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# Exergetic Optimization on Solid Oxide Fuel Cell Systems

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**Abstract :** Biogas can be currently considered as an alternative option for electricity production, mainly due to its high energy content (hydrocarbon-rich source), its renewable status and its relatively low utilization cost. Solid Oxide Fuel Cell (SOFC) stacks convert fuel’s chemical energy to electricity with high efficiencies and reveal significant advantages on fuel flexibility combined with lower emissions rate, especially when utilize biogas. Electricity production by biogas constitutes a composite problem which incorporates an extensive parametric analysis on numerous dynamic variables. The main scope of the presented study is to propose a detailed thermodynamic model on the optimization of SOFC-based power plants’ operation based on fundamental thermodynamics, energy and exergy balances. This model named THERMAS (THERmodynamic MAthematical Simulation model) incorporates each individual process, during electricity production, mathematically simulated for different case studies that represent real life operational conditions. Also, THERMAS offers the opportunity to choose a great variety of different values for each operational parameter individually, thus allowing for studies within unexplored and experimentally impossible operational ranges. Finally, THERMAS innovatively incorporates a specific criterion concluded by the extensive energy analysis to identify the most optimal scenario per simulated system in exergy terms. Therefore, several dynamical parameters as well as several biogas mixture compositions have been taken into account, to cover all the possible incidents. Towards the optimization process in terms of an innovative OPF (OPtimization Factor), presented here, this research study reveals that systems supplied by low methane fuels can be comparable to these supplied by pure methane. To conclude, such an innovative simulation model indicates a perspective on the optimal design of a SOFC stack based system, in the direction of the commercialization of systems utilizing biogas.

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