Graphical Abstract

Coaxial multi-criteria optimization of a methane steam reforming reactor for effective hydrogen production and thermal management

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Highlights

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- Introduction of a novel approach to the macro-patterning concept.
- Sensitivity analysis conducted for the evolutionary algorithm parameters.
- Enhancement of thermal conditions via a modification of the catalyst insert.
- Increase in hydrogen productivity.

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Abstract

The advancement in environmental awareness is the recent driving factor of the energy industry development. The market sentiments dictate the commercialization of unconventional energy sources. Thus, generation via hydrogen conversion gains popularity. The presented research regards the enhancement of the steam reforming reaction, used for the production of hydrogen via the conversion of hydrocarbons. The reforming process characterizes by a strong endothermic nature. The rapid course of the reaction leads to the creation of temperature gradients of a considerable magnitude. The presented research strives to alleviate the negative consequences of the reaction character. An original strategy by the name of macro-patterning is suggested as a remedy. The presented research proposes an updated concept, predicting the introduction of coaxial segments to the catalytic insert. The segments may consist of catalytic material or metallic foam applied for local suppression of the reaction. The morphology of specific segments may be altered independently, to allow for additional control of the reforming reaction. The objective of the research is to define the optimal segment composition. The optimization process is based on an in-house procedure implementing a genetic algorithm. The acquired results appear to validate the macro-pattering concept. A significant unification of the temperature field is obtained, with a simultaneous increase in hydrogen productivity.

Keywords: hydrogen, evolutionary algorithms, reforming, design optimization

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References

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