Volatile Solids Reduction (VSR):
Considerations for Accurate Measurement and Reporting

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What are volatile solids?

- Volatile solids are the portion of total solids present in sludge that contain calorific value.

- They are organic compounds of plant or animal origin.

- They can be removed or reduced through biological processes.

- Total solids consists of volatile and fixed solids (such as silt, gravel).
Why is this important?

- The calorific value provides food for not only microbes, but also potential vectors (rodents, birds etc).

- Calorific content also increases potential odors and consequently increases attraction of vectors (and unwanted public attention).
The Washington State Regulation allows VAR (Vector Attraction Reduction) requirements to be met by quantifying and reporting adequate VSR (rather than relying on incorporation or lime treatment)

- This allows sites to surface apply without incorporation (no till).

- Fulfills VAR requirement for exceptional quality status (allowing resale).
Options:

- For aerobic or anaerobic digesters
  Reduce volatile solids in the sludge by a minimum of 38%.

- Bench testing (post digestion - often used for lagoon solids)
  - Anaerobically digested solids must be reduced less than 17% in the 40 day testing period.
  - Aerobically digested solids must be reduced less than 15% in the 30 day testing period.
VSR may be measured across any part of the sludge-specific process
e.g. digester influent to digester effluent, dewatered material off of a press, drying beds, lagoon material etc.

Not at the headworks or prior to any wastewater specific processes.
What calculations to use

- Approximate mass balance equation
- Full mass balance equation
- Van Kleeck equation
Van Kleeck equation

- Assumes that fixed solids are conserved during the digestion process - creates erroneous data if this is not the case

- Suitable only for steady-state, continuous mix digesters with no decant or significant grit accumulation

- If decant (supernatant) occurs, the volatile solids in the decant must be consistent with that in the digester

- If grit accumulation occurs, equation underestimates volatile solids.
Full mass balance equation

- Appropriate for non-steady state situations

- Requires data for:
  - Volumes
  - Total solids concentrations
  - Volatile solids concentration (total – fixed solids)

- Can be used for all digester situations and operating conditions
Approximate mass balance equation

- Uses average values
- Requires close to steady state situations, or continuous mix digester
- Uniform daily flows
- Accumulation of volatile solids from scum or settling will affect accuracy
Data set handling

- Pennsylvania model provides a good spreadsheet solution
  (Website address for this is on the handout)

- Washington State Department of Ecology has been working on a user friendly version

- Ensuring that sampling locations are selected correctly, and that there are an adequate number of samples in the data set is important
## Typical value ranges*

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Volatile</th>
<th>Fixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Sludge</td>
<td>2 – 8%</td>
<td>75%</td>
<td>20 - 30%</td>
</tr>
<tr>
<td>Raw and WAS</td>
<td>2 - 5%</td>
<td>80%</td>
<td>15 - 25%</td>
</tr>
<tr>
<td>Recirculated Sludge</td>
<td>1.5 - 3%</td>
<td>75%</td>
<td>20-30%</td>
</tr>
<tr>
<td>Supernatant</td>
<td>&lt; 1%</td>
<td>50%</td>
<td>40 – 60%</td>
</tr>
<tr>
<td>Digested Sludge</td>
<td>4 – 8%</td>
<td>50%</td>
<td>40 - 60%</td>
</tr>
</tbody>
</table>

*Copied from the Pennsylvania DEP model
Summary: What is important for accurate measurement?

- Correct sampling locations
  (encompass sludge specific treatments)

- Adequate Sampling events
  (generation of adequate data)

- Consideration of system fluctuations
  (changes in volume, charging or removing sludge from system, decante, silt, gravel and other remnants in the digester that detract from final volumes).

- Correct choice of analytical method
  (which equation to use).
Bench testing requirements

Testing should commence within 6 hours of sample collection for anaerobic solids, and as soon as possible for aerobic solids. Testing should at least commence on the day of sample collection.

- Anaerobically digested solids must reduce in volatiles by less than 17% during the test.

- Aerobically digested solids must reduce volatiles by less than 15% during the test*.

The requirements for bench testing are covered in Appendix D of the White House document.

*Based on arithmetic means for all tests conducted
Consequences of incorrect measurement:

- Out of compliance (violation of rule)
- Possible odor issues at application site.
- Possible attraction of nuisance and pathogen spreading vectors to the site.
- Possible increase in pathogen exposure to the public/site operatives.

None of these consequences are good
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