior safety mechanism to prevent unwanted tank entry.
- Some are plastic, rope, metal, etc.
Factors that Can Affect Tank Performance

- Wastewater Strength and pH
- Variable Flow Patterns
- Detention Time
- Leaking Tank
- Lack of Maintenance
- Presence of substances that can disrupt biological activity
  - Harsh chemicals
  - Cleaners
  - Paint
  - FOG
  - Water softener backwash
  - Pharmaceuticals

Tank Design, Manufacturing and Installation

Homeowner Activity and Maintenance
Factors that Influence Anaerobic Digestion

- pH
- Chemicals
- Highly variable flow patterns
- Pharmaceuticals
- Process wastewaters
- Lack of tank maintenance
Factors that Influence Wastewater Strength

- FOGs
- Flow pattern
- Flow rates
- Nonbiodegradable items
Structural Soundness

- Withstand handling and transport
- Not susceptible to damage during installation
- Resist external and internal pressures
- Properly reinforced according to a standard
  - ASTM
  - NPCA
Ultimately, it is Essential to TEST

- Investigate irregularities in tank of any material thoroughly
- If unsure, consult with manufacturer or engineer
- Testing will ensure quality, watertight installations.
Why do we Care?

- Exfiltration could release untreated sewage deep in the soil
- Infiltration may occur
  - Disrupt settling processes in tanks
  - Overload drainfield or downstream components
Possible Points of Leakage

- Weep holes at the base of the tank
- Mid-seam or top seam joint
- Inlet/outlet pipe penetrations
- Tank top/access riser joint
- Access riser/lid joint
- Any damaged, improperly-formed location or area where material is too thin
Watertightness

- Watertight seals
  - All joints
  - Pipe penetrations
  - Riser and lid
Testing for Watertightness

- Hydrostatic (water) testing
- Vacuum testing
Hydrostatic Testing New Tanks

- Prior to backfilling
  - Cap pipes
  - Fill 2" into riser
  - Soak for 24 hrs
  - Refill if concrete
  - Check in 24 hrs
  - Allowable loss is less than one gallon
Vacuum Testing Equipment

Pipe seal

Vacuum pump

Plate seal on top of riser or tank

Gage to measure vacuum
Checking Existing Tanks for Watertightness

- Plug inlet and outlet
- Ensure no flow
- Water or vacuum test
Watertightness Indicators

- Root intrusion
- High water table area:
  - Pump during wet season and look for infiltration
  - Outflow when there is no inflow
  - Beware of floatation
- Excavate outside of tank and look for evidence of exfiltration – blackness, odor, etc.
Tanks Operation & Maintenance
Operation and Maintenance of Septic Tanks

• Solids accumulate in septic tanks
  – sludge in the bottom
  – scum on top

• Pump before solids begin to increase in the effluent
Frequency Of Pumping

• Calendar recommendation
  – Every 3-5 years

• As needed
  – Measurement of sludge and scum
Determining Need for Pumping

- **Pump when**
  - scum clear space is <3” or
  - sludge clear space is <9”
Pumping Frequency

• Opinions vary on frequency
  – Most tanks are buried – no riser to grade
    • “If you have to dig up the tank, you might as well just pump it”
  – May be dictated by state regulation

• Should be based on actual measurements
  – when accumulated solids affect effluent quality – i.e. science
Tank Inspection at Time of Pumping

• Tank should be thoroughly inspected
  – Damaged or missing baffles
  – General tank deterioration
    • especially in the head space above the water level
  – Honeycomb in concrete surface
  – Pin holes or non-uniform wall thickness in fiberglass or plastic
  – Root intrusion
Root Intrusion
Tank Inspection at Time of Pumping

- Other indications of leaks
  - Fluctuating tank levels
  - Damaged seams
  - Cracks
- Consider adding an effluent screen
- Inspect risers and lids for leakage or damage

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Servicing Effluent Screens

• Clean screen when pumping tank
• Wash material back into tank
• If cleaned at other times:
  – Remove and clean elsewhere
  – Clean over inlet end
  – No solids bypass
Servicing Effluent Screens

• Wear gloves!
  – (and long pants)
• Wash off directly into the inlet end
• Solids bypass protection
Factors that Increase Screen Cleaning Frequency

- High fat, oil and grease in sewage
- Extensive hair or laundry lint
- High water usage or high peak flows
- Screen too small for the application
- Backwash from water softener
  – hotly debated topic
Excessive Screen Clogging May Indicate

- Lack of proper biological activity in the tank
- Excessive flows
  - Infiltration
  - Leaky plumbing fixtures
- Neglecting to pump the tank when needed
Myths and Additives

• Tanks typically do not require additives
  – No need to “start” a tank with a dead chicken (or possum)
  – Adding yeast, while harmless, is not needed
  – Commercial additives are normally not needed and no research supports their use
Myths and Additives

• Beware of any additive that suggests it will reduce pumping frequency
  – Normal function means some accumulation
  – Solids may be washed out to next downstream treatment component
  – Independent research shows no benefit