

Alternative Methods for Producing Fixed Nitrogen

An alternative procedure for oxidizing nitrogen that can operate at low temperature and pressure, decentralizing production of fertilizers and lowering production costs.

Inventors at Georgia Tech have proposed an alternative electrochemical-based method that produces fixed nitrogen at low temperatures and pressures. This electrochemical nitrate production process has several additional advantages when compared to existing processes. To produce nitrate, nitrogen must be reduced to ammonia, and then ammonia must be oxidized in two processes to nitric acid. This process in particular uses an electrochemical or photoelectrochemical cell that is comprised of an anode (positive terminal) or cathode (negative terminal). When a voltage potential is applied to the electrochemical cell electrosynthesis (synthesis of chemical compounds in an electrochemical cell) can occur. The reactor requires an air saturated electrolyte in order to convert oxygen and nitrogen to nitrate. This has several potential advantages over the competing electrochemical technology of electrochemical nitrogen reduction to ammonia: 1) the process directly utilizes air as a reactant, mitigating the need for air separation, 2) the thermodynamic driving force is substantially lower, and 3) the reaction does not compete with hydrogen evolution, improving the potential selectivity of the process.

Summary Bullets

- **Increased efficiency** - directly oxidizes nitrogen to create nitric acid
- **Sustainable practice** - less energy-intensive process than existing practices
- **Cost saving** – elimination of heat and pressure during production

Solution Advantages

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Potential Commercial Applications

- Fertilizer production
- Chemical processing

Background and More Information

The U.S. Fertilizer industry generates more than \$155 billion in economic benefit annually. Two major macronutrients found in all fertilizers are ammonia and nitrate, commonly referred to as fixed nitrogen. Production of fixed nitrogen-based nutrients takes place at large scales through the Haber-Bosch and Ostwald Processes. The key barrier these processes present is the amount of effort needed to break the nitrogen triple bond. To do so, both processes utilize elevated temperatures and pressures. These requirements often restrict nitrate and ammonia production to large centralized production facilities, resulting in high production costs. Currently, electrochemical technologies for nitrogen reduction have been demonstrated, but there are no technologies capable of performing nitrogen oxidation to nitrate.

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