Preliminary design of blue hydrogen process via VHTR

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1. Introduction

Hydrogen is a promising energy carrier that is clean and has no direct emission of CO_2 when utilized and is one of the most promising candidates for counteracting power intermittent caused by the expansion of renewable energies.

The ultimate goal of hydrogen production is water electrolyzed hydrogen from power sources that do not emit CO_2, called 'Green Hydrogen'. However, this type of hydrogen production causes an excessively expensive cost compared to existing SMR (Steam-Methane Reforming) and has the disadvantage of being unsuitable for renewable –energy-poor countries such as South Korea [1].

Therefore, as an intermediate step, the role of blue hydrogen by adding the CCUS (Carbon Capture and Utilization & Storage) process to the existing Steam-Methane Reforming hydrogen is emerging.

The SMR process using VHTR (Very High Temperature Reactor) does not emit CO_2 by methane combustion to supply heat to the SMR process, and it can eliminate the CO_2 emission by electric power used as a compressor driving force. So, it is a process with clean hydrogen potential [2]. However, research on the design of the process considering additional CO_2 capture by adding CCUS to this process has not been enough conducted yet.

In this presentation, the layout of the SMR blue hydrogen production process using VHTR will be presented, and the heat and mass balance will be calculated and evaluated.

2. Process Layout Description

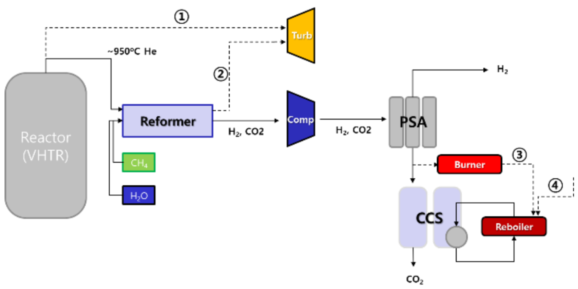

Figure 1. Schematic diagram of the SMR process utilizing VHTR

Figure 1. shows a schematic diagram of the SMR process utilizing VHTR. (For convenience, the heat exchange network is omitted.)

The parts to be considered in the layout in the process schematic diagram are as follows.

① Is it good to use the helium flow branching from the VHTR for the driving force for he compressor?

② OR, is it better to use the heat from the rear end of the reformer?

③ Can PSA tail gas combustion alone provide enough steam for use in CCS?

④ OR, should additional heat be supplied from the rear end of the turbine?

In this study, the layout is confirmed by answering the question, and process optimization considering thermal management is planned to be presented.

3. Choose Carbon Capture Methodology

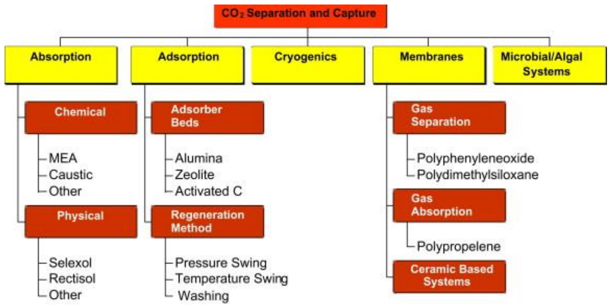

Figure 2. Technical options for CO_2 capture. [3]

Another important consideration is which CO_2 capture method to use. There are two main types of adsorption and absorption, and additionally, membrane separation can be considered. In the presentation, the optimal CCS method for the SMR blue hydrogen process utilizing VHTR will also be considered.

REFERENCES

[1] BloombergNEF. "Hydrogen Economy Outlook." (2020).
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[3] Rao, A. B., & Rubin, E. S. (2002). A technical, economic, and environmental assessment of amine-based CO_2 capture technology for power plant greenhouse gas control. *Environmental science & technology*, *36*(20), 4467-4475.