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(Doctoral thesis abstract)

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【ABSTRACT】

In this study, it was investigated the factors that improve the reactivity due to the structure of Micro-Partition structured catalyst (MPC) with fluid mixing effect and proposed the index for quantitatively evaluating the effect of the reactivity improvement, focusing on a rate-limiting step, using experiments and simulations. Furthermore, the effect of stacking multiple MPCs in the reactor on the reactivity was investigated, and the effective stacking method for MPC was proposed with simulation and demonstrated with experiments.

In Chapter 3, the MPC was applied to the steam reforming of methanol reaction, the water gas shift reaction, and the catalytic hydrogen combustion reaction, which are important reactions in the hydrogen energy, and experimentally indicated that the MPC improved the reactivity to the unprocessed plate-type structured catalyst, then the factors were investigated with reaction rate analysis. Furthermore, the reaction environment in which the MPC is effective was suggested by evaluating the tendency of the effect of the reactivity improvement. In Chapter 4, using a numerical simulation, it was investigated the factors that improve the reactivity due to the MPC by evaluating physical phenomena such as flow, heat, and mass transfer around the catalysts. Furthermore, the unique index, degree of convective mixing (Dcm), for evaluating the fluid mixing effect, focusing on a rate-limiting step, was proposed to identify the structures that contribute to the reactivity improvement.

In Chapter 5, the effects of changing the number of MPC stacking on the reactivity for each reaction were investigated. The reactivity was reduced for a rate-limiting step of a catalytic reaction when the MPCs packed densely in the reactor, whereas that was improved for a rate-limiting step pf an external mass transfer when MPCs stacking in the same method. Furthermore, the effects of the stacking on the fluid mixing effect were also investigated in detail with simulation.

In Chapter 6, the effective MPC stacking method was proposed by simulation and experimentally demonstrated the reactivity improvement for each reaction. The effect of the reactivity improvement using the effective MPC stacking method was larger at lower temperatures under a rate-limiting step of a catalytic reaction. Furthermore, the correlation between the proposed index calculated from the simulations and the parameters related to the reaction rate calculated from the experiments were discussed.