Aqueous CYAN Update

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Aqueous CYAN Basics

(Updated from July 9 Report)

- Same reaction as Classic CYAN:

  $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

- Parts reuse: Aquarium pump, air stone, chemicals. New: replace plastic box with 1-L soda bottle.

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

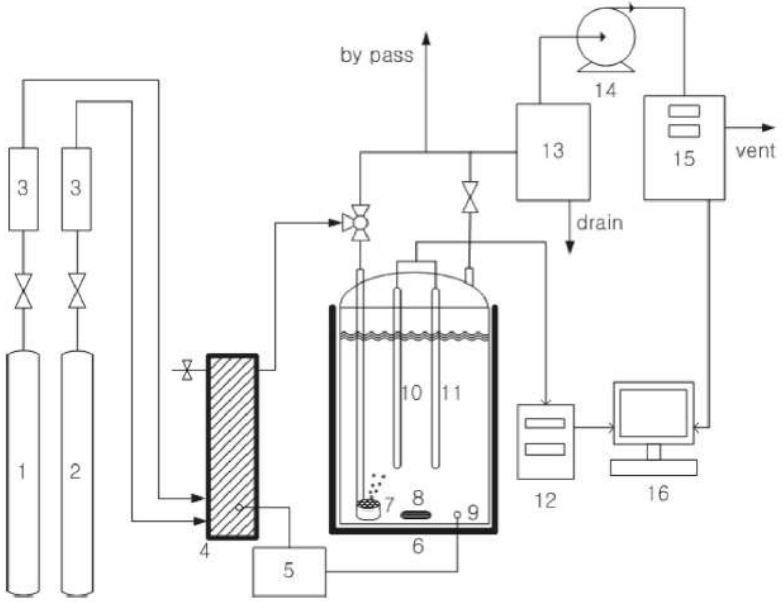


Figure 1. Schematic diagram for a CO_2-capture system using $Ca(OH)_2$ aqueous solution as the absorbent: (1) N_2 cylinder, (2) CO_2 cylinder, (3) MFC, (4) gas mixer, (5) temperature controller, (6) Pyrex reactor, (7) sparser, (8) magnetic stirrer, (9) thermometer, (10) pH sensor, (11) EC sensor, (12)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

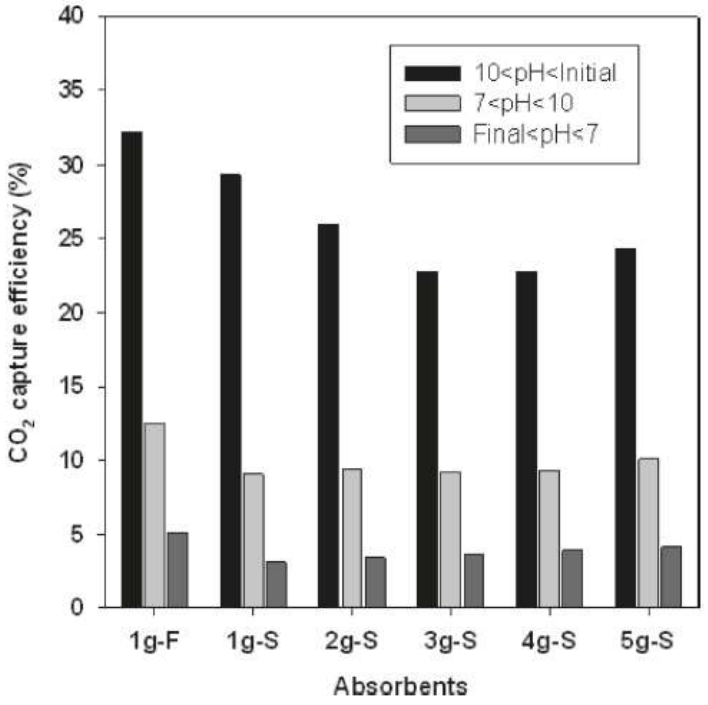


Figure 11. CO_2-capture efficiencies of each absorbent in the pH ranges.

