Aqueous CYAN Update

Topics:

- New pH probe!
- Aqueous run with pH and EC
- Scaling up?

David Wilson
dw@ieee.org

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Aqueous CYAN Basics

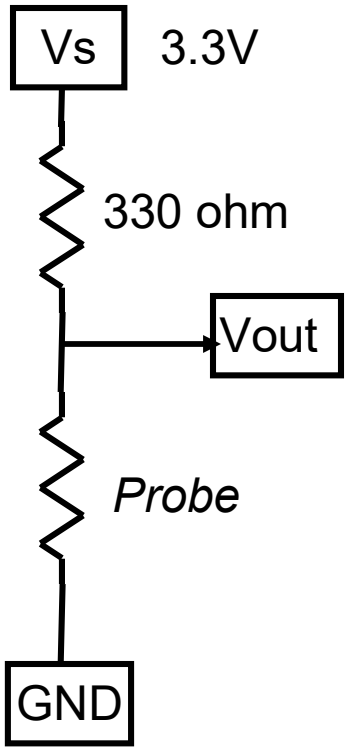
- Same reaction as Classic CYAN:

  $Ca(OH)2 + CO2 \rightarrow CaCO3 + H2O$
- Parts reuse: Aquarium pump, air stone, chemicals, soda bottle
- Newer: Electrical Conductivity (EC) Monitoring
- *Even newer: pH meter*

EC Measurement

https://hackaday.io/project/7008-fly-wars-a-hackers-solution-to-world-hunger/log/24646-three-dollar-ec-ppm-meter-arduino

- Probe: 2 wires, 2 buttons
- Circuit: voltage divider and uC
- PULSED measurement required
- OMIT temperature adjustment
- Note: EC probe interferes with pH measurement, so had to isolate (not shown)



Han's Paper

Carbon Dioxide Capture Using Calcium Hydroxide Aqueous Solution as the Absorbent

Sang-Jun Han, Miran Yoo, Dong-Woo Kim, and Jung-Ho Wee*

Department of Environmental Engineering, The Catholic University of Korea, 43-1, Yeokgok 2-dong, Wonmi-gu, Bucheon-si, Gyeonggi-do 420-743, Republic of Korea

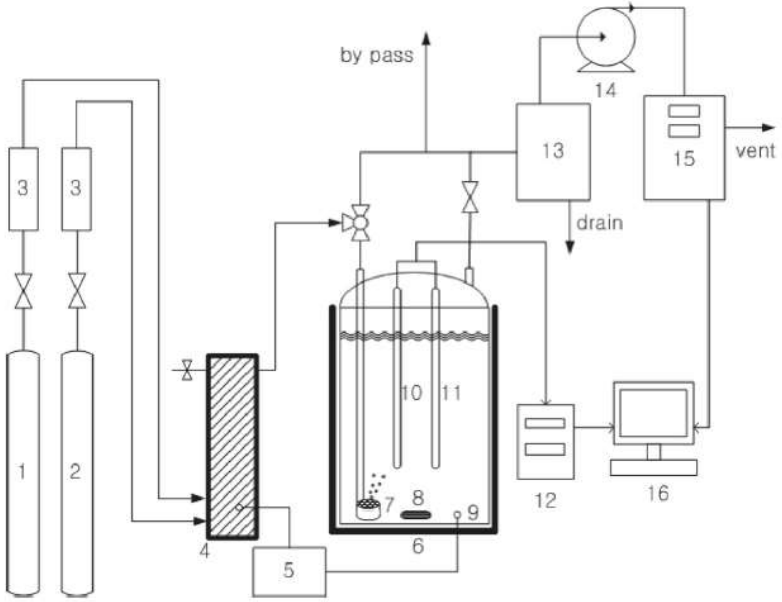


Figure 1. Schematic diagram for a CO_2-capture system using $Ca(OH)_2$ aqueous solution as the absorbent: (1) N_2 cylinder, (2) CO_2 cylinder, (3) MFC, (4) gas mixer, (5) temperature controller, (6) Pyrex reactor, (7) sparser, (8) magnetic stirrer, (9) thermometer, (10) pH sensor, (11) EC sensor, (12) pH/EC meter, (13) dehumidifier, (14) sampling pump, (15) gas analyzer, and (16) computer for data acquisition.

