

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 CO₂ 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.

Contents

1	Introduction	5
	Objective and scope of review	5
	Major design assumptions/criteria for design	5
	Scope of process economics	6
	Overall economic conclusion	7
	Commercial overview of technologies	8
	Process routes	10
	Hydrogen production by water electrolysis	12
	Industrial sizes of electrolyzers	16
2	Process description	18
	Hydrogen production (G-101)	18
	Nitrogen production (G-102)	23
	Ammonia production	28
3	Process discussion	34
4	Process economics	37
	Scope of process economics	37
	Plant economics	37
	Fixed capital costs	38
	Production costs	39
	Overall economic conclusion	39

Tables

Table 1A Key characteristics of electrolytic technologies	13
Table 1B Key operating and physical features of electrolyzers	13
Table 2.1 H ₂ production by electrolysis of water for green ammonia plant—Design bases and	
assumptions	19
Table 2.2 H ₂ production by electrolysis of water for green ammonia plant—Major equipment	20
Table 2.3 N ₂ production by air separation process for green ammomia plant-Design bases and	
assumptions	24
Table 2.4 N ₂ production by air separation process for green ammonia plant—Major equipment	25
Table 2.5 Green ammonia production—Design bases and assumptions	28
Table 2.6 Green ammonia production—Major stream flows	29
Table 3.1 Green ammonia production—Major equipment	35
Table 4.1 Green ammonia production—Total capital investment	41
Table 4.2 Green ammonia production—Production costs	42

Figures

Figure 1.1 A bird eyeview of green ammonia plant	10
Figure 1.2 Outline view of a green ammonia process	11
Figure 1.3 Haldor Topsoe solid-oxide co-electrolysis cell (SOEC) based ammonia process scheme	11
Figure 1.4 Haldor Topsoe solid-oxide co-electrolysis cell (SOEC) based ammonia process scheme	12
Figure 1.5 Alkaline water electrolyzer cell schematic	14
Figure 2.1 H ₂ production by electrolysis of water for green ammonia plant	22
Figure 2.2 Nitrogen production by air separation process for green ammonia plant	27
Figure 2.3 Green ammonia production—Integrated ammonia Process Flow Diagram	31
Figure 2.4 Green ammonia production—Ammonia refrigeration flow diagram	32
Figure 4.1 Green ammonia production—Effect of electricity price on production cost and product	
value of green value	44

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