Bubble Column and Air Sparger Mass Transfer Coefficient Investigation

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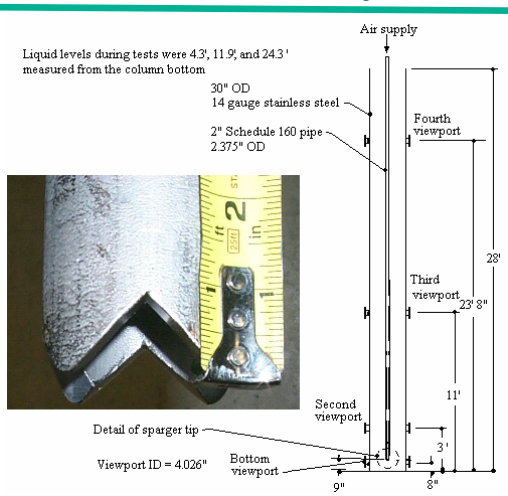
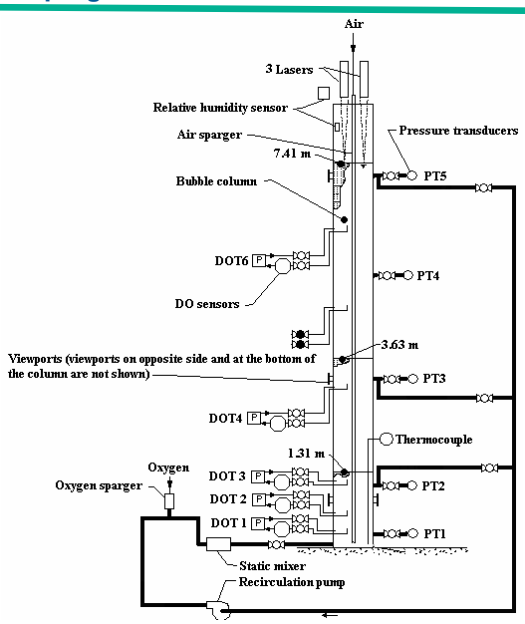
Bubble Column Assembly



Sparger Installed in Bubble Column



Bubble Column, P&ID

Test requirements:

- **Hanford Equipment:**
  - ***Hydrogen generated due to radiolysis*** in nuclear waste tanks.
  - Air spargers installed to augment pulse jet mixers in waste tanks.
  - AZ101, Sludge simulant.
  - Air sparging used to release hydrogen from solution.
- **SRNL Testing:**
  - ***Use oxygen instead of hydrogen*** for testing.
  - ***Determine mass transfer coefficients*** for water and AZ101 simulant.
    - Saturate the system with oxygen.
    - Sparge the system with air.
    - Measure the oxygen decrease due to sparging.
    - Calculate mass transfer coefficients.
  - ***Investigate bubble formation and void fractions in large scale bubble columns***, using Newtonian and Non-Newtonian Fluids.

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Hanford, WTP: D. Sherwood

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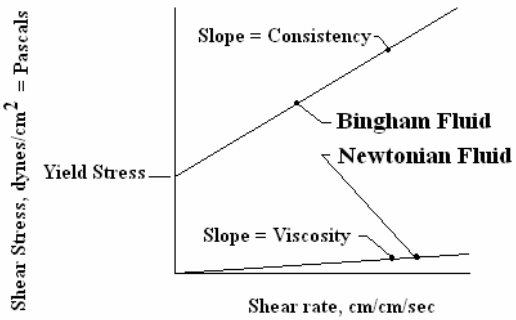
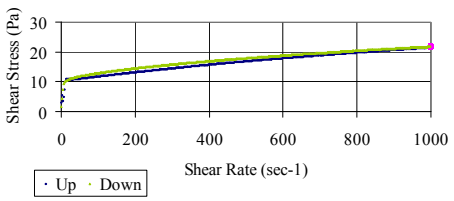
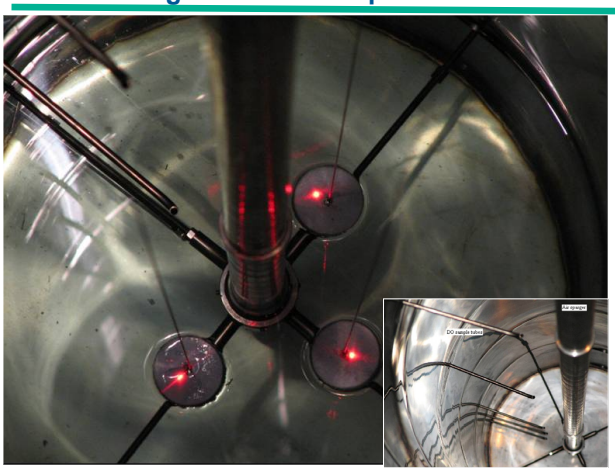