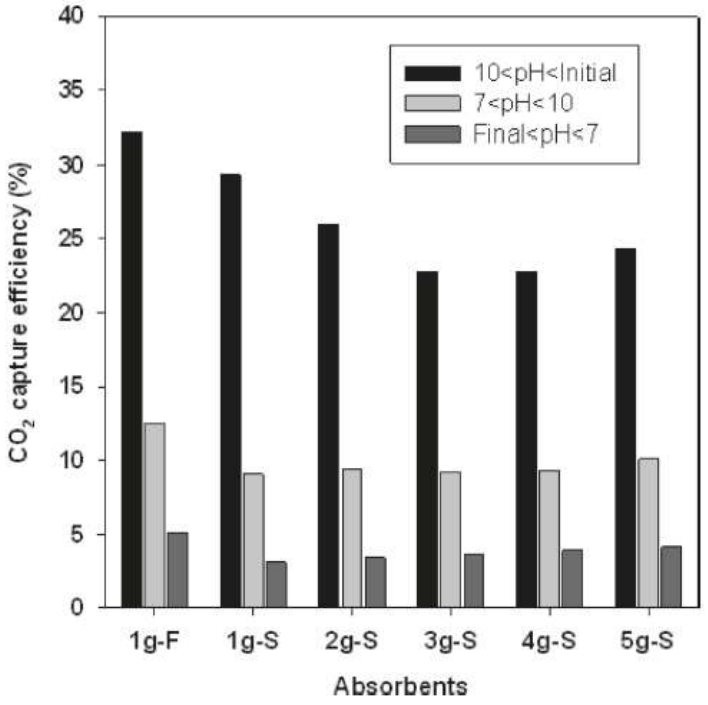
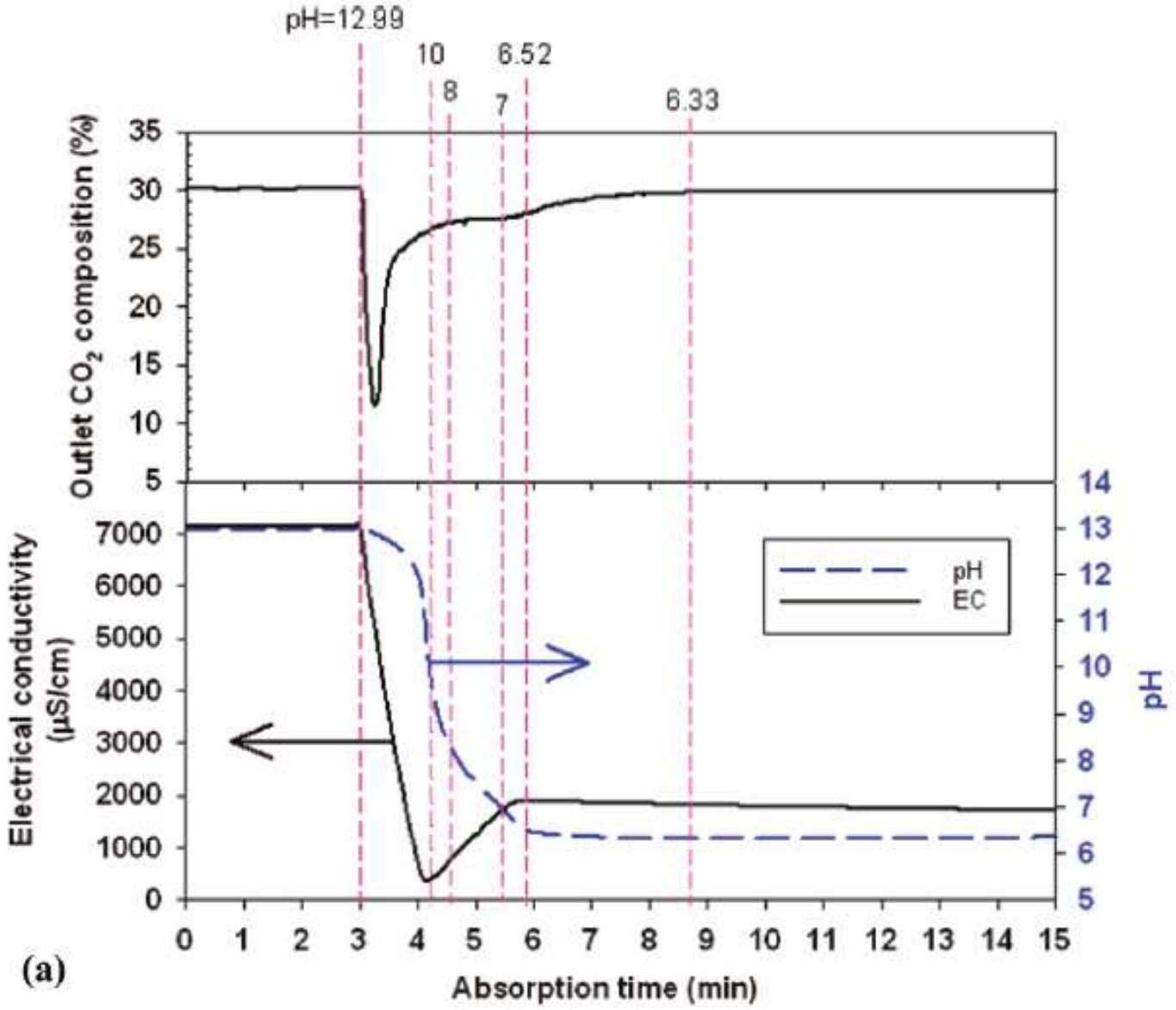


