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

Title of Project : Innovative Water Treatment Technology Combining Advanced Unit Processes and Membrane Separation

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Research Area : Engineering, Civil and Environmental Engineering
Keyword : Water and Wastewater Systems

【Purpose and Background of the Research】

Urbanization and climate change will entail increasingly severe water shortages and deterioration of water quality. Accordingly, demand is strong for low-maintenance high-grade water supply technology, which allows poor-quality water from various sources to be utilized safely with low accompanying costs and energy consumption. Toward this end, innovation is needed with regard to the processes and structures involved in water treatment systems. Targeting application to water treatment, the present research explores ultrafine microparticulation of adsorbents through nano-grinding, performance improvements for coagulants through polymer technology based on the metastable region of multivalent metal salts, and improvements in oxidation performance through combined use of vacuum UV rays and fibrous catalysts. These processes are combined with ceramic membrane separation for the construction of advanced water purification systems.

【Research Methods】

The research approach is based on improving the performance of the materials and equipment used in the core unit processes of water treatment—namely adsorption, coagulation and oxidation.

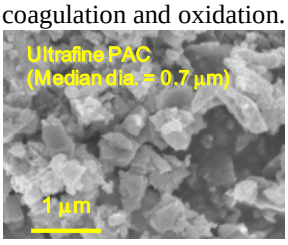

Fig. 1. Ultrafine PAC

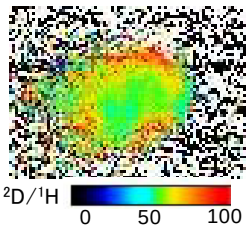

Fig. 2. Isotope microscopy. The MIB (shown in red) adsorbed onto the activated carbon.

(1) Adsorbents are subjected to nanometer-scale microparticulation (Fig. 1), after which the substantial increase in adsorption of polar substances and associated phenomena, such as adsorption onto outer surface of the adsorbent particles, low competitive adsorption, promotion of flocculation and prevention of membrane fouling, are examined on the basis of the physical properties of the material surface and the removed target substances. (2) Coagulants exhibiting low membrane fouling and high virus removal capabilities are developed through polymerization of aluminum, and the correlations with molecular weight, size, structure and electric charge are investigated. (3) OH radical is produced through the combined use of a photocatalyst, hydrogen peroxide and vacuum UV irradiation, for developing an efficient process of decomposing trace chemical substances. By operating pilot membrane processing plants, the entire system is evaluated in terms of energy as well as the ability to remove impurities and trace contaminants.

【Expected Research Achievements and Scientific Significance】

The achievements of this research will give back to society in the form of advanced water treatment technology with a clear scientific foundation by combining the innovative unit processes with ceramic membrane separation (for example, as shown in Fig. 3). The developed technology will play an essential role in ensuring a stable supply of safe water for drinking and everyday use in Japan. Furthermore, such systems can provide solutions to various problems in countries with considerably greater water problems than Japan, allowing for the establishment of world leadership and the expansion of the water business both at home and overseas.

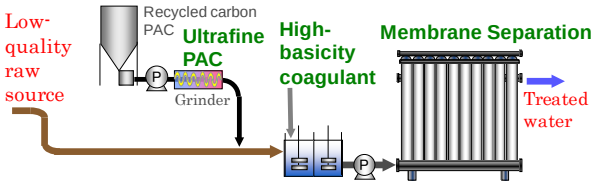

Fig.3. Combined use of ultrafine carbon, high-basicity coagulant and membrane separation.

【Publications Relevant to the Project】

・Ando, N., et al., Direct observation of solid-phase adsorbate concentration profile in powdered activated carbon particle to elucidate mechanism of high adsorption capacity on super-powdered activated carbon. Water Research, 45(2), 761-767, 2011.
・Matsui, Y. et al., Effects of super-powdered activated carbon pretreatment on coagulation and trans-membrane pressure buildup during microfiltration. Water Research, 43(20), 5160-5170, 2009.

【Term of Project】 FY2012-2016

【Budget Allocation】 145,400 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.eng.hokudai.ac.jp/labo/risk/