Rishi Gottimukkala

Dr. Anthony

NCSSM Electrochemistry

Electrochemistry Lab 3 - Maximize Power

Guiding Question:
What specific aspects and variables within a battery affect the power output? Given that, how do we design a copper-zinc battery to achieve the highest power output?

Importance:
Understanding how different configurations affect battery efficiency is important in optimizing electrochemical cells for practical energy reasons. This includes storage, generation, and transmission applications. Also, tactics to increase power will also show tactics to reduce power in certain situations.

Pre-Lab Predictions:
I expected that increasing the surface area of the electrodes and increasing the ion concentration of the salt bridge would increase the battery's power output. Also adding more cotton string might speed up the process of ion flow.

Experimental Procedure:

This changed based on the battery, but here is the general outline

1. Prepare aqueous solutions of copper sulfate, 1 M zinc sulfate, and potassium nitrate.
2. Cut electrode strips (copper and zinc) to specified sizes.
3. Pour copper and zinc sulfate solutions into well tray
4. Dip a cotton string in the potassium nitrate solution to act as the salt bridge.
5. Use the cotton string to connect the two aqueous solutions
6. Put the electrodes in their respective well
7. Measured power output with a voltmeter and alligator clips.

Summary of Experimental Findings:

We tested three different battery configurations, each varying the concentrations, number of salt bridge strings, and electrode size.

<u>First Battery:</u>

- **Components:** Oversaturated copper sulfate solution, 1 M zinc sulfate, 1 cotton string dipped in 1 M potassium nitrate, 3cm x 1cm electrode strips.

- **Output:** 0.222 mW

Second Battery:

- **Components:** Oversaturated copper sulfate solution, 1 M zinc sulfate, 3 cotton strings dipped in oversaturated potassium nitrate, 3cm x 1cm electrode strips.
    - CHANGE: increased potassium nitrate concentration and number of strings
- **Output:** 1.73 mW

Third Battery:

- **Components:** Oversaturated copper sulfate solution, 1 M zinc sulfate, 3 cotton strings dipped in oversaturated potassium nitrate, 6cm x 1cm electrode strips (rolled and fully submerged).
    - CHANGE: increased electrode size and rolled them up
- **Output:** 1.71 mW (second trial: 1.69 mW)

Maximum Output: 1.73 mW

Discussion:

- my expectation that increasing the ion mobility in the salt bridge would improve battery performance was confirmed, as the second battery (which used three cotton salt bridges) produced the highest power output.
- my expectation that increasing electrode surface area would increase power output wasn't confirmed, as the third battery (with larger electrodes) had no significant difference in output from the second battery in terms of voltage.
- This suggests that surface area alone might not be the limiting factor in power generation, and ion mobility plays a larger role.

Proposed Further Experiments:

In further experimentation, we could investigate the effect of different salt bridge materials (different ions) to determine their impact on ion mobility and overall battery efficiency. Additionally, testing varying electrode materials beyond copper and zinc could provide insights into optimizing electrochemical reactions for better power output. Maybe even decreasing the Zinc concentration to near nill would provide better results.