ABSTRACTS / 要旨集

The 5th International Slow Sand and Alternative Biological Filtration Conference

19th (Thu) June-21st（Sat） June 2014
Venue: Civic Reception House Nagoya, JAPAN

Host

/ 5SSABC Conference Steering Commitee

Joint hosting

/ Nagoya City Waterworks & Sewerage Bureau

Sponsor

/ Institute of Water and Environment Business

Supporter

/ IWA, Ministry of Health, Labour and Welfare, Japan International Cooperation Agency, Japan Water Works Association, Japan Society on Water Environment, Japan Small Scale Water Works Association, Japan Water Research Center, Federation of Japan Water Industries,Inc., Japan Water Forum, Life of water Chubu forum, Nagoya Research Institute of WA-Links for Future Development

Cooperation

/ Community Water Supply Support Center of Japan,
Nagoya Water and Sewerage General Service Co.,Ltd.

"Progress in Slow Sand and Alternative Biofiltration Processes

– Further Developments and Applications"

TECHNICAL PROGRAMME

Room 1: Technical oral sessions '**A**' **Room 2**: Technical oral sessions '**B**'
Lobby: Poster Sessions Display time: 19th (Thu) 10:25 - 20th (Fri) 16:00
Discussion time 1: 20th (Fri) 12:30-13:00
Discussion time 2: 20th (Fri) 14:40-15:10

THURSDAY 19 JUNE 2014

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R. Collins / University of New Hampshire , USA
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C: Poster Sessions (Lobby)

Display time: 19th (Thu) 10:25 – 20th（Fri） 16:00

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●Discussion time 2 <20th (Fri) 14:40-15:10>

SATURDAY 21 JUNE 2014

A6: Biosand Filters

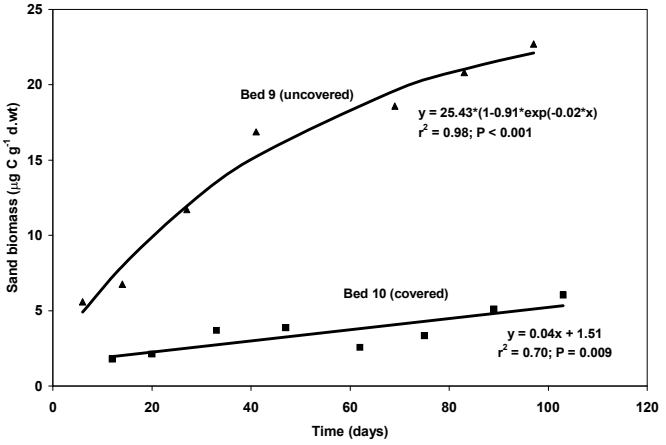
B6: Biofiltration and Soil-Aquifer Treatment

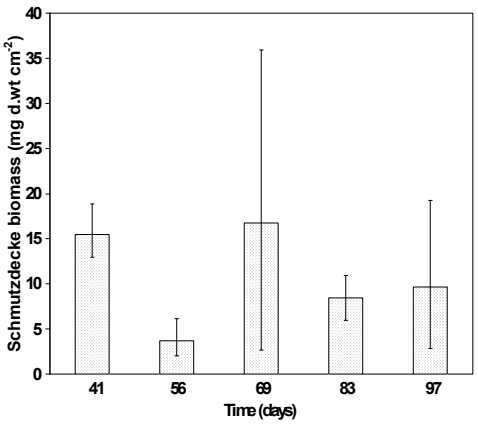
(KL1)

Slow sand filtration: recent research and application perspectives

Nigel J. D. Graham and M. Robin Collins***
**Imperial College London, South Kensington, London SW7 2AZ, UK*
*** University of New Hampshire, Durham, NH, USA*

Slow sand filtration (SSF) has been widely used in the field of water treatment for over 100 years and while important features of the process have been studied in detail, many aspects of the process remain poorly understood. In addition, modifications to the process and pre-treatment methods are required to enhance SSF performance to meet more demanding treated water quality objectives and reduced costs. This paper highlights some of these aspects and refers to recent research that has investigated the nature and role of the biomass in the process, the benefits of applying surface fabric layers, pre-ozonation and GAC sub-layers, and the development of a deterministic-type mathematical model to simulate the SSF process. In all cases, the research has provided useful insights but much futher work is required to consolidate the findings and bring benefits to the application of SSF in practice.





緩速ろ過：最新研究と展望

Nigel J. D. Graham and M. Robin Collins***
**Imperial College London, South Kensington, London SW7 2AZ, UK*
*** University of New Hampshire, Durham, NH, USA*

緩速ろ過（SSF）は水処理業界では 100 年以上、使われてきた。しかしながら、重要な点に関して詳細な研究は行われてきたが、処理行程に関して、まだ多数の点で未解明の点が多く残されている。加えて、緩速ろ過の処理水質向上やコスト削減のため、処理行程や前処理法などの改良が必要である。この論文ではそれらに着目し、またろ過行程でのバイオマスの特性と役割、 表面の砂層表面への布利用やオゾン処理、粒状活性炭処理、更に数学モデルでの検証などの最新研究について紹介する。これらの研究では有益な情報を得られたが、実際に応用するには、更に研究が必要である。

(A1-1)

Overview on the Current Condition of Slow Sand Filtration and its Challenges in Japan

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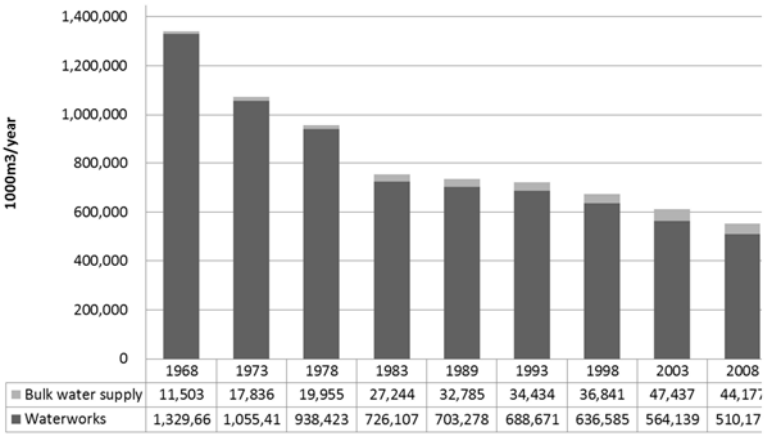
Slow sand filtration (SSF) was introduced to Japan as the modern water supply technology and played significant roles in the development of Japan's water works before the World War II. However, rapid sand filtration became more popular in new plans after the 1960's, reflecting limited space availability in urban areas. SSF received pressures by urban development and source water degradation, and some SSF plants were forced to close. As the result, the amount of purified water by SSF was reduced to 40% of the peak time in the past. Having said that, the number of SSF still amounts to 2,400 in Japan, of which small scale SSFs are dominant. They require technical assistance and renovation of technologies.



