Techno-economic analysis of ammonia synthesis for grid balancing

Description

The Group of Energy Materials (GEM) is currently involved in the development of a reversible solid oxide electrochemical cell (ReSOC) that can convert electricity into fuels (working in electrolysis mode) and fuels into electricity (working in fuel cell mode). The H₂ produced during the electrolysis mode, can be combined with N₂ to produce ammonia (NH₃). In turn, ammonia can be used as fuel for the fuel cell, and/or can be sold into the market. It is synthesised from N₂ and H₂ by the Haber-Bosch process, with N₂ obtained from air. The synthesis of ammonia is divided into three steps: (i) syngas production, (ii) compression and (iii) synthesis and purge gas management. The average ammonia synthesis plant size in EU27 is about 500 kt NH₃/yr. The use of renewables instead of fossil fuels to synthesise ammonia requires smaller plants than those currently used, i.e. (small scale) plants between 25-90 kt NH₃/yr. GEM group aims at modelling and evaluating the process of synthesis of ammonia at small scale. The different process options will be assessed based on their energy efficiency and investment and operational costs.

Objectives

The objectives of this project are:

- Bibliographic review.
- Study of an independent and renewable mini-grid power needs, to determine the best suitable scale of the ammonia plant.
- Definition of the ammonia synthesis process layout at small scale.
- Validated ammonia synthesis model in Aspen Plus.
- Techno-economic evaluation under different upstream and downstream configurations (i.e. ReSOC, multi-product CDU, other electricity storage options, etc.).

Requirements

- Knowledge of process flow modelling, Aspen Plus desirable.
- Knowledge of chemical reactor engineering and separation processes.
- Familiarity with techno-economic evaluations.
- Initiative and autonomy.
- Ability to communicate results (oral and written).
- Good English writing skills.