Figure 11. CO_2-capture efficiencies of each absorbent in the pH ranges.

dx.doi.org/10.1021/ef200415p | *Energy Fuels* 2011, 25, 3825–3834

Han Paper Detail

Saturated Ca(OH)2 solution

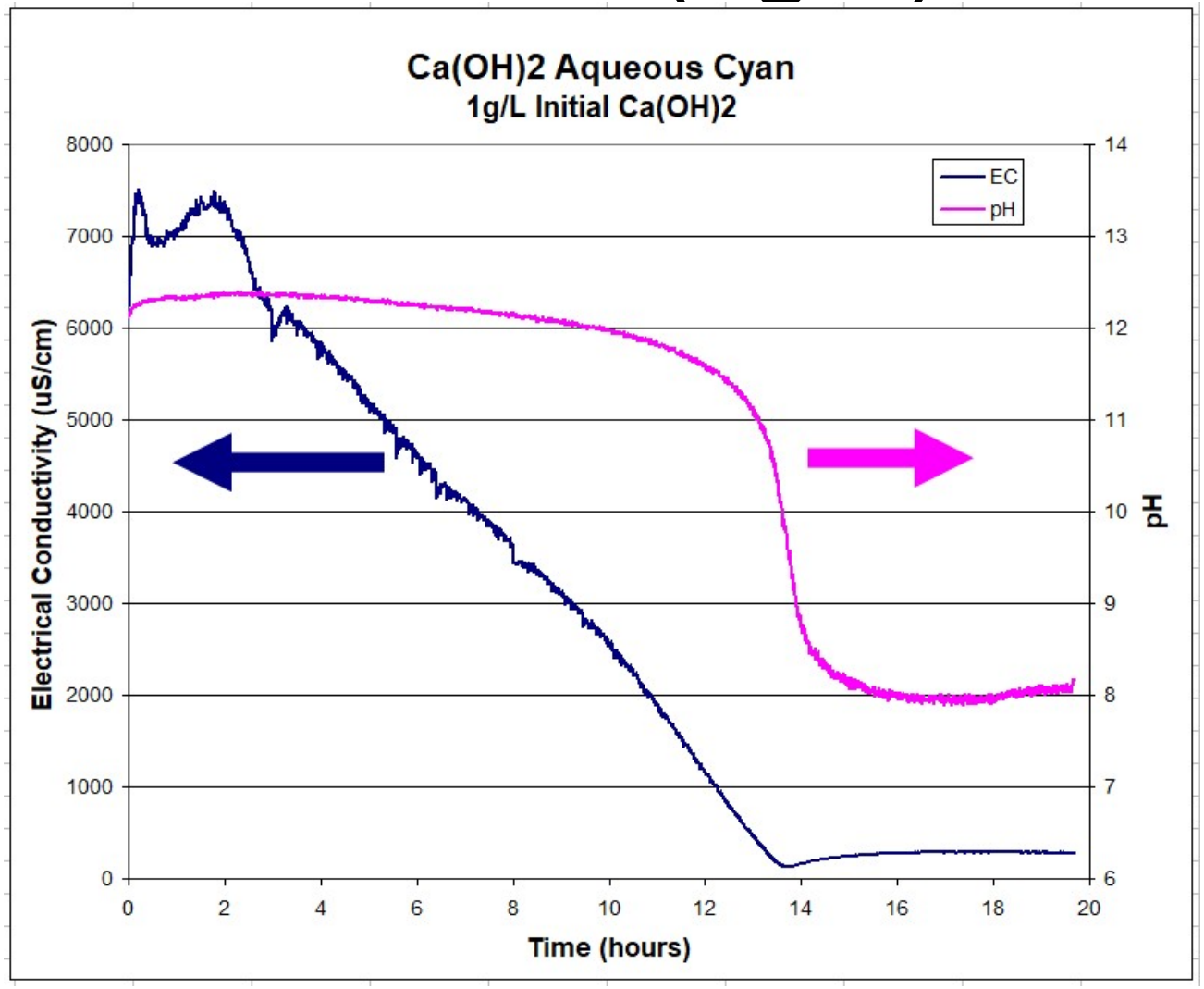


Newest Experiment: Now with pH Meter

- 1g $Ca(OH)_2$ in 1L water. Solubility of $Ca(OH)_2$ in H2O: 1.73 g/L at 20C. [Same as last time]
