Supplementary Information

Stepwise Ammonium Enrichment Using Selective Battery Electrodes

Moon Son [a], Eric Kolvek [b], Taeyoung Kim [c], Wulin Yang [a], Johannes S. Vrouwenvelder [d], Christopher A. Gorski [a], Bruce E. Logan [a,*]

[a] Department of Civil and Environmental Engineering, The Pennsylvania State University, University Park, PA 16802, USA

[b] Department of Chemical Engineering, The Pennsylvania State University, University Park, PA 16802, USA

[c] Department of Chemical and Biomolecular Engineering, and Institute for a Sustainable Environment, Clarkson University, Potsdam, NY 13699, USA

[d] Water Desalination and Reuse Center (WDRC), Division of Biological and Environmental Science and Engineering (BESE), King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, Saudi Arabia

* Corresponding author. Email: blogan@psu.edu; Tel.: +1-814-863-7908

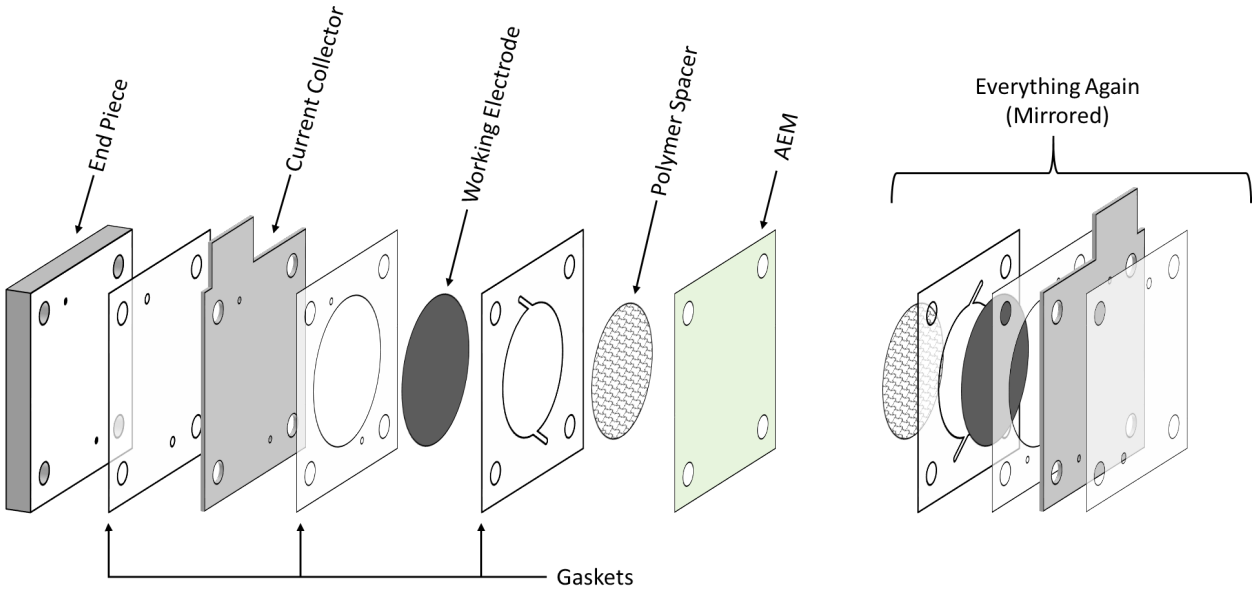

Fig. S1 Schematic of the flow cell assembly. Redrawn image from previous work.[S1] The effective membrane area was 7 cm^2.

