Characteristics of Adsorptive Removal of 2-Methylisoborneol by Micro-milled Activated Carbon

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I want to thank JSWE, Organo Corporation, every specialist related with the 20th Symposium and the members of the Environmental Risk Engineering Laboratory for giving me the best award. Getting the JSWE-ORGANO Doctoral Research award has been one of my dream during my three-year's doctor course. Not for chasing the award, even for getting the chance of attending the Symposium is such an honor for me.

In both research and practice of water purification technology, superfine powdered activated carbon (SPAC) with micron particle size has attracted attention for its higher adsorption capacity of contaminants as well as the higher adsorptive uptake speed than large-sized activated carbon. My work clarified the merits and demerits of micro-milling to produce SPAC and submicron SPAC (SSPAC, the smallest carbon particle produced by current pulverization technology) in terms of 2-methylisoborneol (MIB) removal.

Merits are higher adsorption capacity as well as higher adsorption kinetics on SSPAC and SPAC than on their parent PAC. Because of this merit, spent granular actived carbon (GAC) could be reused: SSPAC from 2-years old GAC and SPAC from 1-year old GAC exhibited the same MIB removal performance as virgin powdered activated carbon (PAC). Demerits are oxidation and aggregation, which were observed for virgin carbons. SPAC produced by dry-milling showed the aggregation of particles and the increase of oxygen content indicating the decrease of hydrophobicity. SSPAC was much smaller in particle size than SPAC but has a higher content of oxygen. Because of these reasons, dry-milled SPAC and wet-milled SSPAC were not superior to wet-milled SPAC.

I am glad that my findings could fill up some research blank of the adsorption performance of actived carbon. I got both physical and mental aid from Prof. Y.Matsui, Dr. T.Matsushita, Dr. N.Shirasaki and other team members including H.Takaesu, Y.Nishimura, Y.Takagi and so on. Above all, without the joint help of Japanese Society and Chinese Goverment, I can not get the precious chance for studying in Hokkaido University. I will not forget all the help and will try my best to repay the world.

Human Enteric Virus Removal from Wastewater: Design and Operational Monitoring of Multiple-barrier System and Virus Removal Efficiency Improvement Using Specific Interaction

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It was a great honour to become a recipient of the prestigious JSWE-ORGANO Doctoral Research award by the JSWE. My heartfelt appreciation goes to all the audiences and committee members for deciding me as a suitable candidate for this great award.

My research was focused on the design and operational monitoring of multiple-barrier system for wastewater reclamation and the improved removal of human enteric viruses causing epidemic gastroenteritis from wastewater by specific interaction. Meta-analysis approach was used to calculate average $\log_{10}$ reductions achievable for different viruses by different treatment unit processes. Furthermore, meta-analysis was extended to identify suitable bacteriophage indicators which can be used to monitor human enteric virus removal by different treatment unit processes. The specific interactions between human enteric viruses and wastewater solids was studied using human norovirus/human rotavirus and *Enterobacter cloacae* SENG-6 possessing histo-blood group antigen-like substances (HBGAs) as model microorganisms. Presence of HBGA-like substances which are specific receptors for norovirus resulted in increased retention of norovirus by microfiltration.

None of these would be possible without the great supervisors, Associate Professor Daisuke Sano, Professor Satoshi Okabe and Assistant Professor Masaaki Kitajima. I am grateful for their kind mentoring and great advices during the study and my stay at Hokkaido University. All my laboratory colleagues and friends are greatly acknowledged for their continuous support. I would like to take this opportunity to thank the Japanese government and people for providing me the much-needed support through a MEXT scholarship. All my family members and teachers who have been supporting me until now are fondly remembered at this occasion.

電極支援型 MBR における膜ファウリング抑制効果の解明

Impact of Anodic Respiration on Membrane Fouling in Electrode-assisted Membrane Bioreactor

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この度は，平成 29 年度日本水環境学会博士研究奨励賞（オルガノ賞）優秀賞の授与を賜り，誠にありがとうございます。オルガノ株式会社様およびご選考いただいた先生方をはじめとする学会関係者皆様に厚くお礼申しあげます。 この受賞を励みに，よりよい水環境の創造につながる研究に取り組みたいと存じます。

近年，水，エネルギー資源の逼迫に対応するため，エネルギー回収型水処理技術として，バイオ燃料電池と膜分離活性汚泥法（MBR）を統合した電極支援型 MBR（e-MBR）が注目を集めています。e-MBR は創エネルギーかつ省エネルギーに高度な処理水質の実現が可能な次世代型排水処理技術であり，更なる省エネルギーのためには膜ファウリング抑制が重要です。e-MBR は電極が電子受容体なため，エアレーションによる酸素供給が不要な一方，エアレーションを除くことで顕著な膜ファウリングが懸念されます。しかし，電極呼吸が膜ファウリング進行に及ぼす影響は明らかではありません。

そこで本研究は，e-MBR での膜ファウリング進行評価を目的とし，電極呼吸を制御した e-MBR を構築し，膜ファウリングへの影響を比較検証しました。この結果，電極呼吸の促進にともない膜ファウリングは抑制され，膜ファウリング原因物質であるバイオポリマーの生産量が低減することが分かりました。次に，MBR より単離した電気生産能を有する膜ファウリング原因菌 *Klebsiella pneumoniae* strain S05 を用いて，電極を含む電子受容体の種類が膜ファウリングに及ぼす効果を比較しました。この結果，電子受容体の種類にかかわらず，その量の減少によるバイオポリマー生産量，顕著な膜ファウリングを確認できました。本研究を通じ，e-MBR はエアレーションと同程度の膜ファウリング進行を無曝気運転で達成できること，また，電子受容体の高濃度かつ万遍ない供給は膜ファウリングを効果的に抑制し，とくに e-MBR の場合はアノード電極の電位操作が効果的であるという知見を得ることができました。

最後になりましたが，研究の遂行にあたり，北海道大学 水質変換工学研究室にてお世話になった岡部聡教授，佐野大輔准教授，石井聡助教，北島正章助教，福島寿和博士，また共に研究を行った寺田浩太郎くん，井川祐介くん，三宅広くん，杉山凌一くん，山嵜寿美さん，Rimana Islam Papry さんをはじめ研究室の皆様に感謝の意を示します。とくに岡部聡教授には学士，修士，博士と計 7 年間，大変お世話になりました。この場をお借りして，改めてお礼申しあげます。