Electrified Water Disinfection and Ammonia removal via *on-site* Electrochlorination

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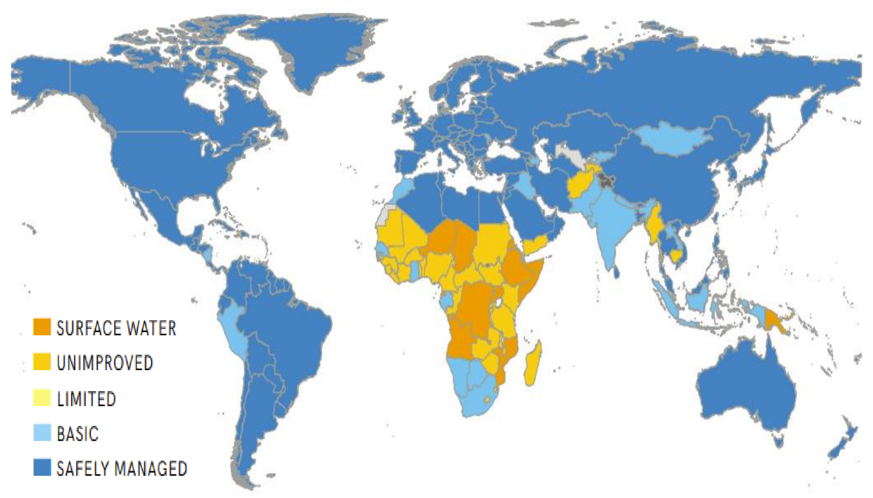
Introduction



29% of global population still do not have access to safely managed drinking water sources [2]

High capital cost required for centralized treatment and water distribution grids

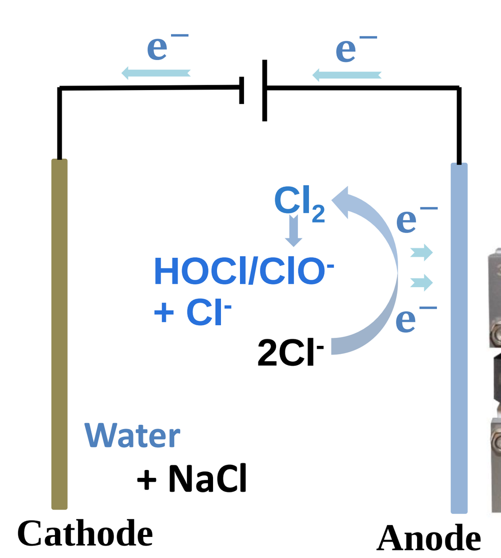
On-site electrochlorination oxidizes ubiquitous chloride ions into chlorine: $2Cl^- + 2e^- \rightarrow Cl_2$

Enacts primary disinfection and provide disinfectant residuals

On-site electrochlorination does not require chemical addition and does not generate waste

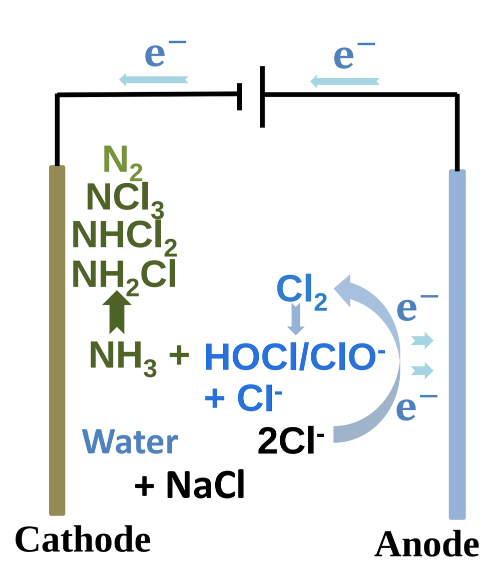
Can be implemented for ammonia removal in ammonia contaminated waters

Materials and Methods



On-site electrochlorination for water disinfection

- Flow through reactor
- Cross velocities of 1.3-11.0 cm s^{-1} were examined (0.1-0.9 L min^{-1})
- Galvanostatic operation mode (current densities of j = 5-15 mA cm^{-2} were tested)
- Ti/RuO_2, Ti/IrO_2 and BDD anode materials were evaluated, and Ti plate was used as a cathode
- $[Cl^-]_0$=50-250 mg L^{-1} (below MCL of chloride for drinking water)

