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論　文　要　旨
Thesis Abstract

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※報告番号	第　　　　号	氏　名 (Name)	Pajak Marcin

主論文題名　（Title）

An evolutionary multi-objective optimization of the catalyst distribution in a methane-steam reformin reactor

内容の要旨　（Abstract）

The advancement in environmental awareness is the recent driving factor of the energy industry development. The market sentiments dictate the improvement of current technologies and the commercialization of more sustainable and unconventional energy sources. Energy generation via hydrogen conversion gains in popularity, as new technologies and the sole hydrogen topic are appearing more frequently. Unfortunately, setting up the whole hydrogen industry can not be acquired on the spot. The most crucial issues regard the scarcity of hydrogen and the lack of a proper distribution network. Regardless, new ideas of hydrogen exploitation are presented on a daily basis, indicating the future commercialization of the technology. The presented research regards the enhancement of the steam reforming reaction, used for the production of hydrogen via the conversion of hydrocarbons. Steam reforming is a process widely used in industry to supply hydrogen for ammonia production. The reforming process characterizes by unfavorable conditions, having an adverse influence both on the process effectiveness and materials degradation. The strong endothermic nature of this process is one of the most serious problems. The rapid course of the reaction leads to the creation of temperature gradients of considerable magnitude. The gradients have a negative influence on the temperature field, resulting in an exceptionally non-uniform distribution across the reforming unit. The phenomenon may result in a reduction of the catalyst lifetime and its uneven degradation due to occurring thermal stresses and rapid temperature changes. The presented research strives to limit the temperature gradients present during the process. An original strategy by the name of macro-patterning is suggested as a remedy for the creation of temperature gradients. The proposed concept predicts modification of the catalyst insert of the reactor. The insert is divided into separate segments. The segments may contain catalytic material or introduce non-reactive, porous segments with superior thermal conducting properties. The morphology of specific segments may be altered independently, to allow for additional control of the reforming process occurrence. The catalytic insert division is possible in longitudinal and radial directions. The objective of the thesis is to verify the prospects of macro-patterning introduction and define the optimal segments' composition, using an in-house code developed in C++. The optimization process is based on an in-house procedure implementing a genetic algorithm. The algorithm analyzes every possible combination of segments. The investigation includes reactors divided only in longitudinal or

radial directions and inserts divided in both directions. The acquired results appear to confirm the macro-pattering is a promising concept. A significant unification of the temperature field is obtained, with simultaneous maintenance of the amount of acquired hydrogen at a satisfactory level.

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