	1968	1973	1978	1983	1989	1993	1998	2003	2008
Bulk water supply	11,503	17,836	19,955	27,244	32,785	34,434	36,841	47,437	44,17
Waterworks	1,329,66	1,055,41	938,423	726,107	703,278	688,671	636,585	564,139	510,17

Annual purification amount of SSF (1968-2008)

日本における緩速ろ過の現状と課題

山村尊房,

一般社団法人名古屋環未来研究所

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緩速ろ過は近代水道技術として日本に導入され、第二次世界大戦前の日本の水道の発展に顕著な役割を果たした。しかし、1960 年代以降は、都市域の用地確保の制約を反映して急速ろ過が普及した。緩速ろ過は都市開発や水源水質悪化の影響を受け、いくつかの緩速ろ過施設は閉鎖を余儀なくされた。その結果、緩速ろ過による浄水量は過去のピーク時の 40%にまで減少した。しかし、緩速ろ過の施設数は依然として日本国内で 2, 400 を数えており、その多くは小規模な施設である。これらに対しては、技術支援や技術改革が必要となっている。

(A1-2)

The Centenary Slow Sand Filtration in Nagoya City - A 100 Year Trend of Water Quality-

Kenji MORI

Nagoya City Waterworks & Sewerage Bureau

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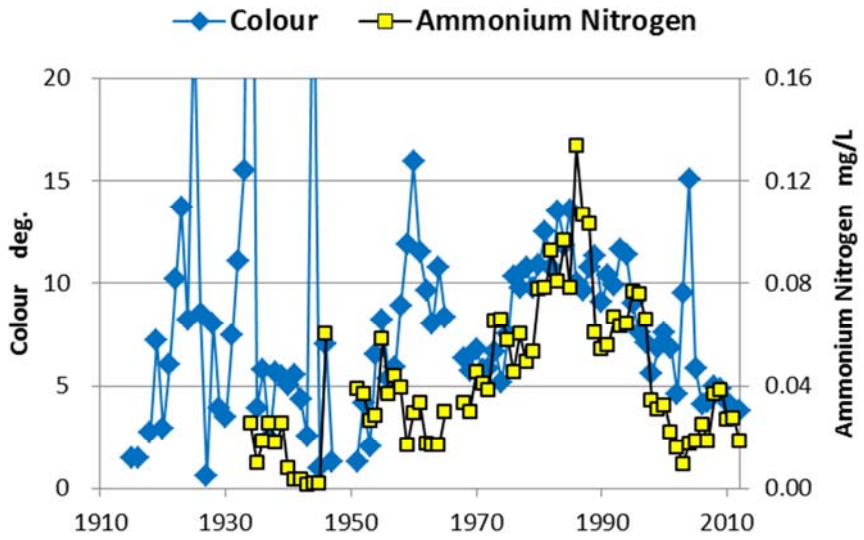
The data of the water quality, which had been accumulated for nearly 100 years, were analyzed to watch the long-term trend. As 14 indexes have been measured since our establishment, the past and present water qualities can be compared.

During past 100 years, raw water was severely polluted twice, around 1960 and during 1980s. It is inferred that the causes of the pollution are industrial wastewater for the former and domestic wastewater for the latter. Both slow and rapid sand filtration systems have capacity to remove the pollutant in domestic wastewater. But, a slow sand filtration system could not enough remove the pollutant by industrial wastewater.



100 年を迎える名古屋市の緩速ろ過～100 年にわたる水質の推移

森　健次

名古屋市上下水道局

名古屋市中区三の丸三丁目１番１号

100 年にわたり蓄積された水質データから、長期トレンドを解析した。創設以来継続して測定されてきた 14 の指標について、過去から今日にわたる比較が可能であった。

原水水質は、1960 年前後と 1980 年代の２度にわたり、深刻な汚濁に見舞われた。前者は工場排水、後者は生活排水が原因と推測される。生活排水よる汚濁物質は、緩速、急速のいずれのろ過方式によっても除去できたが、工場排水よる汚濁物質は、緩速ろ過では十分に除去できなかった。

(A1-3)

Value of Adenosine Tri-Phosphate and Total Cell Count for the assessment of general microbial water quality after sand filtration

Aleksandra Magic-Knezev, Luc Zandvliet , Willem A. Oorthuizen**, Ed J.van der Mark***
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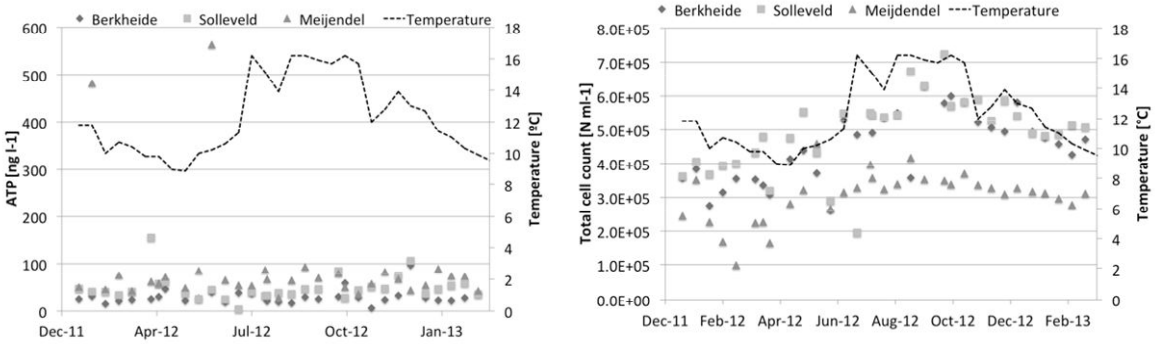
***Dune water company Dunea, Zoetermeer, The Netherlands*

In the present study we evaluated the suitability of two culture independent methods for the assessment of general microbial water quality after three sand filtration systems: dune recharge (DR), rapid sand filtration (RSF) and slow sand filtration (SSF). General microbial water quality was furthermore compared with the occurrence of faecal indicators in the DR. The concentration of total adenosine tri- phosphate (ATP) and total cell count (TCC) in water were measured during the period of 16 months in effluents of DR, RSF and SSF at three production locations of the Dune water company Dunea. Dune filtrates exhibited relatively stable ATP values that were not affected by temperatures between 8-18 °C. TCC values increased at increased temperature on account of LNA cells while HNA cell numbers remained stable. RSF reduced the ATP concentration and TCC values by 65-89% and 16-24%, respectively, but occasionally bacteria were also released from RSF. SSF reduced the ATP concentration and TCC values by 80-95% and 45-52%, respectively. SSF filters with the shorter lifetime exhibited better reduction of ATP and TCC values. ATP and TCC are valuable parameters for the routine monitoring of general microbial water quality and can be used to assess the efficiency of processes applied during drinking water production.