- Calibration of EC probe: estimate 8000uS/cm (*) in our solution
- Pumped air through air stone (bubbler), while measuring EC every 30 seconds.
- *Also* measured pH *(with meter).*
- Kept going until EC and pH flattened out
- Used distilled water this time: no initial sediment

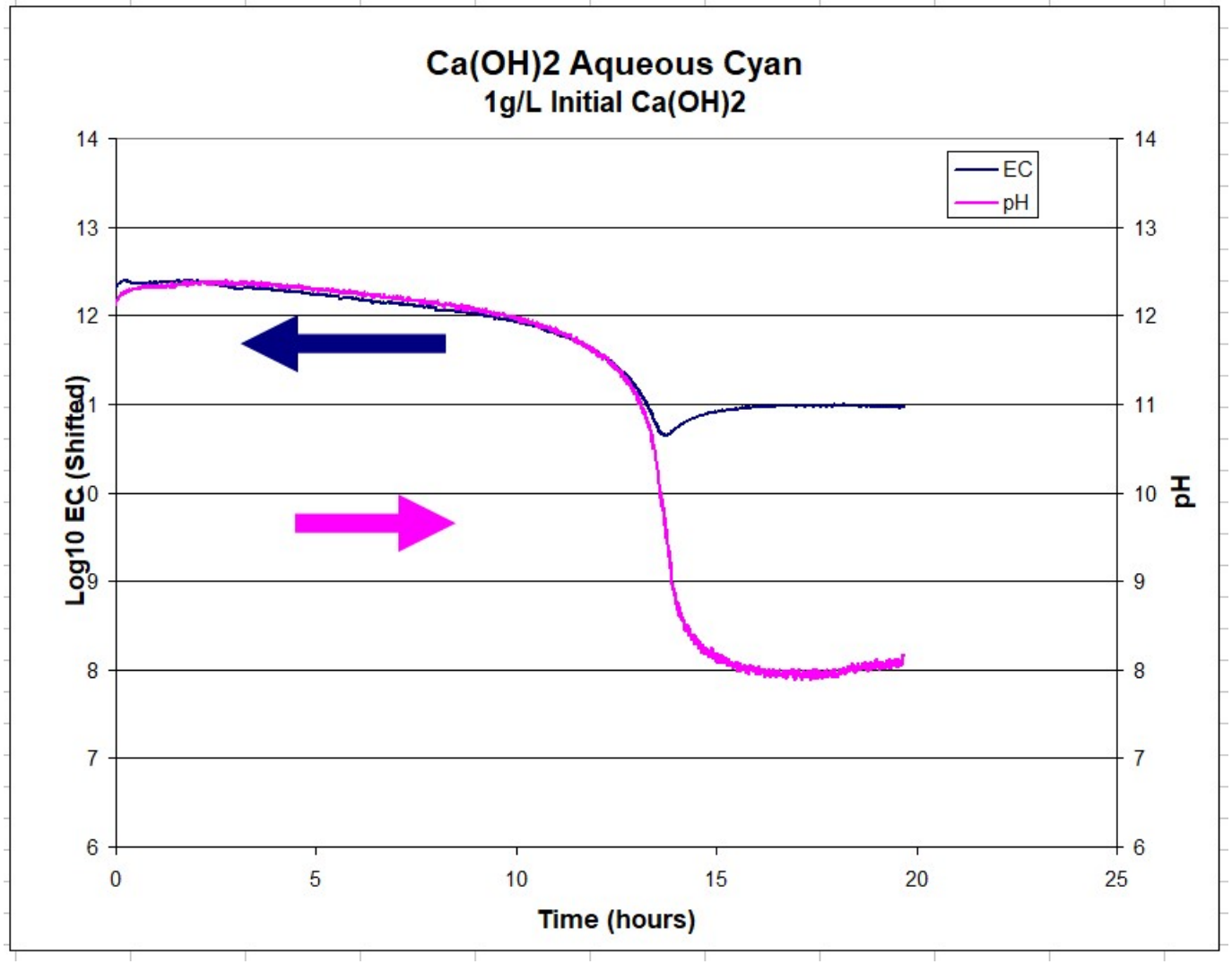
•Note on units: S ≡ Siemens ≡ mho ≡ 1/ohm
•It is /cm because it's a spatially distributed resitance

