A thermally regenerative ammonia-based battery for efficient harvesting of low-grade thermal energy as electrical power

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Nernst equations for calculating electrode potentials:

Anode: \[ E = E^0 - \frac{RT}{2F} \ln \frac{[a(NH_3)]^4}{a(Cu(NH_3)e^{2+})} \] \hspace{2cm} \text{(S1)}

Cathode: \[ E = E^0 - \frac{RT}{2F} \ln \frac{1}{a(Cu^{2+})} \] \hspace{2cm} \text{(S2)}

Figure S1. (A) Power production and (B) electrode potentials using 0 – 8 M NH$_4$NO$_3$ as the supporting electrolyte, with 0.1 M Cu(II) in both electrolyte and 1 M ammonia in the anolyte. Both catholyte and anolyte were in static conditions. Error bars represent standard deviations based on measurements with duplicate reactors. Cathode concentration polarization occurred at high current density range with 3 – 8 M NH$_4$NO$_3$, resulting in power overshoot with these conditions.
Figure S2. Whole batch cycle performance (A) power density (B) electrode potentials of four successive cycles. The initial electrolyte contained 0.1 M Cu(II), 5 M NH₄NO₃ and additional 2 M NH₃ in the anolyte. The electrolyte was then thermally regenerated and operated for 3 successive cycles. “With acid” stands for the condition where acid was added to dissolve the Cu(OH)₂ precipitates during the catholyte regeneration.
Figure S3. (A) Conductivity and (B) pH of 0.1 M Cu(NO₃)₂ solutions with various concentrations of ammonium salts, with or without addition of 1 M ammonia in the solutions. Given the same molar concentration of salt, although NH₄Cl had a higher conductivity than NH₄NO₃, the formation of CuCl₄⁻ complex ions prevented the use of NH₄Cl as the supporting electrolyte.
**Figure S4.** Equivalent circuit for whole cell impedance analysis. The reaction resistance was the sum of anode charge transfer resistance ($R_{ct,an}$), cathode charge transfer resistance ($R_{ct,cat}$), and diffusion resistance ($R_{d,cat}$).