緩速ろ過後の微生物の観点での水質評価のための ATP 値と全菌数

Aleksandra Magic-Knezev, Luc Zandvliet , Willem A. Oorthuizen**, Ed J.van der Mark***
Het Waterlaboratorium, Lucasweg 2, 2031 BE Haarlem, The Netherlands
***Dune water company Dunea, Zoetermeer, The Netherlands*

３種類（砂丘浸透水、急速ろ過、緩速ろ過）のろ過水、微生物の視点での水質評価をするため、2 系統での試験をした。砂丘浸透水で一般細菌と糞便性細菌と比較した。砂丘地にある水道水製造会社で、上記 3 種類のろ過水中の ATP と全菌数を 16 ヶ月間に渡り計測した。砂丘浸透水では水温（8～18℃）に関係なく ATP 値は比較的に安定していた。低核酸（LNA）細菌数は水温上昇で増え全菌数も増えたが、高核酸（HNA）細菌数は変化がなかった。急速ろ過では ATP は 65~89%、また全菌数は 16～24%それぞれ減少したが、急速ろ過では細菌は時々漏出した。緩速ろ過では ATP は 80～95%、全菌数は 45～52%減少した。緩速ろ過は短期間で ATP や全菌数を減少させた。ATP や全菌数測定は、日常的に行われる一般微生物水質試験の重要な項目で、良質の飲料水製造のために効果的で、利用することができよう。

(A1-4)

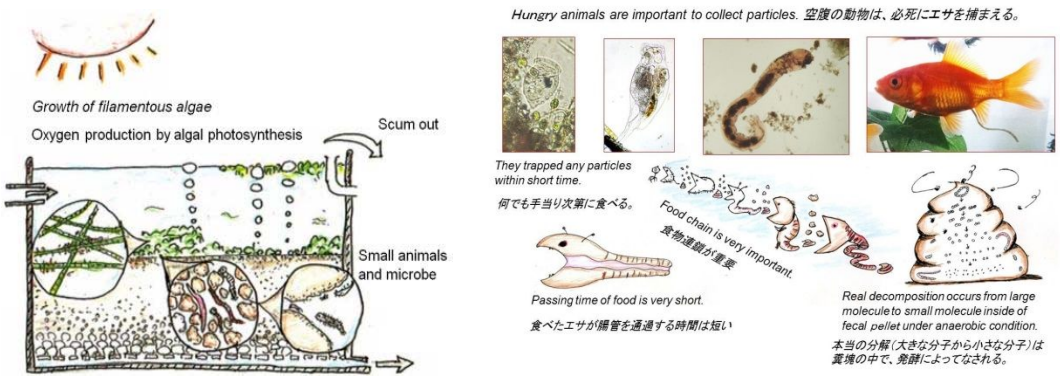
Food chain is the key in ecological purification system: new concept and new name of slow sand filter

Nobutada NAKAMOTO

Prof. Emeritus of Shinshu University, Ueda, Japan

Community Water Supply Support Center of Japan, 1218-5, Suwagata, Ueda, Nagano, 386-0032, Japan

Slow sand filter is based on the biological community. High filter rate of 40cm/h had been adopted as standard flow rate by Thames Water Utilities. Impurity of dissolved and particulate substance is eliminated during several minutes passing through the active sand layer. Food chain is the key for the purification process. Unwilling action to small organisms is not good. Gentle for small organisms is the key for Ecological Purification System which is a new concept and a new name of slow sand filter.



生物浄化法（エコロジカル浄化法）の基本は食物連鎖：緩速ろ過の新しい概念と新しい名前

中本信忠

信州大名誉教授、ＮＰＯ地域水道支援センター

緩速ろ過は生物群集の活躍が主で、英国ロンドンのテムズ水道の標準ろ過速度は9.6m/日。溶存および懸濁物は、砂層上部の生物が活躍している層を通過する時間は数分。浄化過程の鍵は、生物群集の食物連鎖である。微小生物が嫌がることをしない。微小生物に“やさしい”が生物浄化法の鍵で、緩速ろ過の新しい概念と新しい名前。

(B1-1)

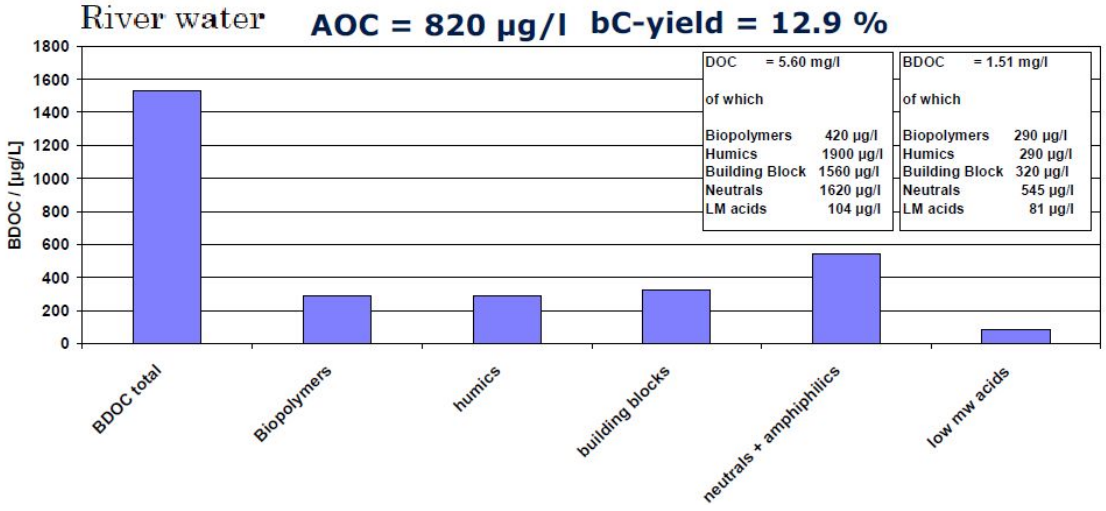
Treatment oriented method to determine potential for biological removal of NOM-components

Wolfgang Uhl　Technische Universität Dresden, Germany

Bioprocesses play an important role in Natural Organic Matter (NOM)-removal (THM-precursors, taste, odour, regrowth potential, etc.) in drinking water production. It is important to know whether compounds can be removed by the bioprocess.

