ELECTRICALLY HEATED STRUCTURED CATALYST FOR HYDROGEN PRODUCTION

V.Palma[1*] , E. Meloni[1], G. Iervolino [1]

*(vpalma@unisa.it)

[1]Department of Industrial Engineering, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano (SA), Italy.

Electrification of industrial processes is an often discussed strategy for reducing greenhouse gas emissions from energy-intensive process industries and is highlighted in many literature studies. Indeed, electricity is a versatile energy carrier that allows for a wide variety of options. In particular, with this option it is possible to replace the thermal power systems of the various process units with an electrical power supply.

This proposal seems interesting from several points of view since, if the electricity comes from renewable sources (water, light, wind) there are no environmental impacts from the use of this energy source, moreover the electricity applied to endothermic industrial processes allows to reverse the heat flow, thus intensifying the performance of the catalysts and the system

Inverting the thermal flow, exploiting the "Joule" effect is absolutely interesting as it allows to reach the desired temperatures directly on the catalytic active sites, thus reducing the classic thermal profiles due to heating coming from the external walls of the reactor towards the inside of the catalyst. therefore, this solution is obviously interesting for the steam reforming process.

Several works in the literature have dealt with this theme, confirming the scientific and industrial interest that, never as in this period linked to the energy transition, seems to be increasingly growing towards the production of hydrogen and towards the "transition" to sustainable configurations of industrial processes.

For this reason, in this paper we want to propose a new catalytic configuration for an electrified steam reforming process. Specifically, it involves investigating the performance of a structured nickel-based catalyst supported on alumina, and deposited on a carrier with high thermal conductivity, consisting of SiC foams. The catalyst heating was obtained by the Joule effect due to the passage of current through the electric resistances in Kantal, arranged directly on the surface of the catalyst.

Preliminary controlled heating tests were carried out and they demonstrated the catalyst's ability to heat up thanks to the Joule effect, up to temperatures of over 900 °C, without any other external heat source. Preliminary catalytic activity tests were conducted at an S/C ratio equal 3 and two different WHSV values, respectively equal to 8.4 and 2.8 h^{-1}.

From the experimental results it was observed that with this catalytic system it is possible to sustain the reaction obtaining a higher methane conversion.

Moreover, the results reported for both tests show that there is a heat dissipation effect which is more significant in the tests with a lower flow rate, typically of laboratory scale reactor. Despite the presence of such thermal dissipation effects, the comparison of the energy results with other reference electrified systems has proved extremely promising as the values in terms of kWh Nm^{-3} of H_2 are significantly lower both in comparison to commercial electrolysers and compared to other types of electrified reactor reported in the literature.

In conclusion it is possible to state that the electrification of structured catalysts is certainly a road with ample potential for the intensification of chemical processes, with particular reference to those endothermic reactions where the phenomena of heat transport are extremely complicated and limiting.