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Green Ammonia Technology

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Abstract

Green ammonia refers to ammonia produced through a process that emits zero or a minimal amount of carbon dioxide (and other greenhouse substances) in the environment. Technologies for green ammonia production, which are in the emerging stage, are technically and environmentally quite opposite to the modern-day conventional ammonia technologies that, depending on the type of carbon-bearing fossil materials used to make ammonia, produce 1.5–2.5 tons of CO_2 per ton of ammonia. The ammonia industry is responsible for over 1% of the global greenhouse gas emissions.

With a growing demand for nitrogen from agriculture and industry, the problem of carbon footprint of the ammonia industry is recently getting more and more attention for a resolution. There are basically two ways to reduce or eliminate CO_2 emission from an ammonia production process; the first option is to use a technology of production, which would not produce CO_2 as an inevitable by-product of the process. The second option is to use carbon-bearing fuel/raw materials and capture/remove the CO_2 emitting from the process. This review presents the techno-economic evaluation of a green ammonia process based on the first option.

The *green ammonia process* essentially consists of three main steps: production of green hydrogen (by electrolysis of water using solar-energy based electricity), production of green nitrogen, and finally, production of green ammonia from green H_2 and green N_2. Hence, as mentioned above, this *green ammonia process* avoids the use of carbon-containing fuels and raw materials.

Currently, the economics of such a green ammonia process (given inside) are not compatible with those of conventional ammonia processes. There are, however, certain ifs and buts, which can make the green ammonia process economically closer to a conventional process. Those things are described in this review.

The analysis of the technology is based on a simulated design of a hypothetical green ammonia plant of 200 Mtpd (metric tons per day) capacity. Different aspects of the technology have been analyzed and the analysis results, depending on the feature of technology, are presented in descriptive, tabulated, or diagrammatic formats. Main elements/sections of the technology analysis include selection and statement of assumptions/bases for process design, process design details (process description with a complete statement of process operating conditions, material and energy balance, process flow diagram, process discussion, process equipment listing with sizes, utilities consumption, capital costs, production costs, and a brief economic discussion.

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