Dissolved organic compounds (DOC) are separated by LC-OCD (Liquid Chromatography-Organic Carbon Detection) into fractions of biopolymers, humics of high molecular weight, building blocks and low molecular weight acids and neutrals. The data obtained are discussed in relation to results from pilot investigations.

The results clearly show that the yield for biomass production is much higher for the river water compared to the groundwater. Furthermore, the river water contains lots of biopolymers which are detrimental to membranes. However, they can at least partly be removed by biodegradation.



処理方法による天然有機物の潜在生物分解能について

Wolfgang Uhl　Technische Universität Dresden, Germany

飲料水の生物処理では、天然有機物（トリハロメタン前駆物質、味、臭気、潜在増殖能など）の除去割合が重要である。生物処理の過程でどの様な物質が除かれるかを知ることが重要である。溶存有機物は、液クロで生体高分子、高分子腐植物質、酸性低分子、中性分子などに分けた。得られた結果は、パイロット試験結果と比べ検討した。生物生産量は地下水と比べ、河川水の方が明らかに多かった。更に、河川水中には、膜分析で、生物高分子が大量に含まれていた。しかしながら、生物分解により、少なくとも、ある程度は、除去できた。

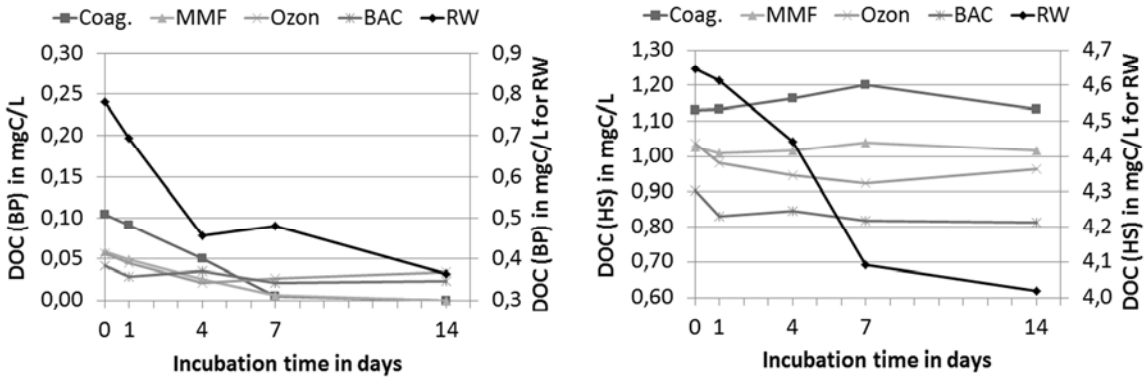
(B1-2)

Evaluation of dissolved organic matter fractions removal due to biodegradation

E. Vasyukova, R. Proft, W. Uhl

Technische Universität Dresden, Institute of Urban Water Management, Chair of Water Supply Engineering, 01062 Dresden, Germany

The objective of this study was to evaluate the biodegradability of dissolved organic carbon and organic nitrogen fractions of different composition and origin, as well as to understand how these NOM fractions are removed during full-scale drinking water treatment. Samples across three drinking water plants treating surface waters of different origin were investigated. The observed microbial catabolism of natural organic matter of the whole molecular weight spectrum points out the need for control of all fractions by treatment processes in order to minimize the risk of microbial proliferation in drinking water distribution systems. The results furthermore indicate the importance of an optimised coagulation procedure as the main process to remove to a large extent the high molecular weight DOC and DON including their biodegradable part.



生物分解による溶存有機物質の除去評価

E. Vasyukova, R. Proft, W. Uhl

Technische Universität Dresden, Institute of Urban Water Management, Chair of Water Supply Engineering, 01062 Dresden, Germany

この研究では各種原水での溶存有機物および有機窒素成分の生物分解性を評価し、実際規模の浄化試験で天然由来の有機物除去能を推測することである。異なる水源の表流水を３つの水処理施設で試験した。微生物分解した天然有機物の分子量分布から、水道水供給システムでの微生物増殖のリスクを最小にする処理方法を考察した。実験結果は、生分解性部分を含む高分子の溶存有機物、溶存窒素除去には、凝集処理も重要であることを示した。

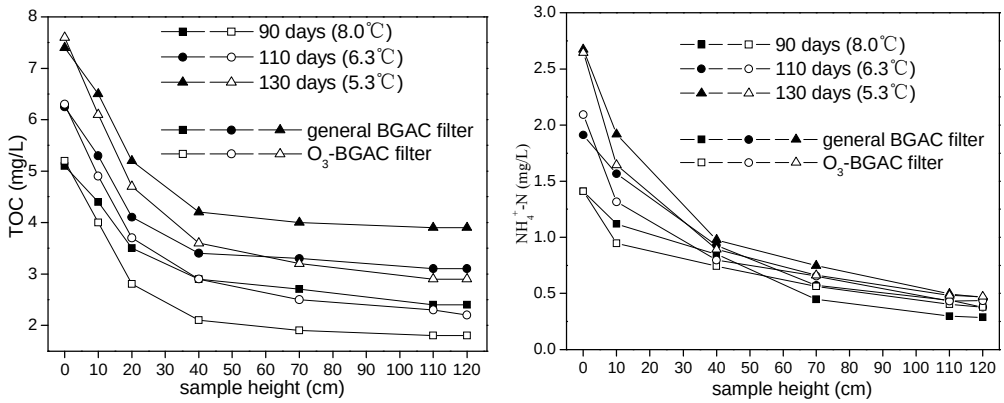
(B1-3)

Influence of preozonation on the performance of subsequent bio-filter in water treatment under low temperature condition: Biomass and community analysis

Jiaxuan Yang, Jun Ma, Dan Song, Yulong Shi, Xuedong Zhai*

State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, PR China Address: 73 Huanghe Rd. Harbin 150090, China. majun@hit.edu.cn

Biomass and community are essential for the performance of drinking water biofilters. In the present study, two biological granular activated carbon (BGAC) filters, feeding with the water after coagulation-sedimentation with or without pre-ozonation treatment, were investigated over a period of 5 months under lower temperature condition. To explore the mechanism of treatment, BGAC particles were sampled from four different heights of the filter (10, 40, 70 and 110 cm), the active biomass and microbial community in the filter, based on 16S rRNA gene-DGGE, were monitored at the mature stage of two BGAC columns. The importance and role of preozonation has been demonstrated.



