

# **Technological Innovation System of Membrane Bioreactor in China**

## **Abstract**

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Since water problems were getting serious to hinder the process of sustainable development in China, growing attention has been paid to those technologies having high hygiene quality effluent and potentials for reusing and recycling as advantage. This raises the feasibility and significance of diffusion of Membrane bioreactor (MBR) technology.

Membrane bioreactors have been increasingly used for wastewater treatment that requires excellent effluent quality and water reclamation. To accelerate the diffusion of MBR technology in society, it is necessary to study the technological changes in term of innovation system. First, present state of technological innovations system (TIS) of MBR technology in China is identified. As an attempt for functions of innovation systems in water treatment technology field, MBR and its spatial domain in the context of a developing country are examined. Each function in MBR innovation system is analyzed to draw a picture of the whole system performance. Second, a dynamic vision of technological innovation system is obtained. Rested on a belief that the dynamics of technological innovation system may contribute a valuable and clear image to the process of sustainable socio-technical change, how functions interact with each other, and are there any critically important functions are discussed.

By applying the functions approach, the author aims at ascertaining how functions are currently filled in the innovation system of MBR. Bibliometrics analysis such as academic publication and patent data will be used to quantify certain innovation system functions as knowledge development. In addition, qualitative methods are also employed to understand the insight of correlations between functions.

The empirical results show that Function 1 entrepreneurial activities, overseas companies may invest in R&D via acquisition of other companies while MBR or other membrane technology is the core business for Chinese companies and key for their competency as well.

Second function is a brief review of knowledge generation of MBR technology in China for last two decades, which includes publication, citation and patents analysis. In all, good performance of this function is found resulting from quantity and quality of the R&D in Bibliometrics measure.

One finding from Function 3 is that the central region of social network based on co-author data is more homogeneous with regard to out-degree influence than with regard to prominence. But the diffusion to commercial application is far from satisfying.

Due to one but strong government in China, Function 4 and 7 are not outstanding but relatively stable compared to other countries. During different period of time, the attitude, master plan and tax regimes induce or hinder other functions performance in the system.

In term of MBR market, more than 10% Compound Annual Growth Rate (CAGR) in late years is mostly accepted by both Chinese and international reviewers when some of them even optimistically estimate more 15% CAGR in the future 5 years.

Recourse mobilization, the 6th function, consists of capital and human resources. Those inputs have been steadily provided, while it is somehow difficult to prove effectiveness of resource allocation within MBR system via aspect of time.

In this research, the quantitative exercise is largely intended to strengthen a basically qualitative argument rather than presenting a statistically valid argument by itself. In addition, analyzing correlations between different functions over time requires obtaining qualitative insights in their relations.

In the diffusion process, the performance of technological innovation system is not continuous. At the beginning, there was almost no commercial market for MBR technology under the policy gaps. In the first five-year period, innovation system was hindered based on the negative results of several functions. However, TIS performance alters to virtuous cycle, when some changes in functions occur.

According to alter of virtuous and vicious cycles, changes of several functions indicate that functions influence each other. Fulfillment or lack of a certain function quietly likely has its effects on other functions.

It could be derived from analysis and discussion that technological innovation is necessary to relieve China from its water problems in order to achieve the sustainable development of the society. As a promising technology, understanding performance of MBR innovation system and interaction among functions are essential to achieve this objective.

The performance of TIS lies on each function's condition and interactions among functions as well. Because functions have correlation on account of sharing or overlapping actors or resources, it suggests that there could be some critically important function may influence several other functions.

**Key words:** technological innovation system, membrane bioreactor, functions of innovation system