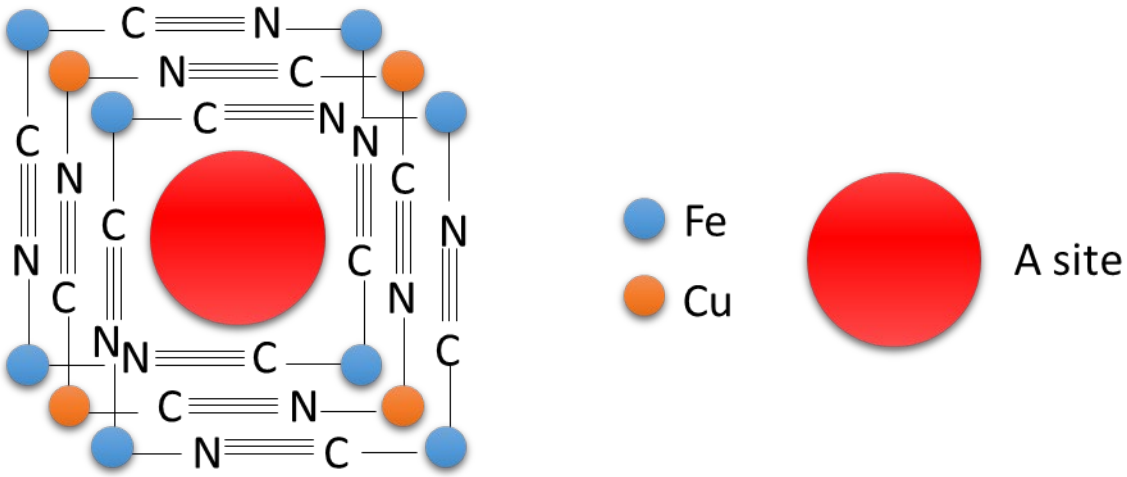

Fig. S2 (a) Structure of copper hexacynoferrate (CuHCF). The size of the interstitial sites (A site) is 3.2~4.6 Å. Redrawn image from previous work.[S2]