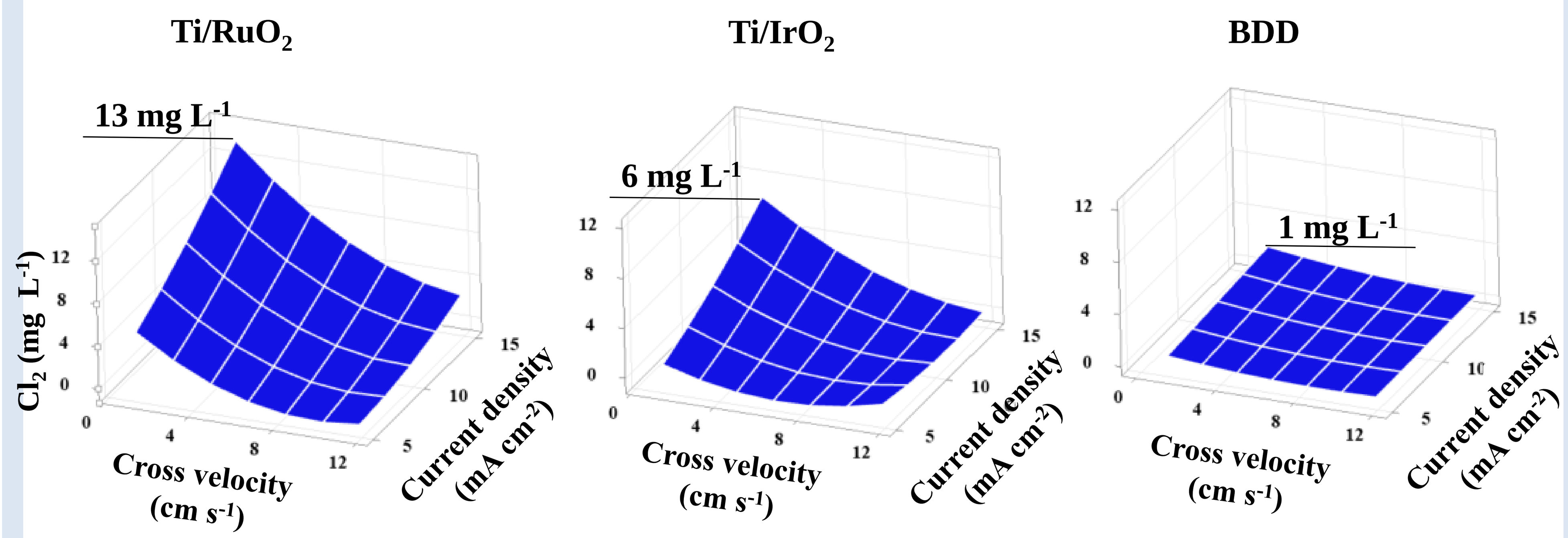


On-site electrochlorination for ammonia removal

- Batch type reactor (0.2 L volume)
- Galvanostatic operation mode (constant current density of j = 17 mA cm^{-2} (i = 0.1 A))
- Ti/IrO_2 mesh as an anode and Ti plate as a cathode material
- $[Cl^-]_0$= 3000 mg L^{-1} (concentration usually found in brine waters)
- 10 and 20 mg $[NH_4^+\text{-}N]_0$ L^{-1} were tested