Results (1g/L)


Ca(OH)2 Aqueous Cyan
1g/L Initial Ca(OH)2
EC
pH
Electrical Conductivity (uS/cm)
pH
Time (hours)
0
1000
2000
3000
4000
5000
6000
7000
8000
6
7
8
9
10
11
12
13
14
0
2
4
6
8
10
12
14
16
18
20

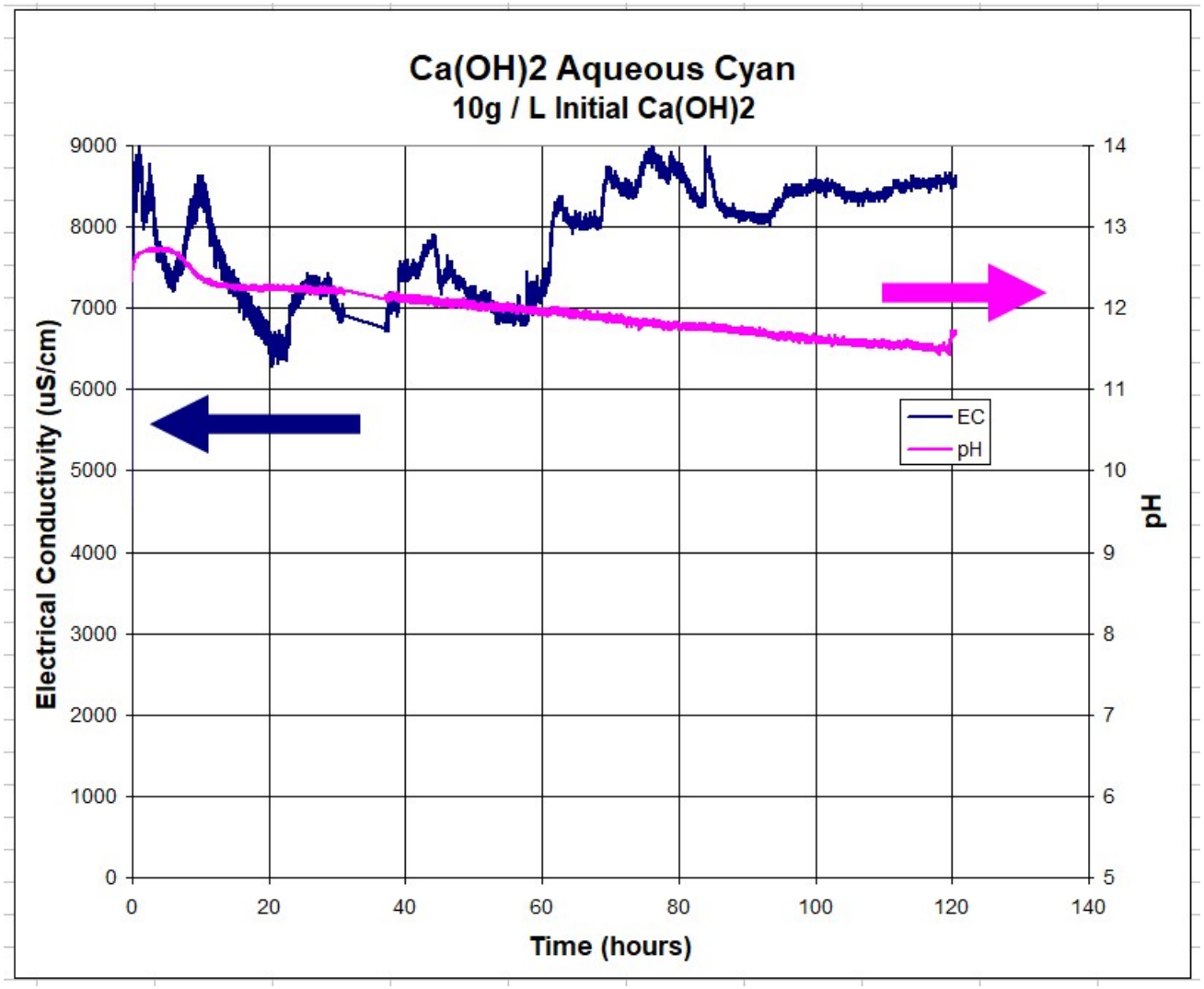
What if we take log10 of EC?