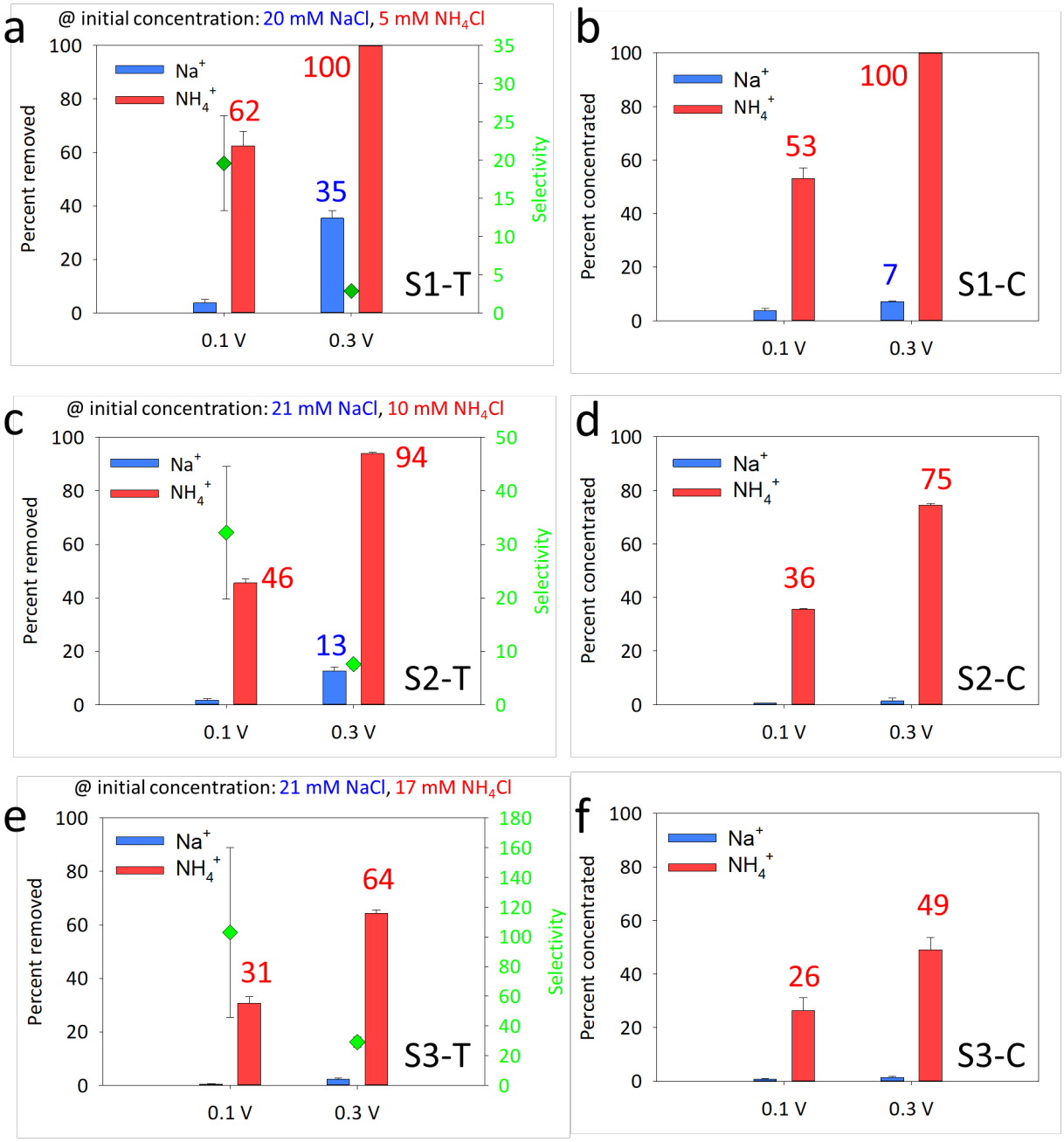

Fig. S3 Percent removed or concentrated of Na^+ and NH_4^+ of (a–b) S1, (c–d) S2, and (e–f) S3 as a function of the cell voltage from 0.1 to 0.3 V. Selectivity of ions removal (NH_4^+/Na^+) is also shown for the treated stream.

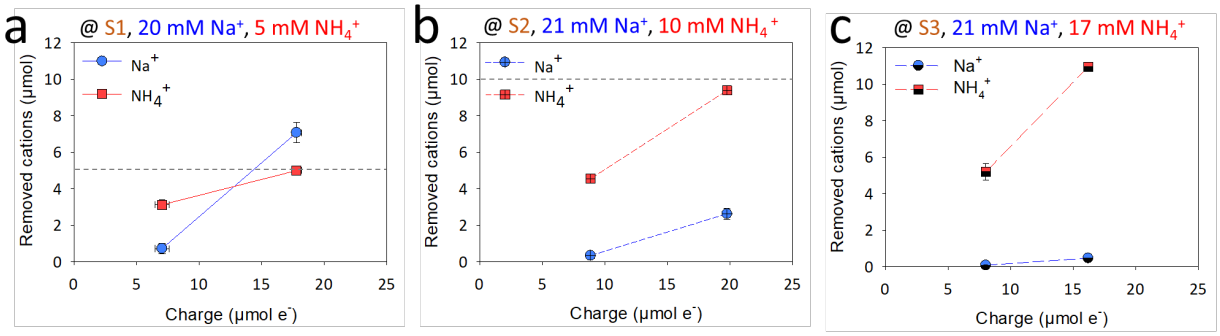

Fig. S4 Removed cations of (a) S1, (b) S2, and (c) S3 as a function of the amount of charge. Concentration of the feed waters was varied depending on the effluent concentration of the previous stage (S1: 20 mM NaCl and 5 mM NH_4Cl, S2: 21 mM NaCl and 10 mM NH_4Cl, and S3: 21 mM NaCl and 17 mM NH_4Cl). Dash lines indicate initial NH_4^+ concentration present in the solution.

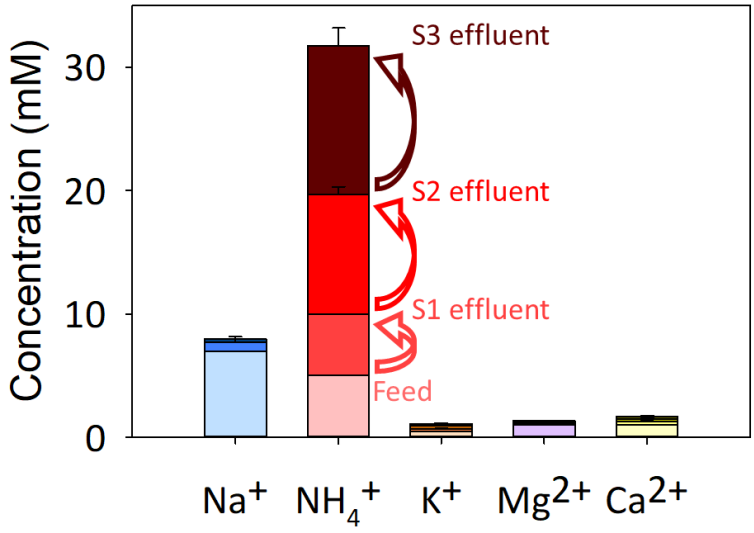

Fig. S5 Concentration of the feed and concentrated effluents of each stage of cations over three stages at an applied voltage of 0.3 V using synthetic wastewater.

References

S1. T. Kim, C. A. Gorski and B. E. Logan, Ammonium removal from domestic wastewater using selective battery electrodes, *Environ. Sci. Technol. Lett.*, 2018, **5**, 578-583.

S2. C. D. Wessells, S. V. Peddada, M. T. McDowell, R. A. Huggins and Y. Cui, The effect of insertion species on nanostructured open framework hexacyanoferrate battery electrodes, *J. Electrochem. Soc.*, 2011, **159**, A98-A103.