

**【Grant-in-Aid for Scientific Research(S)】**  
**Science and Engineering (Engineering)**



**Title of Project : Design and Operation of Micro Chemical Devices and Plants for Mass Production of Functional Materials**

Shinji Hasebe  
( Kyoto University, Graduate School of Engineering, Professor )

Research Area : Engineering

Keyword : Nano and micro chemical systems, Reactor, Process design, Process control

**【Purpose and Background of the Research】**

So far, new products have been developed under the condition that can be achieved by conventional devices. For the restructuring of chemical industries, this concept must be changed, i.e. the devices and plants should be designed so as to satisfy the request of the new product production.

By adopting this concept, design procedure of functional micro devices is developed in this research. The concept of “micro segments” is effectively used in it.

The integration method of micro devices for mass production and the operation and monitoring methods for long term operation are developed as well as the design procedure.

Through the experimental study using pilot plants, the effectiveness of proposed procedures are validated. Then, a new concept of design and operation in Chemical Engineering is proposed.

**【Research Methods】**

In the first half of the research period, two themes, “the development of design procedure of micro devices” and “the development of integration and operation procedures” are emphasized. For the first theme, the liquid, vapor, liquid-liquid and liquid-vapor reactions by various types of micro reactors are executed, and a design procedure of the micro devices is derived through the experimental study. For the second theme, integration and monitoring method for diagnosis are derived by using systems approach.

The latter half of the period is devoted to the unification of two themes, and the effectiveness of the proposed procedure is validated by using the experimental study of prototype micro plant.

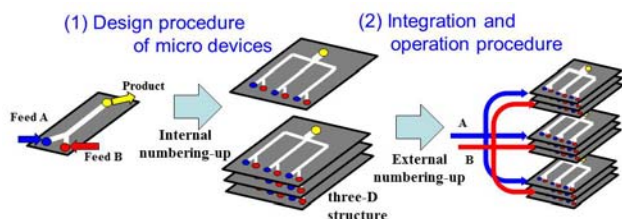


Figure 1 Design Procedure of Micro Plant

**【Expected Research Achievements and Scientific Significance】**

A dominant feature of this research is to develop design and operation method of industrial size plants. The devices and plants are designed under the concept of “process oriented synthesis,” i.e. the feature of functional materials is created by the shape of the device. Thus, the developed procedures can be applied to the design problem of conventional chemical plants as well as the micro chemical plants. Through the development of new design procedure, a new concept of process engineering can be proposed.

When the design and operation procedures of micro plant for mass production are developed, the plant size can be reduced drastically by the effective mixing, reaction and heat exchange, and it contributes the restructuring of Japanese chemical industries (See Fig. 2).

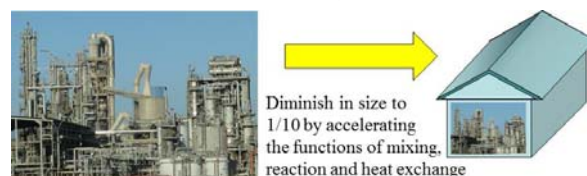


Figure 2 Micro Chemical Plant for Mass Production

**【Publications Relevant to the Project】**

- N. Aoki, R. Umei, A. Yoshida, K. Mae, "Design Method for Micromixers Considering Influence of Channel Confluence and Channel Bend on Diffusion Length", *Chem. Eng. J.*, 167, 643-650 (2011)
- Y. Tanaka, O. Tonomura, K. Isozaki, & S. Hasebe: "Detection and Diagnosis of Blockage in Parallelized Microreactors", *Chem. Eng. J.*, 167, 483-489 (2011)

**【Term of Project】** FY2013-2017

**【Budget Allocation】** 162,000 Thousand Yen

**【Homepage Address and Other Contact Information】**

<http://www-pse.cheme.kyoto-u.ac.jp/>  
hasebe@cheme.kyoto-u.ac.jp