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

Main Take-aways (for me) from Han's Paper

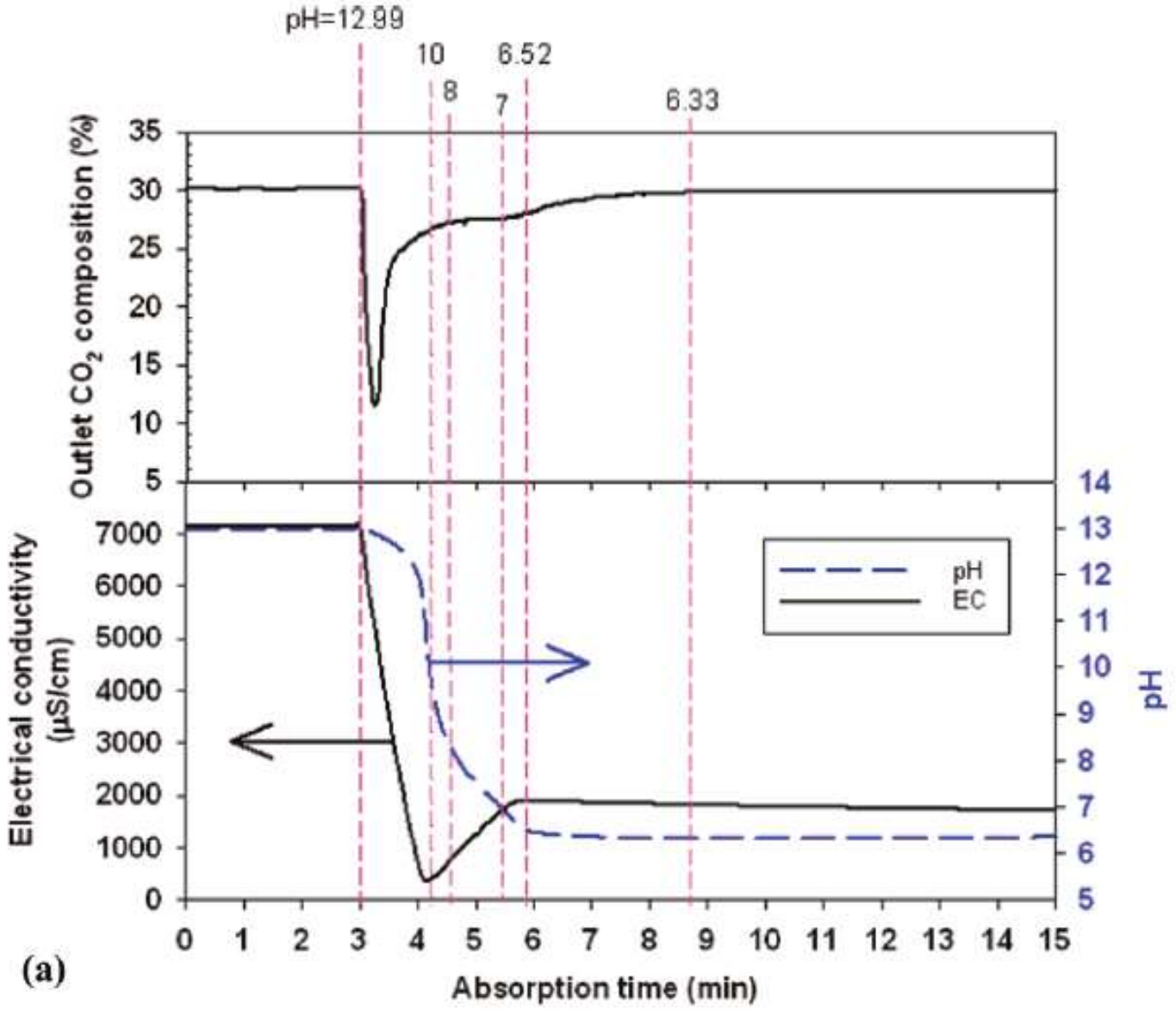
- When pH goes < 10 as CO_2 is captured, $CaCO_3$ (precipitate) production STOPS.
- As pH continues to drop, $CaCO_3$ combines with more CO_2 to produce (soluble!) HCO_3^- ions…
- …until by the time pH <7, there's no more $CaCO_3$ precipitate.

➢ We should stop when pH reaches 10, so we can recover solid output, and

➢ Most CO_2 has already been captured.