バイオフィルターの低温下でのオゾン処理の影響：生物群集解析

Jiaxuan Yang, Jun Ma, Dan Song, Yulong Shi, Xuedong Zhai*

State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, PR China Address: 73 Huanghe Rd. Harbin 150090, China. majun@hit.edu.cn

飲料水用の生物ろ過では、生物群集は不可欠である。本研究では低温下で 5 ヶ月の期間にわたり凝集沈殿後とオゾン前処理無しで、生物活性炭ろ過実験を行った。ろ過の高さ（10, 40, 70 および 110cm）毎に採取し、活性の良い生物群集と微生物群集の量を、16S rRNA、遺伝子―DGGE で生物活性炭カラムの熟成度を調べた。オゾン前処理の重要性を示した。

(B1-4)

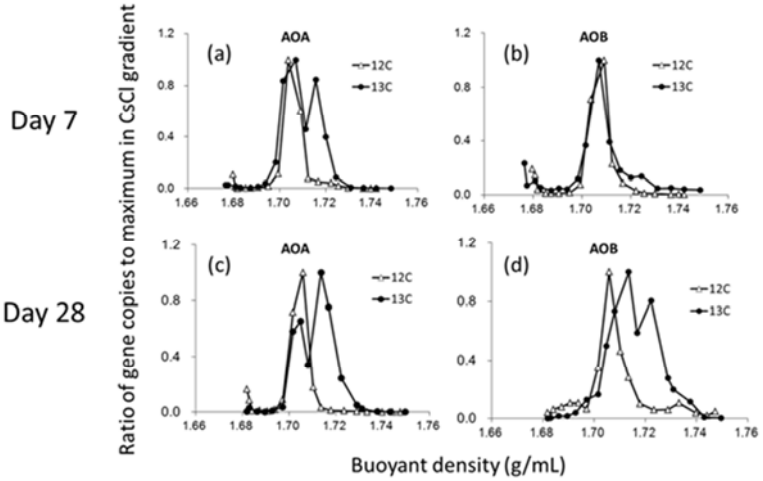
Autotrophic growth competition between ammonia-oxidizing archaea and ammonia-oxidizing bacteria in biological activated carbon filter with nitrification potential

Ikuro KASUGA[*], *Jia NIU*[*], *Futoshi KURISU*[*], *Hiroaki FURUMAI*[*] *and Takaaki SHIGEEDA*[**]

[*]*The University of Tokyo, 7-3-1, Hongo, Bunkyo, Tokyo 113-8656, Japan*

[**]*Bureau of Waterworks, Tokyo Metropolitan Government, 2-8-1, Nishi-Shinjuku, Shinjuku, Tokyo 163-8001, Japan*

Biological activated carbon (BAC) filtration combined with preceding ozone oxidation has been established as a major advanced drinking water purification process. One of the most important functions of BAC is the biological oxidation of ammonia, which can serve as a precursor for odourous trichloramine. The activity of ammonia-oxidizing microorganisms in the BAC filter is related to the nitrification performance of BAC. In the present study, autotrophic growth competitions between ammonia-oxidizing archaea (AOA) and ammonia-oxidizing bacteria (AOB) associated with BAC were evaluated by DNA stable isotope probing. When low levels of ammonium (0.14 mg N/L) were continuously supplied to BAC collected from a full-scale drinking water purification plant in Tokyo, AOA rather than AOB demonstrated higher autotrophic growth activity following 7 days of incubation. After 28 days, both AOA and AOB showed autotrophic growth. These results indicate that AOA outcompete AOB for the oxidation of low levels of ammonium in BAC filters.



硝化能を有する生物活性炭ろ過におけるアンモニア酸化古細菌とアンモニア酸化細菌の独立増殖競合の評価

春日郁朗[*]・*牛佳*[*]・*栗栖太*[*]・*古米弘明*[*]・*重枝孝明*[**]

**東京大学　大学院工学系研究科都市工学専攻　113-8656 東京都文京区本郷7-3-1*

***東京都水道局　163-8001 東京都新宿区西新宿2-8-1*

生物活性炭において硝化を担うアンモニア酸化古細菌とアンモニア酸化細菌の独立増殖の競合をDNA 安定同位体プローブ法によって解析した。その結果、0.14mgN/L のアンモニア態窒素に対する増殖応答は、アンモニア酸化古細菌の方が優れていることが明らかになり、実際の硝化においてもアンモニア酸化古細菌が重要な役割を果たしていることが推察された。

(A2-1)

Gut bacterial floras of aquatic invertebrates inhabiting slow sand filter beds

Juni TAKEUCHI, Yajing ZHAO**, Ryoki TANAKA****

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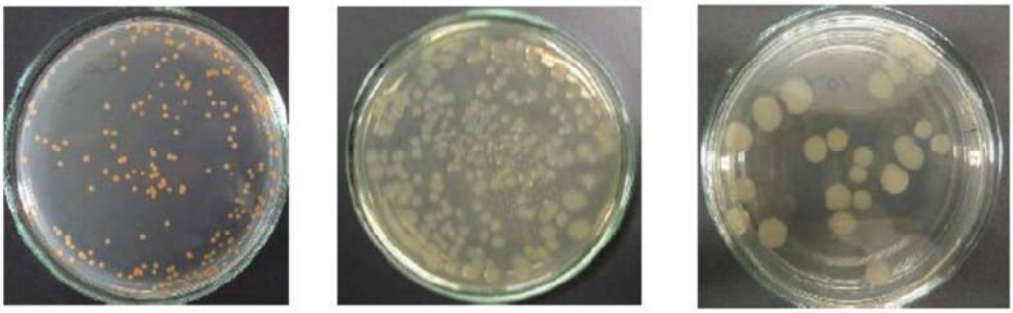
Aerobic heterotrophic bacteria from gut contents of small animals as "internal colonizers" were identified by partial sequencing 16S rDNA after surface sterilization by the UV irradiation. The gut floras turned out quite uniform composition, thus suggesting the animals fed on their favorite food under natural conditions. The present results may possibly explain that the fermentative flora and the resultant faecal pellets associated hydrolytic enzymic activities would contribute to remove excess organics and harmful microbes from the filtered drinking water.



