**Electric Steam Reforming – Reduction of CO2-Emissions by Integration of Renewable Energy into the Steam Reformer**

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**Highlights**

* Electrically driven steam reformer
* Significant reduction of CO2-emissions
* Highly compact

Through the last 20 years, a continuously increasing focus has been on how to limit the human impact on pollution, where especially CO2-emission has been linked to a global impact on the climate. In parallel, sustainable electricity has made a significant technology leap and sustainable electricity production by wind and sun has become economically feasible. This development is an encouragement to rethink already existing technologies used in the chemical industry.

Many bulk chemicals, including for example methanol, acetic acid, and ammonia, are today produced in a process with multiple steps. Often the first step is steam reforming of natural gas to produce hydrogen or synthesis gas (a mixture with mainly hydrogen and carbon monoxide) followed by the actual synthesis and purification. A key process to produce synthesis gas is steam methane reforming (SMR). This is a strongly endothermic process requiring considerable fuel combustion to reach the desired exit temperature and methane conversion. According to some sources, SMR may account for nearly 3% of global CO2 emissions. Hence, there is a considerable incentive to modify the technology to reduce the climate impact.

Several initiatives have improved the efficiency in synthesis gas based chemical plants in recent years. These include the use of bayonet type steam reformers, heat exchange reformers, and the use of electrically driven utilities. All of these improve the efficiency thus reducing the CO2-emissions. However, the extensive use of fuel combustion for the SMR remains. This work presents a novel approach by which electricity is integrated into the steam reformer almost eliminating the need for fuel combustion.

The development of a compact electrically heated steam reformer integrating electricity into the catalyst will be described. Proof of concept experiments will be presented along with CFD and reactor analysis to demonstrate the performance of the technology.

Process development studies have been carried out in parallel to the experimental activities. These studies have been performed for production of hydrogen and carbon monoxide and for various chemicals. Both natural gas and bio-derived feedstock have been considered. As an example, for a hydrogen plant the electric reformer offers a solution which:

* Uses up to 35% less natural gas compared to a tubular reformer.
* Has up 95% less CO2 emissions compared to a tubular reformer based hydrogen plant.
* Is significantly more compact in size.

An economical analysis indicates that the electric reformer could be cost competitive to the more classical routes for chemicals production. The actual transition for when the electric reformer would be cheaper than the more traditional fired steam reformer depends on the prices of electricity and feedstock. The use of electricity is in most case more than 70% lower compared to alkaline electrolysis.

The presentation will describe the development of the electric reformer with selected experimental results. The potential of replacing the fired steam reformer with an electric steam reformer will be presented based on process economical calculations in comparison with state of the art technologies. Finally, the perspectives of the new technology as a means to reduce human climate impact will be discussed.