UNIVERSITY OF WATERLOO

TECHNOLOGY SUMMARY

Electrochemical System for CO2 reduction, hydrogen gas production, and treatment of Ammonia Waste

Background

Many industries, water and wastewater treatment plants, farmers, etc., produce large amounts of ammonia as a waste product. The most common approach to treat N-waste in wastewater treatment is to convert ammonium (NH4+) to nitrogen gas (N2) using such techniques as biological treatment, wet oxidation, and breakpoint chlorination. In particular, ammonia by-product of anaerobic digestion of nitrogenous organic wastes and wastewater can be converted to ammonium sulphate via reaction with sulphuric acid, which can be used as a source of fertilizer.

However high sulphur content fertilizers can have harmful environmental effects (eg. soil acidification) which are restricted in many municipalities. Using nitric acid instead to produce an ammonium nitrate salt fertilizer product is a viable alternative however the price of nitric acid is 3-4 times higher than that of sulphuric acid and thus is not economically feasible.

Description of the invention

Using a nanostructured nickel-based catalyst anode and a divided electrochemical cell configuration, ammonium nitrate (NH_4NO_3) can be synthesised directly from ammonia via its partial electrooxidation, which does not require the addition of nitric acid. Through the selection of various method parameters, the production of ammonium nitrate in mixture with only K and P (or K and S) containing compounds can yield final products that can be directly used as a fertilizer. Further the oxidation of ammonia to nitrate at the anode can be coupled with a value-added process at the cathode, such as green hydrogen production (or hydrogen evolution reaction, (HER) or electrochemical CO_2 reduction (CO_2R) to fuels (eg. syngas) or valuable other C1-C2 compounds (eg. ethylene, carboxylic acids).

Advantages

- Cost effective (ie. Nitric acid free) production of ammonium salt fertilizer from wastewater
- Enhanced aerobic digestion wastewater process functionality
- Selective generation of valuable waste by-products (eg. fertilizer, CO_2 reduction, H_2 production, carboxylic acids, syngas, ethylene, others) – “green chemistry”

Potential applications

- Ammonia laden wastewater treatment
- Anaerobic digestion functional enhancement
- Green house gas reduction (CO_2 treatment) and green energy production (eg. syngas, H_2)
- Generation of other valuable by-products

Reference

10211

Patent status

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Stage of development

Prototype
Ongoing research

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