寒天培地上に形成されたコロニー（左：ミジンコ、中：アブラミミズ、右：イトミミズ）

緩速ろ過池の砂層中に生息している水生無脊椎動物の消化管フローラ

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微小動物の消化管に生息する好気性従属栄養細菌を紫外線照射による表面殺菌で"内在菌"として分別、16S 系統遺伝子の部分塩基配列を調べて同定した。菌相はきわめて均質であり、自然条件下では微小動物が餌をより好みして摂食している様子が示唆された。今回の結果から、発酵代謝を営む菌相と加水分解活性を有する糞塊によって余剰有機物を分解したり、有害な微生物を駆除したりする効能に貢献している可能性がある。

(A2-2)

The functioning of biological slow sand filtration in relation to the presence and the role of Annelids in the schmutzdecke

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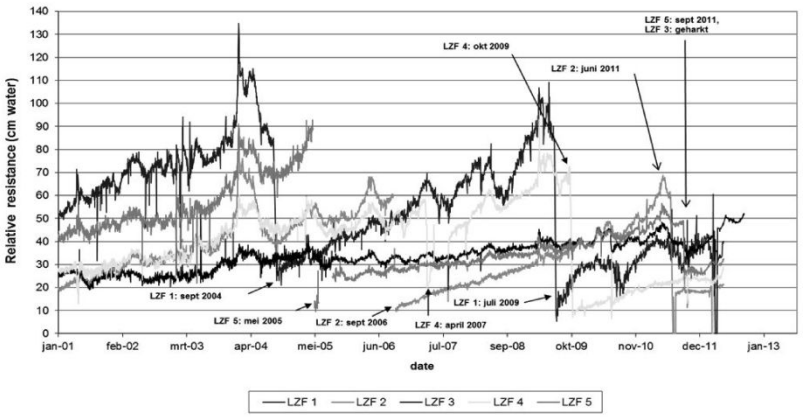
***Waterbedrijf Groningen, The Netherlands*

At Waterbedrijf Groningen, The Netherlands for the purification of surface water to drinking water slow sand filtration is used. There are five slow sand filters, and slow sand filter three (SSF3) has different behavior in head loss (clogging). SSF3 had run for more than 25 years without renewing the schmutzdecke due to clogging. Experiments showed that certain type of annelids give the schmutzdecke a different structure than the schmutzdecke found in the other filters. The presence of the annelids had no effect on the log removal of pathogenic microorganism of the filter. Identification of the worm is doubtful. Comparison of the annelid found in the water of SSF3 and annelids found in the surrounding ground of the filters showed that the origin of the "water"-annelid lies somewhere different. The annelid is not found in the other SSF and therefore slow sand filter four is inoculated with approximately a thousand annelids. In the next years yearly the structure of the schmutzdecke is examined.



Development of (normalized) head loss of the SSF units during a period of 12 years.

汚砂（ろ過膜）内の環形動物の役割と生物処理としての緩速ろ過機能の関係

Gerhard H. Wubbels, Jantinus H. Bruins*, Mieneke Bosman* and Dirk v.d. Woerdt***
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オランダ、ウォーターベッドリフ・グローニンゲン社では表流水の浄化に緩速ろ過を採用している。５つの緩速ろ過池があり、その中のろ過池３（SSF3）ではろ過閉塞指標の損失水頭の変化に関して興味ある点があった。SSF3 は 25 年以上、ろ過閉塞なしで、削り取りをする必要なかった。実験観察で環形動物（ミズミミズ）の仲間がいる汚泥（ろ過膜）は、他のろ過膜と異なっていた。環形動物が居ても、ろ過池での病原微生物除去に関しては何も影響を及ぼしていなかった。虫の同定は難しい。ろ過施設周辺の地面から見つかった環形動物と SSF3 内の水から見つかった環形動物を比べると、その虫の発生源は違うようだ。また、環形動物が見られない他の緩速ろ過池もあったが、ろ過池（SSF4）に約 1,000 匹の環形動物を入れてみた。今後、数年間、年ごとに汚泥（ろ過膜）を観測する予定である。

(A2-3)

The Inhibitory Effect of Tubificid on Head Loss in Slow Sand Filtration

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We observed a lower rate of head loss in the Noda Water Purification Plant's No.2 Slow Sand Filter (in Hiroshima Prefecture, Japan), where tubificid had lived continuously. So, in order to further investigate the relationship between tubificid and the rate of head loss, we experimented with a small slow sand filter. We confirmed that tubificid effect the rate of head loss in slow sand filters.

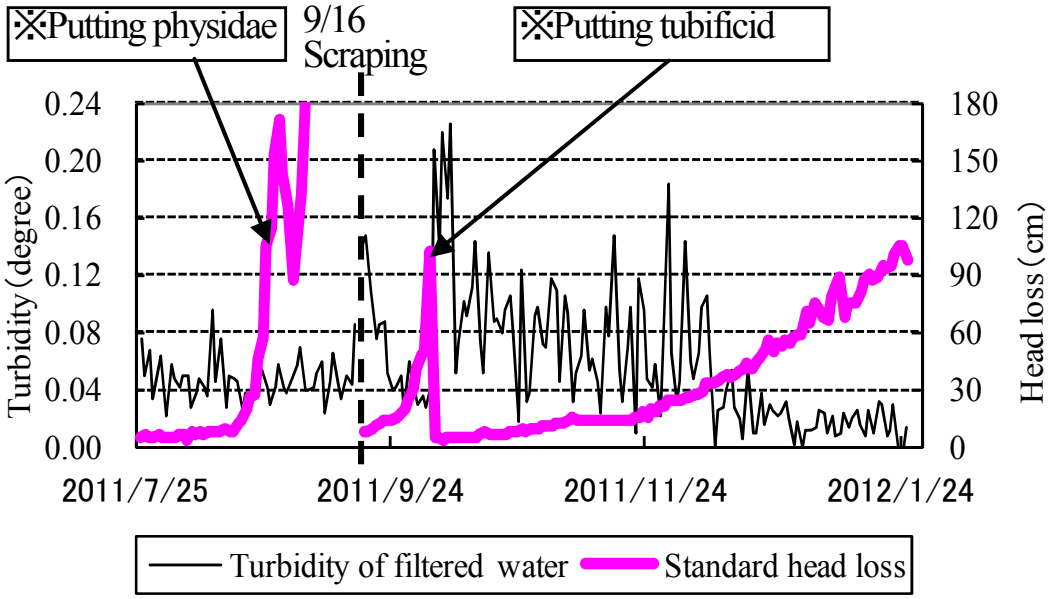

Figure Trends of standard head loss and turbidity of filtered water of the small slow sand filtration device

