Modification of Membrane Surface and Possibility for Treatment of Polluted Water Applications

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Water is an essential factor for the survival of humans and human activities. However, the population growth and the expansion of urban and industrial areas are putting amount of stress on the environment. Water scarcity is one of the most challenging problems affecting people throughout the world. Water management has become one of the key factors for the sustainable development of natural resources. The World Health Organization (WHO) related that approximately half of the population from developing countries has health problems related to the lack of suitable drinking water access or to the presence of microbiological contamination in water. It became more interesting to me as I initiated my doctoral research to treat polluted water and reuse the clean water, especially in the polluted water in Vietnam. It is known that wastewater is another promising resource for clean water production.

Nowadays, membrane filtration is considered an important technology that can contribute to alleviate fresh water scarcity and ease water stress. Membrane technology has been strongly developed for various applications such as the production of pure water and ultrapure water, hemofiltration, desalination and decontamination of polluted water. Although, the costs of membranes have decreased during the last decade, this technology is not yet broadcasted worldwide, especially for poorest communities. Membrane filtration is an energy-saving and eco-friend separation process. The intense efforts have been implementing in membrane technology to make it more efficient, which, in turn, drives down cost and attracts investments.

One of the most challenges to membrane technology is the fouling phenomenon, which often occurred during filtration due to the accumulation of rejected substances on membrane surface, leading to the membrane flux decline during filtration and thus, reduce membrane separation capacity and increase the cost of whole process by the deposit of a new layer on the membrane surface (cake filtration) or into the membrane pores.

In order to overcome the fouling, the modification of membrane surfaces is a useful solution, in which the surface grafting polymerization is one of the proper methods, because the graft reactions could be performed in the mild conditions at room temperature and atmospheric pressure, without affecting properties of material bulk, and it can be connected to the final stage of membrane manufacturing process, easily apply in practice. The hydrophilic or charged functional groups can be introduced onto membrane surfaces via graft polymerization, changing membrane surface chemistry and topology in such way that could reduce the fouling factors and enhance membrane separation performance.

Therefore, my dissertation could have a contribution to the development of membrane materials which have a great characteristic and separation performance, especially for filtration of high fouling tendency objects to decontaminate polluted water and reuse the clean water.

For this research work, Sylff fellowship and SRA award made a significant contribution. After receiving SRA grant, I joined Tokyo Institute of Technology (Tokyo Tech), Japan for 3 months and enrolled in Department of Chemical Engineering, Tokyo Institute of Technology, one of the well-known institutions for training and research activities in Japan.

My doctoral research modified the thin film composite reverse osmosis polyamide membrane BW30, one of the most popular commercial membranes by UV – induced, redox - initiated and atmospheric pressure plasma – induced graft polymerization method and the possibility for improvement of membrane filtration property to reuse the fresh water. The obtained experimental results in Japan revealed that the formation of the grafted layer on modified membrane surface with the new surface functionality and the lower surface roughness contributed to the enhancement of separation and antifouling properties of membranes. Under the relevant graft polymerization conditions, the modified membranes could have a better separation capacity due to the significant enhancement of flux with very good retention for removal of organic compounds in a feed solution. The antifouling property of membranes is also improved because of the higher flux maintained ratios and the lower irreversible fouling factors as compared to that of unmodified one. In addition, the modified membranes could have a good chemical resistance with stable separation performance in a wide range of pH and concentration of feed solution. The research work at the Department of Chemical Engineering, Tokyo Institute of Technology has made my work on the data and source collection almost complete.

All of the conclusions I've made would not have been possible without my research stay in Japan. The research work I conducted at the Tokyo Tech was an essential part of the work on my PhD. In this way, my research works could have a contribution for the development of the high performance separation membranes and the application of membrane technology economically and efficiently in the production of pure water and ultrapure water, as well as in the decontamination of polluted water, in order to reuse water resources, and decrease environmental pollution.