

Electrically heated reactor for steam methane reforming

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Introduction

Steam methane reforming (SMR) is a highly endothermic process, in which methane is reacted with water to produce hydrogen. Currently, more than 80% of the overall H₂ stems from this process. The required energy is provided via fuel combustion and radiant heat transfer in fired furnaces. Heating of the reformer results in the release of approximately 1% of the world's CO₂ emissions, thus providing a highly valuable target for the decarbonization of the chemical industry. Electrified reactors are a compact and flexible alternative that can replace the traditional fire-heated reactors. In this context, SYPOX has developed electrified chemical reactors to both save costs and reduce CO₂ emissions. Replacing fossil fuel combustion with resistive heating reduces CO₂ emissions, intensifies processes with reactors 100 times smaller, and brings additional revenue to plant operators by stabilizing the power grid. In the case of SMR, the use of electrically heated reformers simplifies design, increases thermal efficiency, and reduces CO₂ emissions by 40%. [1] Thanks to its robust modular design, the SYPOX reactor configuration is a potential game changer for decarbonizing the chemical industry through direct electrification of high-temperature thermochemical processes.

Materials and Methods

The SYPOX reactor is formed by a structured ceramic support, coated with a Ni catalyst, and co-axial FeCrAl heating elements (*Table 1*) [4]. The catalytic tests have been performed on a bench scale rig, that involves a pre-heating oven and a downstream electrified reformer equipped with an on-line gas chromatograph. The tests are performed at 10 bar, S/C > 1.5 and temperatures from 600 °C and 1000 °C.

Results and Discussion

The axial temperature profiles measured during reaction conditions increase linearly as the heat flux (surface load) of the heating element is constant (*Figure 1*). This is possible as the resistivity of the heating element is temperature independent. At the same time, the annular gap formed by the heating element and the ceramic supported catalyst has been tuned to values below 1 mm where mass transport phenomena limitations are minimized. In this way, the temperature difference between the heating elements, the reacting gas and the catalytic material minimizes the risk of carbon formation. Temperature cycling did not affect the performance of the catalyst due to the stability of the ceramic support and the strong adherence of the catalyst. The technology realizes heating increments of approximately 30 °C min⁻¹ without having problems on both ceramic supported catalyst and metallic heating elements (*Figure 1*).

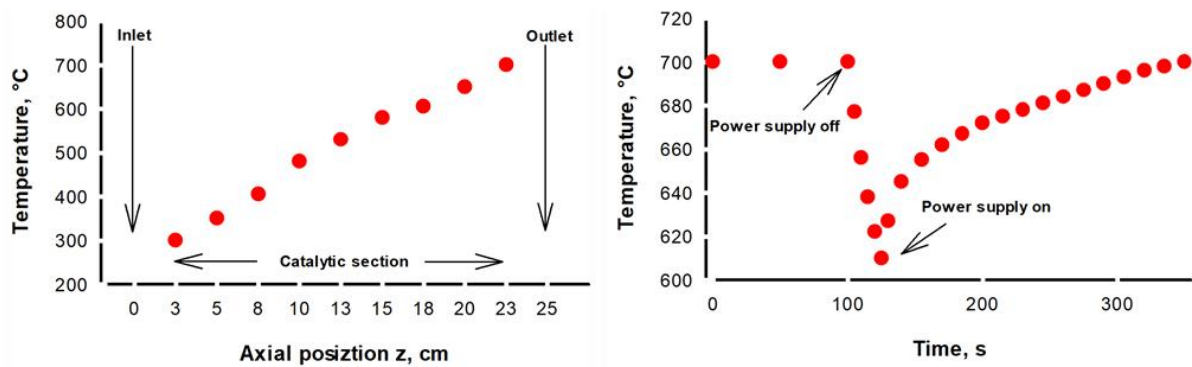


Figure 1. (Left) Axial temperature profile during reaction, (Right) outlet temperature dynamic profile.

References

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