**A MODELING AND SIMULATION STUDY ON THE PERFORMANCE OF CO2 METHANATION IN A CATALYTIC MEMBRANE REACTOR**

**Panagiotis Boutikos1\***

1 *Centre for Research and Technology Hellas, Chemical Process Engineering Research Institute*

*Egialias 52, 15125, Athens, Greece*

*\*corresponding author:* [*mpoutikos@certh.gr*](mailto:mpoutikos@certh.gr)

**ABSTRACT**

The exponential growth of the renewable enegy production over the last few years has given rise to the problem of the energy storage, required by the discontinuous nature of the main renewable energy resources [1]. The energy storage is required to avoid the mismatching occurrence between the effective power production and the instantaneous energy demand generated several times along the year. In this sence, Power-to-Gas (PtG), particularly Power-to-Methane (PtM) is a promising approach for long-term energy storage, since it allows the conversion of excess energy into chemical energy carriers, such as methane. The PtM donates to the conversion of electrical energy from renewable sources into hydrogen (via water electrolysis), which in turn reacts with carbon dioxide (CO2) to produce synthetic methane, also called Subtitute Natural Gas (SNG). To transform renewable H2 and CO2 into CH4, methanation reaction must be conducted. Catalytic CO2 methanation (CO2 + 4H4 ↔ CH4 + 2H2O, ΔHR,298K = - 164.9 kJ/mol) is a reversible, exothermic reaction and is usually limited by thermodynamic equilibrium [2]. Supported metallic catalysts such as Ni, Rh, and Ru have been explored for this reaction [3]. In addition, various reactors have been developed, including fixed bed and fluidized-bed. Catalytic membrane reactors have also been utilized for CO2 methanation. According to the Le Chatelier's principle, steam removal from the reaction medium by a water perm-selective membrane shifts the equilibrium toward CH4 production [4]. Moreover, the decrease of steam concentration can mitigate the deactivation of the catalysts. Therefore, in this study, a one-dimensional mathematical model will be developed for CO2 methanation in a water-permeable membrane reactor. Main objective is to investigate the interplay of water permeation and methanation within the membrane reactor. In this regard, the detailed distribution of the reactant/product species and H2O permeation flux along the membrane is analysed. Then, the effect of various operation parameters on CO2 conversion will be discussed. In addition, the influence of permeation selectivity of CO2 and H2 will be also presented.

**KEYWORDS:** Modeling, Simulation, Membrane reactor, CO2 methanation

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