Han Paper Detail

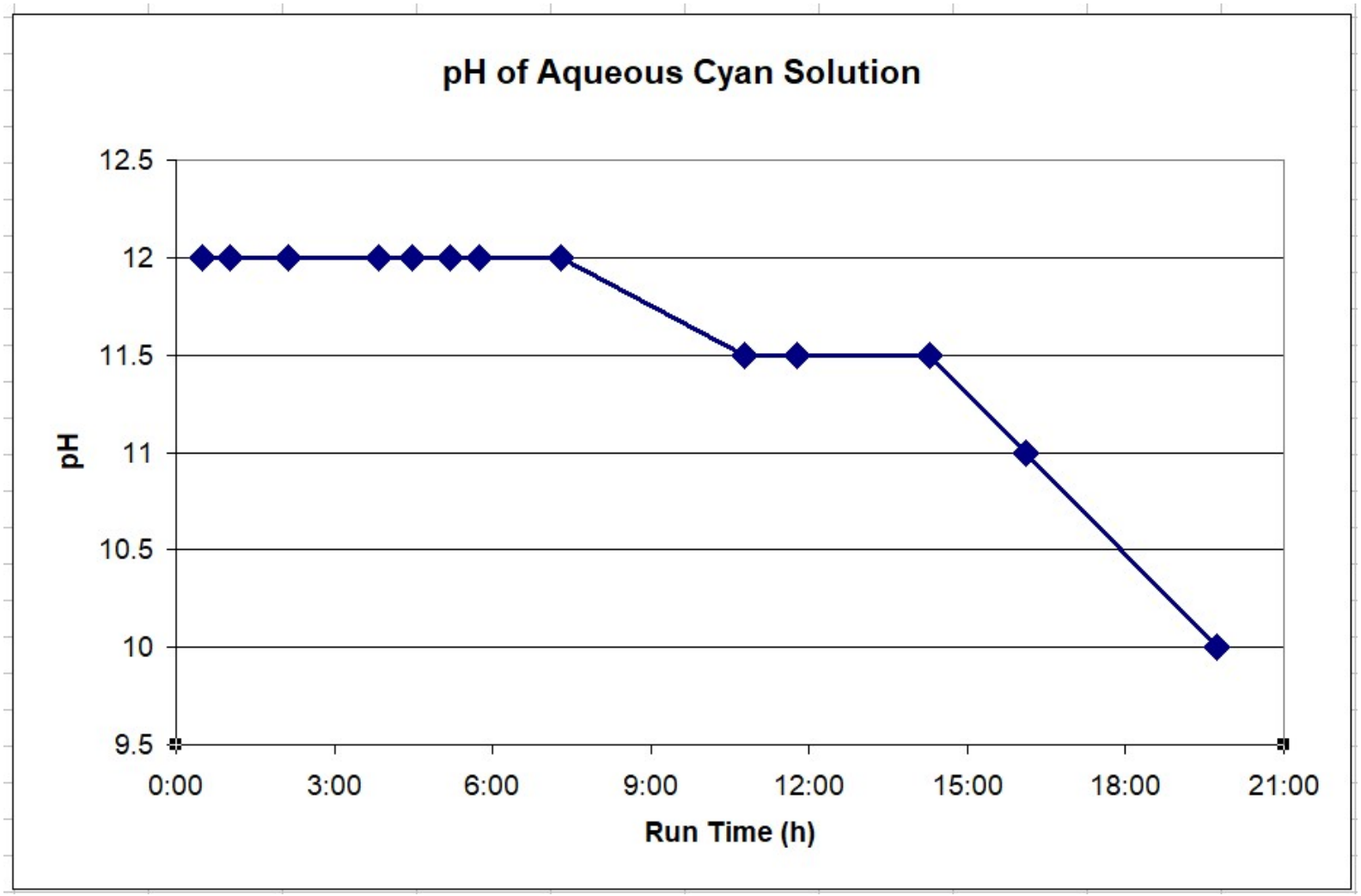
Saturated Ca(OH)2 solution



My Experiment

- 1g $Ca(OH)_2$ in 1L water. Solubility of $Ca(OH)_2$ in H2O: 1.73 g/L at 20C.
- Pumped air through air stone (bubbler), periodically checking pH with pH paper.
- Stopped when pH reached 10.

pH vs. Time


pH of Aqueous Cyan Solution
12.5
12
11.5
11
10.5
10
9.5
pH
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
Run Time (h)

Results

- Stopped at 19:44.
- Siphoned out clear solution
- Dried precipitate in air

Analysis

- Weight of dry precipitate: 1.044g
- Vinegar test: significant bubbling!
- Calculated CO2 captured: 0.459g (from 1g input material—77% of theoretical)

Followup

- **Caveat:** calculated capture amount may be over-estimate due to impurities in water and sorbent.
- Ideas for automating end of process:
  - Electronic pH meter ($$)
  - Electronic resistivity measurement ($)
- Need to pump more air
- How to separate and dry precipitate?