(and shift to line up with pH)



Scaling up: 10g/L Aqueous Test

First run, uninterrupted

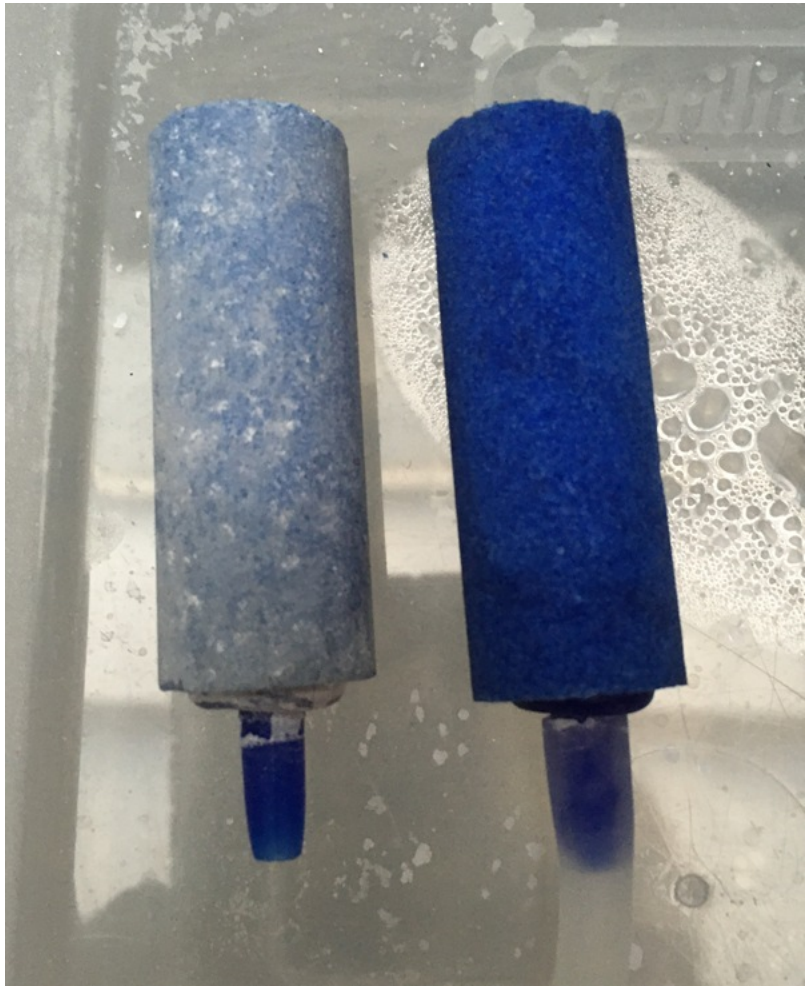


Why?

