

Innovative Ammonia Synthesis (Haber-Bosch) Processes and Nuclear-powered Ammonia Production Plants

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Energy, Environment, and Aerospace

Abstract

This technology describes methods to modify conventional ammonia synthesis systems to enable low-carbon ammonia production. The approach focuses on replacing fossil-derived inputs with low-carbon energy sources and on process redesigns that improve efficiency and reduce lifecycle emissions.

Problem

Global ammonia production depends on fossil hydrogen and energy-intensive processes, causing high CO₂

emissions, freshwater strain, and logistical barriers to scaling carbon-free ammonia.

Solution

Replace fossil H₂ with electrolysis thermally integrated with nuclear power and redesign Haber-Bosch steps to lower energy use, enable seawater/brackish feed, and improve conversion.

Value Proposition

Higher ammonia yield and production rate with lower energy costs and lifecycle emissions through process simplification and SMR thermal integration, enabling smaller distributed plants and better economics for low-carbon ammonia.

Benefit

Global ammonia production is a large, energy-intensive industry that currently depends heavily on fossil-based hydrogen production, contributing significant CO₂ emissions and fossil energy use. Meeting growing fertilizer and industrial demand while reducing emissions is therefore a major challenge. Producing hydrogen from water electrolysis requires substantial electricity and stresses fresh water supplies when scaled, and hydrogen's low volumetric energy density complicates storage and transport, creating economic and logistical barriers to deploying carbon-free ammonia at scale.

This technology provides a pathway to produce ammonia with little or no carbon emissions by replacing fossil-derived hydrogen with hydrogen from water electrolysis powered and thermally integrated with nuclear energy, and by redesigning Haber-Bosch process steps to improve conversion and reduce energy losses. By pairing ammonia synthesis with high-temperature steam electrolysis and small modular reactors, the solution reduces the electricity and cooling burdens of hydrogen production and enables use of seawater/brackish water feedstocks to lessen pressure on freshwater resources

The value proposition is higher ammonia yield and production rate at lower energy cost and lifecycle emissions, achieved through process simplification, interbed ammonia removal, and thermal integration with SMR heat and power. This improves economics for carbon-free ammonia, facilitates distributed or smaller-scale plants, and makes ammonia a more practical

hydrogen carrier and low#carbon fuel/feedstock option for agriculture, shipping, and industry.

Researchers

[Hailel Wang](#)

[Manjur Basnet](#)

[Frank Katjipaha](#)

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Intellectual Property

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