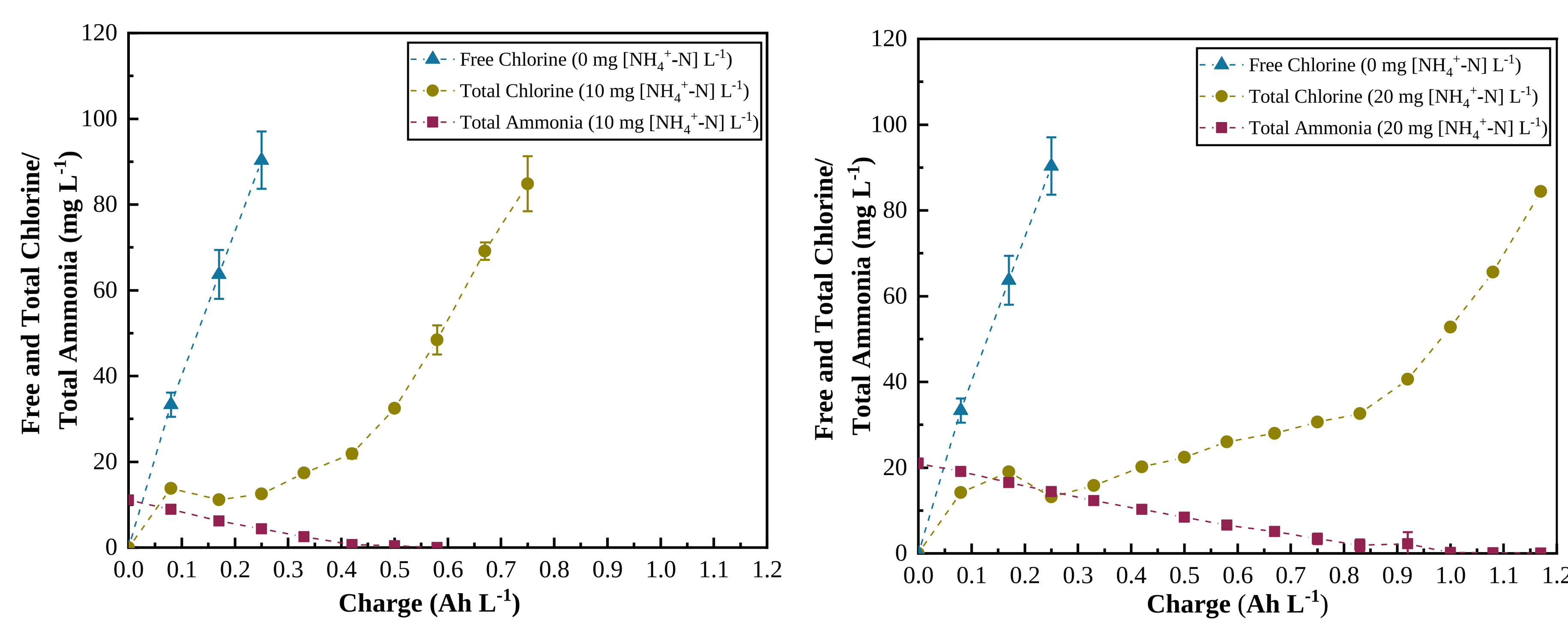
Results and Discussion

On-site electrochlorination for water disinfection



***Ti/RuO_2* was evaluated as the most efficient electrocatalysts for sustained active chlorine production.**
Desirable chlorine content might ne insured by selecting appropriate operating parameters.
Cross velocity was identified as the most influential parameter on active chlorine production.

On-site electrochlorination for ammonia removal



$$2NH_3 + 3HOCl \rightarrow N_2 + 3H2O + 3H^+ + 3Cl^-$$

Oxidation of ammonia during on-site electrochloirnation takes place in the vicinity of the anode surface due to local excess of HOCl trough mechanism of chlorine break point.

Conclusion

- ✓ Ti/RuO_2 was evaluated as most efficient electrocatalyst for sustained electro generation of active chlorine.
- ✓ Desirable chlorine content might ne insured by selecting appropriate operating parameters. Content as high as 13 ppm of active chlorine were produced in a single pass of electrochemical flow cell.
- ✓ Cross velocity was identified as the most influential parameter on active chlorine production.
- ✓ Gradual total ammonia oxidation during *on-site* electrochloirnation takes place in the vicinity of the anode surface due to local excess of HOCl through mechanism of chlorine breaking point.

Future Work

- Compare mechanism of chlorine break point during *on-site* electrochloirnation with conventional chlorination.
- Evaluate mechanism of chlorine break point during *on-site* electrochloirnation at different hydraulic parameters (different rotation speeds).
- Evaluate mechanism of chlorine break point during *on-site* electrochloirnation at different charge transfer rates.

References

[1] S. Garcia-Segura, A. B. Nienhauser, A. S. Fajardo, R. Bansal, C. L. Conrad, J. D. Fortner, M. Marcos-Hernández, T. Rogers, D. Villagran, M. S. Wong and P. Westerhof, "Disparities between experimental and environmental conditions: Research steps toward making electrochemical water treatment a reality", *Current Opinion in Electrochemistry,* vol. 22, pp. 9-16, 2020.

[2] World Health Organization, "Progress on drinking-water, sanitation and hygiene", 22 February 2018.

[3] EPA, "Disinfection Profiling and Benchmarking. Technical Guidance and Manual", 2020.

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