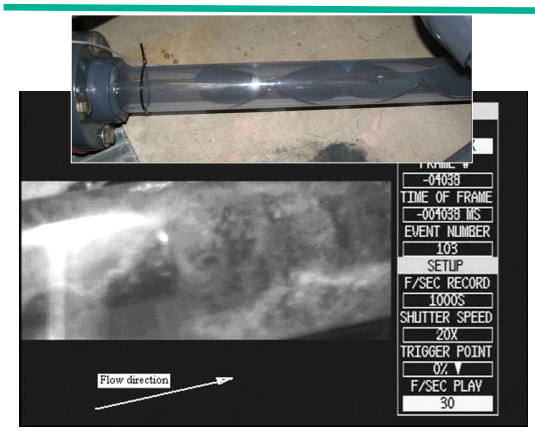
AZ101 simulant, 25 C



Sludge Simulant Properties



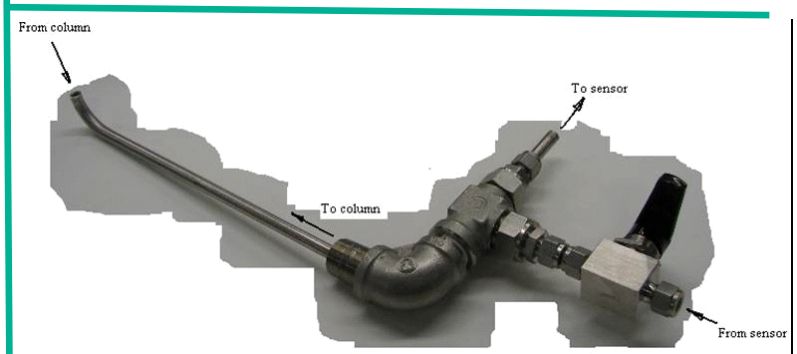
Dissolved Oxygen Probes and Laser Level Measurements

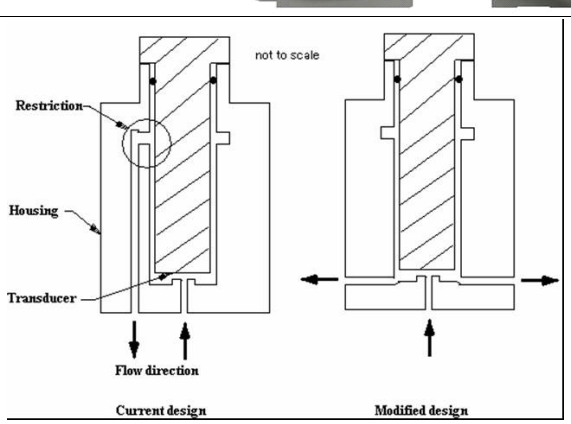


Oxygen Addition Through Static Mixer

Test Fluids and Equipment:

- **Test Fluids:**
  - Sludge simulant, 13 and 30 Pascal yield stress with AFA.
    - pH =10, oxides, hydroxides, nitrates, metals.
  - Water with and without AFA.
- **Test Equipment:**
  - Laser level measurements.
  - Pressure transducers.
  - Dissolved oxygen sensors.
  - Uniform oxygen addition to the bubble column through sintered metal filter and static mixer.





