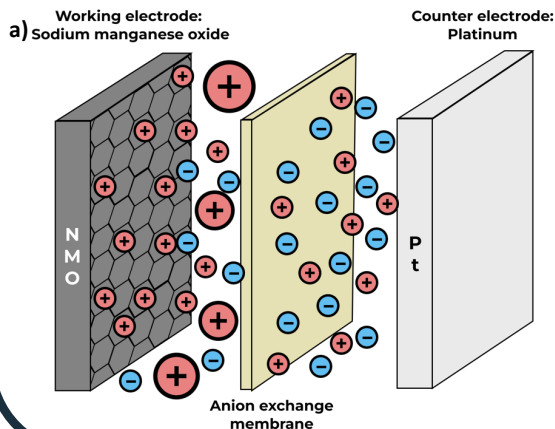


Introduction

Conventional fertilizer production relies on the Haber Bosch process, which uses hydrogen from cracking fossil fuels and nitrogen from the air to create ammonia. However, the process uses ~1% of the world's total energy production and accounts for ~1% of global CO₂ emissions¹. Despite its drawbacks, our population is heavily dependent on the Haber Bosch process with ~50% of the world's food production relying on it². This raises a major problem: **we have a process that uses an immense amount of energy, yet we can't sustain our population without it, so what can we do?**

Urine is a valuable resource, concentrated with nutrients, that is produced worldwide. In total, global urban wastewater can potentially meet over 3% of agricultural fertilizer demand³. However, it also contains lots of contaminants. Thus, a potential solution is to recover urine as a resource and remove the contaminants. One of such is sodium, which is concentrated in urine and inhibits plants' ability to absorb water.

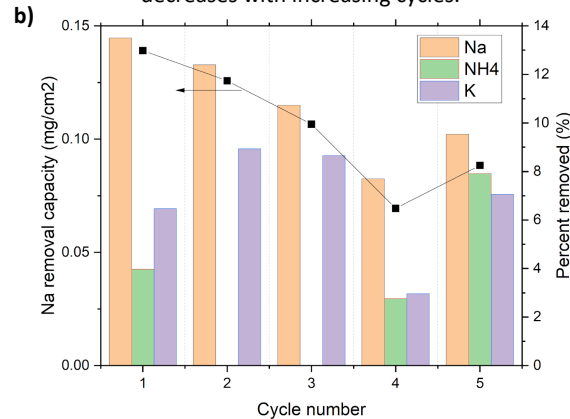
Materials And Methods



Sodium Manganese Oxide (NMO) was used as the electrode. NMO has pockets that we can push sodium ions into using electrochemistry. By controlling the electrochemical operating parameters, we can push the sodium ions into and out of the electrode, which allows us to reuse the electrode. By controlling the size of the pockets, we can promote the insertion of one type of ion over others, for example, sodium ions over potassium ions.

Research Highlights

In real hydrolyzed urine, the percentage removal of sodium ions for a single sodium manganese oxide (NMO) electrode decreases with increasing cycles.

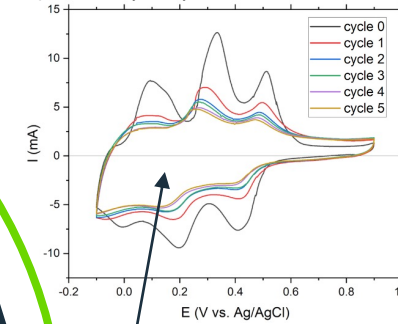


This is found by repeatedly pushing sodium ions into the sodium manganese oxide (NMO) electrode from urine and regenerating it by pushing the sodium ions back out into a salt solution.

Hypothesis: The ionic composition of real hydrolyzed urine impacted the stability of the NMO electrode.

A few positively charged ions were further investigated using binary solutions including potassium, ammonium, and ammonia. Most notably, ammonium led to a decrease in area in the cyclic voltammogram (Fig. d). This decrease was not noticeable with potassium or ammonia, helping to define the operating regimes of sodium capacitive deionization.

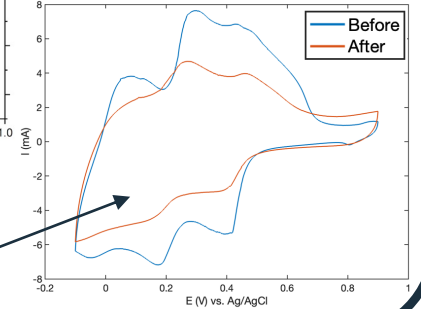
c) In real hydrolyzed urine



Area indicative of electrode's removal capacity;
Small area = small removal capacity

Graphs / Diagrams

d) in ammonium chloride and sodium chloride solution



Discussion / Conclusion

The cyclic voltammogram in Fig. c shows a decrease in the area under the graph with increasing cycles. The area corresponds to the amount of charge transferred while running the cyclic voltammogram and is used mainly as an indicator of the removal capacity of the electrode. The decrease in the area shown indicates a decrease in the removal capacity of the electrode.

To interrogate the source of the problem, we performed successive sodium removal cycles on synthetic urine. Synthetic urine has the same ionic composition as real hydrolyzed urine but without organic compounds. The results were similar with a decrease in removal capacity and percentage removal of sodium ions, confirming our hypothesis.