Accuracy of Rapid Field Testing of Advanced OWTS Effluent

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1. The Problem
2. The Project
3. Initial Tests
4. Alternative Tests
5. Conclusions
Problem: Nitrogen in Wastewater

Residential Wastewater

Algal Bloom
Narragansett Bay

Fish Kill
Greenwich Bay
Solution: Advanced N-Removal OWTS

19 mg N/L Total Nitrogen
Are They Working?

- Effluent N concentrations not monitored after installation
- Systems may not be properly installed/maintained
- Uncertainty surrounding performance
- N inputs to coastal systems could be higher than expected
Our Study

Monitor system performance and operational parameters

Rapid tests for field use

Develop statistical model for performance optimization

Adjust systems accordingly

Measure changes in response to adjustments
Sampling Design

42 systems sampled monthly:

17 Systems
Orenco Advantex AX20®

14 Systems
BioMicrobics FAST®

11 Systems
SeptiTec h D®

http://www.orenco.com/sales/choose_asystem/index.cfm
http://www.septitech.com/staar-residential/
Sampling Locations
Analyses

Field Analysis
- Hydraulic Flow
- Recirculation Ratio
- Water Temperature

Lab Analysis
- BOD$_5$
- COD
- Total Nitrogen
- Alkalinity
- DO
- NH$_4^+$
- NO$_3^-$
- pH
Evaluation of Rapid Tests

- Used by service providers to evaluate performance
- Provide quick results on-site
- Allow for quick system adjustment
Are rapid tests accurate?

Rapid Field Tests  ?  Standard Laboratory Methods
Initial Suite of Rapid Tests

- **Test strips:**
  - pH
  - Nitrate
  - Ammonium
  - Alkalinity

- **Pocket meter:**
  - pH

- **Titration kit:**
  - Dissolved oxygen
Accuracy

Graph showing the relationship between laboratory values and rapid field test values. The graph includes a line with a slope of 1 and an intercept of 0. The data points indicate a high degree of accuracy.
Rapid Tests in the Field

<table>
<thead>
<tr>
<th>Property</th>
<th>Regression parameter:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>18.9*</td>
</tr>
<tr>
<td>Ammonium</td>
<td>4.5*</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>2.4*</td>
</tr>
<tr>
<td>Nitrate</td>
<td>1.5*</td>
</tr>
<tr>
<td>pH – test strips</td>
<td>4.0*</td>
</tr>
<tr>
<td>pH – pen</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Rapid Tests in the Field

pH Strips

Field Test Values vs. Standard Values

Nitrate Strips

Field Test Values vs. Standard Values

NO₃⁻ (mg N/L)
Rapid Tests in the Lab

- Alkalinity
- Nitrate
- Ammonium
- pH
Rapid Tests in the Lab

Do field conditions introduce error?
Sources of Error in the Field

Varying light conditions in the field complicate visual comparisons to color charts.

<table>
<thead>
<tr>
<th>Nitrite as NO₂-N ppm</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate as NO₃-N ppm</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

**TO USE:**
Immerse test strip for 2 seconds and remove with pads face up. **DO NOT SHAKE OFF EXCESS WATER.** Wait 1 minute and immediately compare to color chart.

**TIPS**
- Keep wet fingers out of the vial.
- For best results, immerse strip to a depth of 12”-18”.
- Close vial tightly after removing strip.
- Store in a cool, dry place.
Sources of Error in the Field
Alternative Suite of Rapid Tests

- 5-in-1 test strips
  - Nitrate
  - pH
  - Alkalinity

- Test kit
  - Ammonium
Alternative Rapid Tests in the Field

<table>
<thead>
<tr>
<th>Property</th>
<th>Intercept</th>
<th>Slope</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity</td>
<td>31.6</td>
<td>0.50</td>
<td>0.52</td>
</tr>
<tr>
<td>Ammonium</td>
<td>1.4</td>
<td>0.92</td>
<td>0.39</td>
</tr>
<tr>
<td>Nitrate</td>
<td>14.4</td>
<td>1.35</td>
<td>0.20</td>
</tr>
<tr>
<td>pH</td>
<td>0.9</td>
<td>1.17</td>
<td>0.50</td>
</tr>
</tbody>
</table>
So, Are Rapid Tests Accurate?

- Some are:
  - Pocket pH meter
  - 5-in-1 strips
  - Ammonium test kit

- Affected by field conditions
  - More controlled environment
  - Portable colorimeter

- Assess accuracy before use
  - Only **accurate** rapid tests are useful to evaluate system performance