Advanced Reactor Design for CO_2-Methanation

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To reduce CO_2 emissions, the use of CO_2 as a raw material for manufacturing base chemicals is of particular importance in the modern industry. Therefore, Power-to-X (PtX) technologies offer an attractive way to use CO_2 emissions for different applications such as synthetic natural gas (SNG) and so-called e-fuels. Such processes include electrolysis to produce renewable H_2, processing steps for purification of CO_2 and reactor system to synthesize the desired product [1]. Due to the use of renewable energy in the production process, PtX can significantly support sustainable processing in future industrial practice. Despite the benefit, however, the realization of PtX technologies is still a challenge in terms of technological aspects as well as invest and operational costs.

One of the most investigated PtX technologies is the methanation of CO_2. The first commercial plant was built in Werlte (Germany) in 2013 and is operated by Audi [2]. MAN Diesel & Turbo SE was responsible for design and manufacturing of the reactor system. Since then, the original reactor concept is developed further towards a higher conversion level and higher methane content in the product stream in combination with a maximized space velocity. New concepts were studied by model-based analyses and verified by continuous pilot plant testing. The new reactor concept can handle enormous heat loadings by an optimized combination of a high efficient cooling system and an advanced reactant feeding system. This combination results in lower investment and operational costs and provides much higher production rates. SNG produced by the new design full-fills now, in contrast to the concept of Werlte, high calorific value specification (Wobbe-index) required for injection into the H-gas grid. In our contribution, the development of the optimal reactor design will be described and validated by experimental data. It is shown that the process is more efficient compared to other reactor concepts regarding the main process characteristics (yield, throughput, hotspot temperature).

References

[1] Bertau, M.; Offermanns, H.; Plass, L.; Schmidt, F.; Wernicke, H.-J., „Methanol: The Basic Chemical and Energy Feedstock of the Future“, Springer, 2014.

[2] http://www.powertogas.info/power-to-gas/pilotprojekte-im-ueberblick/audi-e-gas-projekt/