A methodological framework for the development of feasible CO2 conversion processes

Converting captured CO2 feedstock into valuable chemical products is viewed as one of the potential ways to reduce atmospheric CO2 emission. To this end, a methodological framework is suggested to support the development of feasible CO2 conversion processes that can contribute to the CO2 reduction by replacing non-CO2 utilizing processes or non CO2 -based products. The framework encompasses several execution and decision steps and uses three main criteria, which are the demand availability, CO2 reduction feasibility, and economic feasibility. As an illustrative example, a methanol plant employing combined reforming (CR) of methane reaction is developed. To supply the CO2 feedstock, the aMDEA-based CO2 capture applied to a SMR-based H2 plant is considered. A baseline process is developed and is compared with a non-CO2 utilizing conventional methanol plant (process substitution) and a gasoline production process (product substitution) in terms of the established criteria. For the former, it is verified that the methanol production via combined reforming leads to cheaper unit production cost as well as lower net CO2 emission compared to the conventional methanol plant. For the latter, it is shown that the feasibility of the CO2-based methanol as an alternative fuel to gasoline highly depends on the type and price of the raw materials. To improve the developed baseline CO2 conversion process further, (1) some of the combined reforming reaction related design variables are fine-tuned using a sensitivity analysis and an equilibrated syngas plot, and (2) utilization of various renewable energy resources for the internal electricity demand is examined.