Dissolved Oxygen Sensors

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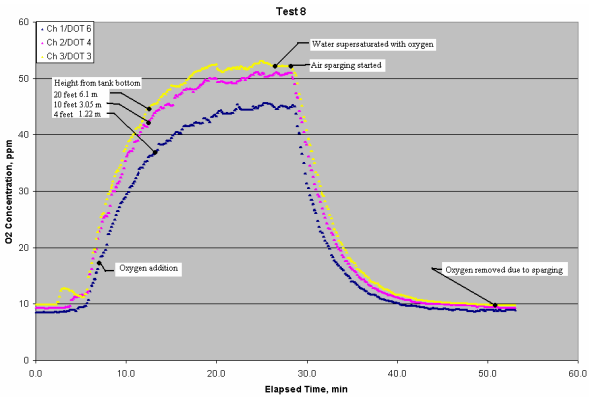
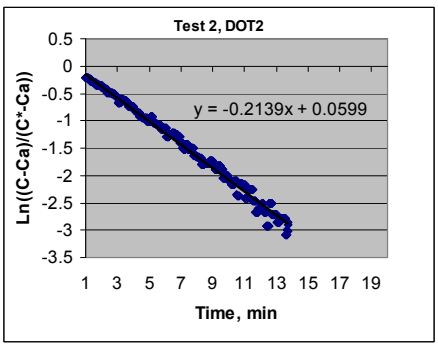
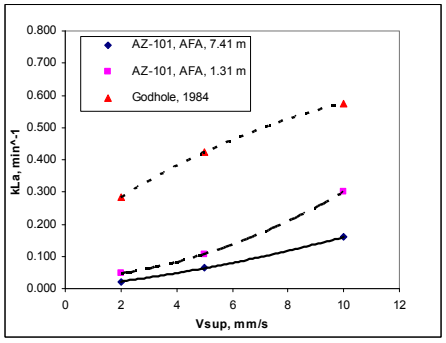


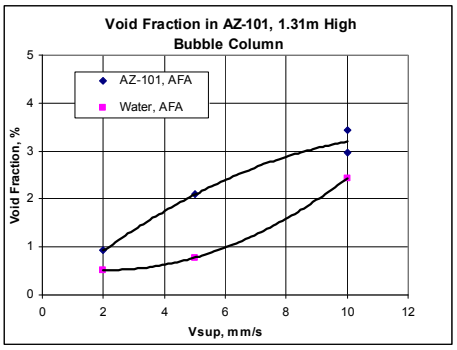
Typical DO Concentration



Typical DO Test Results



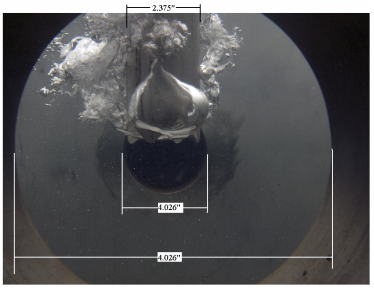
Typical Mass Transfer Coefficients



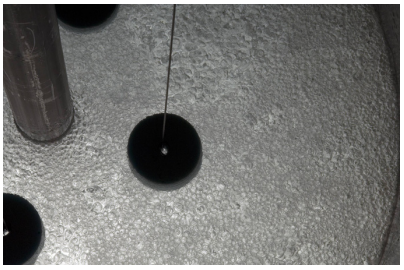
Void Fraction Results

Test results:

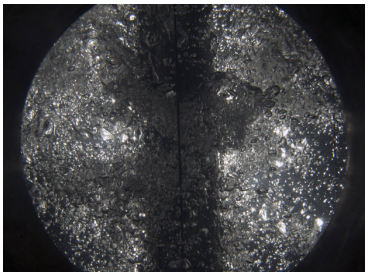
- **Technique evaluates hydrogen release from nuclear waste.**
- **Mass transfer coefficients:**
  - $$k_L a = -\frac{1}{t} \cdot \ln\left(\frac{C(t) - Ca}{C^* - Ca}\right)$$
  - Low superficial, average, velocity.
  - Experimental results consistently lower than theory.
    - Water: 15 to 70% less than theoretical.
    - AZ101, Sludge simulant: 360 to 1300% less than theoretical.
    - Settling affects mass transfer.
- **Void fractions:**
  - AFA increases gas holdup.



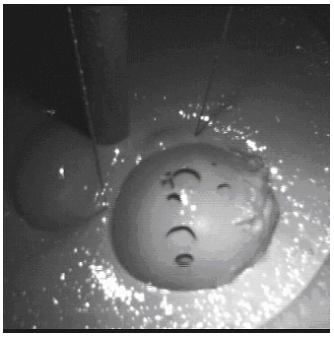
Sparger Tip, Water



Surface, Water



Viewport, Water



Surface, AZ101

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