イトミミズ類による緩速ろ過池の損失水頭上昇に対する抑制効果

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広島県営水道の埜田浄水場の２号緩速ろ過池において，損失水頭の上昇が緩やかになる傾向が認められ，そこでは継続してイトミミズ類が認められた。そこで，損失水頭とイトミミズ類の関係を緩速ろ過ミニプラントにより実験を行った。その結果，緩速ろ過池の損失水頭上昇に対する，イトミミズ類による抑制効果が確認された。

(A2-4)

Schmutzdecke Development and Treated Water Quality

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Seasonal schmutzdecke development is observed during filtration operation using new schmutzdecke samplers in two field scale slow sand filters while most field scale investigations observe schmutzdecke only at the end of filter runs because of difficulties to obtain schmutzdecke with supernatant on it. Detailed analysis of schmutzdecke during filter operation can improve operational management through better understanding of slow sand filter. The new schmutzdecke sampler featured in this paper is a portable sand bed on a mesh container (30cm x 20cm) which is set on the filter bed after cleaning between filter runs. The sampler enables collecting active schmutzdecke without disturbing it because it makes unnecessary to cut out operating schmutzdecke. This paper observes the schmutzdecke collected from seven samplers set on the filter bed with the interval of approximately two weeks during a filter run and discusses the algae species, biomass and filter performance.

生物ろ過膜の発達と処理水質

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名古屋市上下水道局
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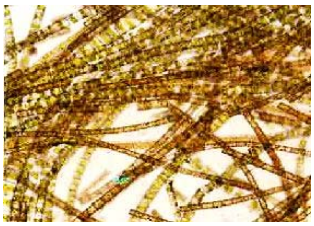

実施設において、緩速ろ過池の生物ろ過膜をろ過池に水がある状態で採取することは難しい。そのため、生物ろ過膜は、清掃などでろ過池を空にしたときのみ調査されていることが多い。今回、新しく考案したろ過膜採取器を用いて、ろ過継続中の生物ろ過膜の季節的発達状態を観察した。ろ過継続中の生物ろ過膜の調査は、緩速ろ過のメカニズムをより深く知り、緩速ろ過の運転管理を改善していく上で有用である。本論文の新しい生物ろ過膜採取器は、メッシュの容器(30cm x 20cm)に砂を入れた持ち運びが可能なろ床で、ろ過池清掃後、ろ過床の上に置く。この採取器は生物ろ過膜を切り取る必要がないため、生物ろ過膜を乱すことなく採取できる。本論文では、１池あたり７個のろ過採取装置を設置し、約２週間の間隔で１個ずつ回収して得られた生物ろ過膜について、構成する藻類種とバイオマスの変化をろ過パフォーマンスとともに考察した。

(A2-5)

Biological Iron Removal from Community Water Source -Corriverton, Republic of Guyana-

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After completion of a project with grant aid from JICA in 2010, quality of supplied water has significantly improved in Corriverton, Republic of Guyana. Prior to this project, Corriverton used to be supplied raw water directly from deep wells without any disinfection. The raw water had iron concentrations exceeding the WHO standards and faecal coliforms were often detected in it. To address these problems, a WTP with a slow sand filter was constructed by the project to remove excess iron and biological contamination in raw water.

Average iron removal ratio in the newly-constructed WTP is 88%, and the average iron concentration of treated water is 0.23mg/L during February to July 2013. Frequency of sand scraping is every 2 to 3 weeks, and the filters resume operation after a few hours of scraping due to fast breeding of iron bacteria. In this project, the slow sand filter with iron bacteria has successfully showed a high iron removal efficiency as well as conventional purification capacity with easier operation and maintenance compared to the rapid sand filter. The significant improvement of water quality has been well recognized by customers.

Date	pH		Turbidity (NTU)		Iron (mg/L)	
	Raw water	Treated water	Raw water	Treated water	Raw water	Treated water
26/Feb./2013	5.98	ND	10.9	ND	1.61	ND
19/Mar./2013	5.76	ND	14.0	ND	2.02	ND
7/May/2013	6.01	ND	9.2	ND	1.98	ND
4/Jun./2013	5.83	6.61	20.3	2.90	ND	0.39
18/Jun./2013	5.77	6.61	14.7	0.60	ND	0.13
3/Jul./2013	5.64	6.34	12.6	1.30	ND	0.18
17/Jul./2013	5.77	6.22	20.1	0.90	ND	ND
Average	5.82	6.45	14.5	1.43	1.87	0.23

鉄バクテリアを用いた緩速ろ過方式の浄水施設導入 −ガイアナ共同共和国、コリバートン地区−

中園隼人・パッタタパ・武智昭・スニルダットバッラン

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日本の無償資金協力により、2010 年に鉄バクテリアを用いた緩速ろ過方式の浄水施設がガイアナ国コリバートン地区に整備された。施設整備前のコリバートン地区では、揚水ポンプで地下水をくみ上げた後、塩素消毒をせず、揚水ポンプの圧力で配水本管から給水区域全体に配水されていた。原水水質に関しては、WHO 基準値（鉄 0.3mg/L 以下、大腸菌群数 100mL 中非検出）を越える鉄と大腸菌群数が検出された。施設整備後（2013 年 2～7 月）の鉄の除去率は 88%で、浄水の平均鉄濃度は 0.23mg/L であった。また、鉄バクテリアの繁殖が速いため、ろ過池の砂掻きは 2,3 週間おきに実施しており、砂掻き終了後数時間でろ過池の通水を行っている。ろ過池の維持管理が容易で、適切に運転管理されているため、浄水水質が安定しており、水道利用者から水質が良くなったと好評を得ている。

(B2-1)

Renewal and selection of granular activated carbon in advanced drinking water purification in Tokyo

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One of the most significant tastes and odors in drinking water is musty odor such as 2-methylisoborneol (2-MIB) and geosmin because they are difficult to remove completely by conventional drinking water purification. Since 1974, 2-MIB had been detected in the Edo River, one of the main water sources of Tokyo, and had caused musty odors in purified water from Kanamachi purification plant (PP). In order to remove 2-MIB efficiently and stably, Tokyo Waterworks decided to introduce advanced drinking water purification (ADWP), which consists of ozonation and biological activated carbon (BAC) filtration, to Kanamachi PP. It is necessary to replace granular activated carbon (GAC) within a proper period to maintain its performance. After the introduction of ADWP, Tokyo Waterworks had conducted follow-up research to determine the renewal period. In this paper, the renewal period, based on both removal performance and cost-effectiveness, and a revised period, based on TOC removal, are discussed. The relationship between GAC performance and raw materials is also described.