- Air stone getting clogged before run finishes
- Air stone not resting on bottom, so sediment+input material not getting stirred up

Continuing Issue: Dirty Air Stone

OLD NEW



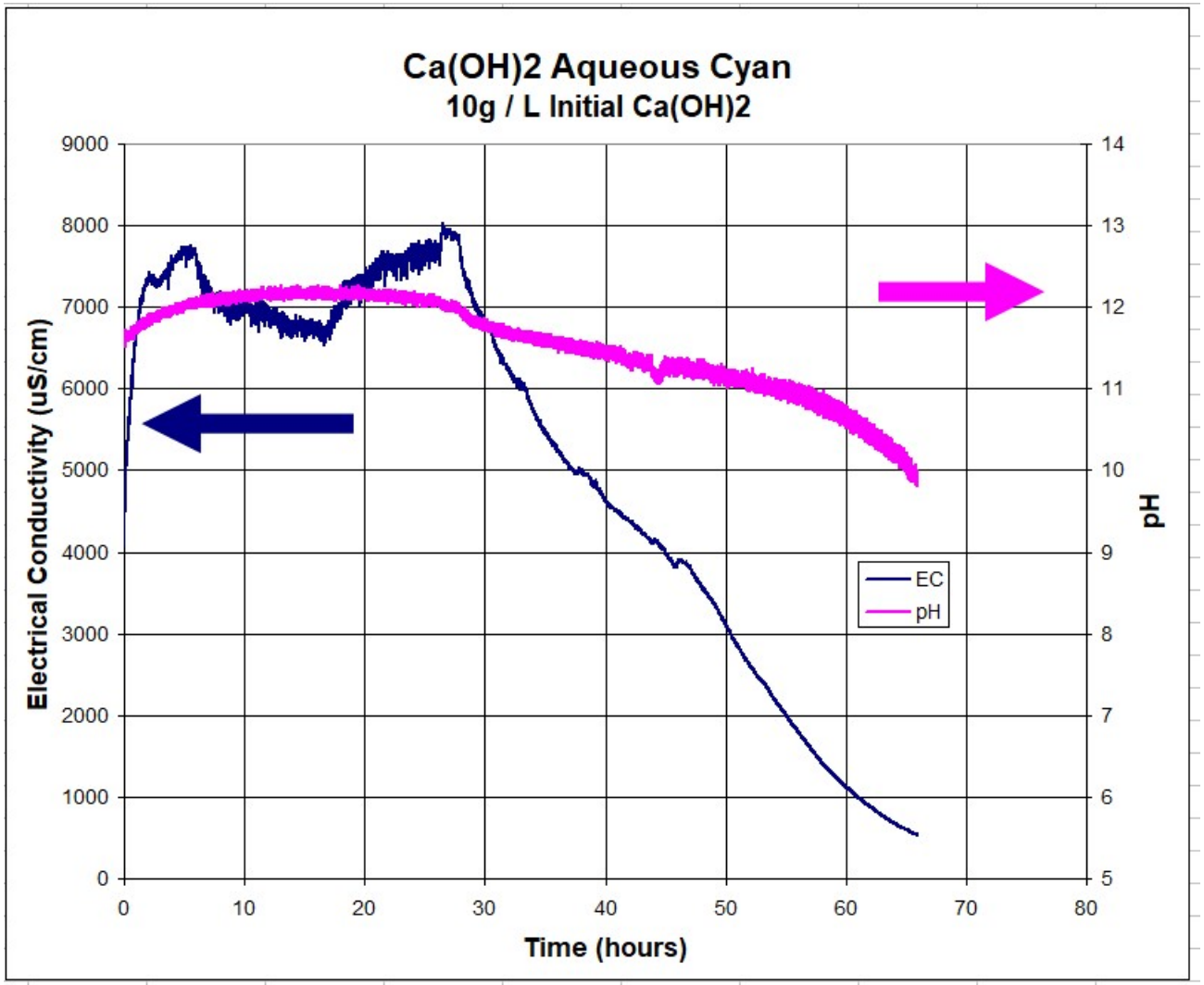
OLD NEW

Attempted remedies

- Clean air stone
- Shake bottle thoroughly to stir up sediment
- Make sure air stone rests on *bottom* of bottle to stir up sediment

Scaling up: 10g/L Aqueous Test

CONTINUED after remedies



After 10g run…

For Followup

- Better aerator (sparger) needed?
- Understand pH vs. EC
- Need to pump more air
- How to separate and dry precipitate?
- Weigh precipitates from both runs and calculate amount of CO2 captured