

論 文 要 旨

Thesis Abstract

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主論文題名 (Title)			
An evolutionary multi-objective optimization of the catalyst distribution in a methane-steam reforming reactor			
内容の要旨 (Abstract)			
<p>The advancement in the environmental awareness is the recent driving factor of the energy industry development. The market sentiments dictate improvement of current technologies and commercialization of more sustainable and unconventional energy sources. Energy generation via hydrogen conversion gains on 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 scarcity of hydrogen and lack of proper distribution network. Regardless, new ideas of hydrogen exploitation are presented on a daily basis, indicating the prospective commercialization of the technology. The presented research regards enhancement of the steam reforming reaction, used for production of hydrogen via conversion of hydrocarbons. The steam reforming is a process widely used in industry to supply hydrogen for the ammonia production. The reforming process characterizes with 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. Rapid course of the reaction leads to 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 catalyst lifetime and its uneven degradation, on account of 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 an 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-patterning being 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.</p>			