Table Degradation of removal performance of BAC filter in the first study.

Indicator	Degradation of removal	Proper renewal period
UV260	Become 0% after 86 months	7 - 8 years
NH_3-N	Leakage occurred in low water temperature after 6 years	7 - 8 years
2-MIB	Maintain about 100 % through investigation period	-
MBAS	Frequent leakage observed after 7 years	7 years
THMFP	Maintain about 30 % through investigation period	-

東京都水道局における生物活性炭吸着池の運用について

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飲料水質の異臭味として大きな問題となる物質に、通常処理では完全な除去が難しい2-MIB やジェオスミン等のかび臭原因物質があげられる。1974 年以降、東京都水道局の主要水源である江戸川において2-MIB が検出されるようになり、江戸川から取水する金町浄水場の水質管理上、大きな課題となっていた。このため、東京都水道局では、2-MIB を効果的かつ安定的に除去するため、オゾン処理と生物活性炭処理を組み合わせた高度浄水処理を導入した。本稿では、高度浄水処理導入後の追跡調査により決定した粒状活性炭の更新頻度について述べる。また、原材料の異なる粒状活性炭による処理性についても報告する。

(B2-2)

Removal of easily and more complex biodegradable NOM by full-scale BAC filters to produce biological stable drinking water

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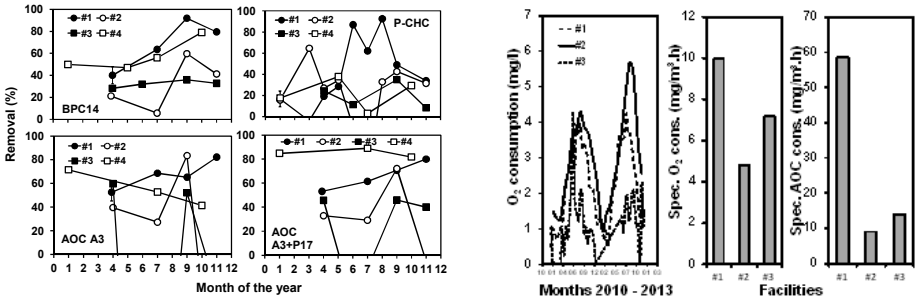
Distribution of drinking water without chlorine requires low microbial growth potential of the water, which can be assessed with methods detecting biodegradable compounds at low concentrations. Recent insights showed that besides the easily assimilable organic carbon AOC measured with P17/Nox more complex biodegradable compounds or biopolymers are also of significance for the biological stability of water. Therefore, the impact of full-scale Biological Activated Carbon (BAC) filtration processes on the biological stability of water was determined at four full-scale water treatment plants using newly developed methods. The results indicate the importance of BAC filtration for the concentration of more complex biodegradable AOC and particulate organic matter in the water. The removal rate of biodegradable compounds in BAC filtration is affected by influent quality, temperature, and results also indicate an effect of reactivation frequency of the activated carbon.



生物学的に安定した水道水生産のための実サイズの生物活性炭ろ過による易分解性および生物分解性有機物の除去

W. A. M. Hijnen, R. Schurer**, B. Martijn***, J. A. Bahlman, W. Hoogenboezem****, P. W. J. J. van der Wielen**

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塩素なしの飲料水供給には水中の微生物の潜在増殖能の低さが必要で、そのために、低濃度の生物分解化合物の測定評価技術が必要である。容易に生物分解可能の有機物の他に、より安定した水道水のため、高度に複雑な生物分解化合物や高分子を P17/Nox 法で測定した。実際規模の生物活性炭(BAC)ろ過での処理実験は、新たに建設された 4 つのプラントで行われた。原水中の複雑な生物分解物質や粒状有機物の除去について 4 つの BAC ろ過でその重要性を示した。生物分解化合物の除去速度は、原水の水質、温度、活性炭の性能にも影響された。

(B2-3)

Applicability of Spherical Coconut Shell Activated Carbon to Biological Activated Carbon for Advanced Drinking Water Treatment

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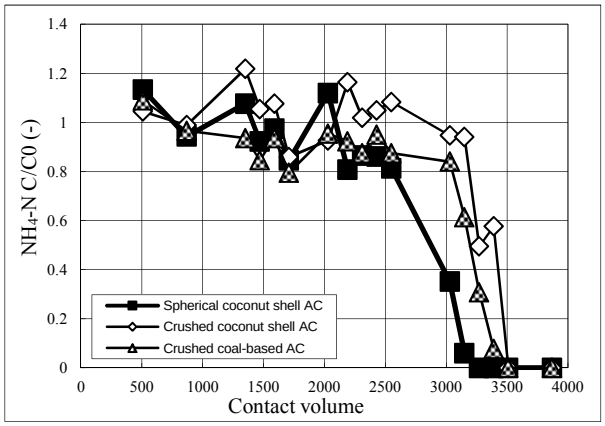
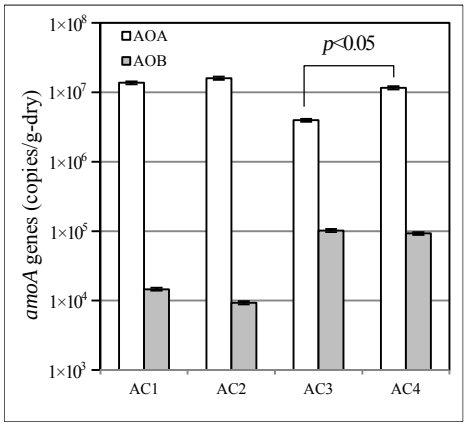
High-performance spherical activated carbon (AC) derived from coconut shell for advanced drinking water treatment was newly developed. The mesopore and macropore volumes of spherical coconut shell AC are about three times as much as those of crushed coconut shell AC. In terms of applicability as biological AC, the spherical coconut shell AC shows the earliest start of nitrification reaction than crushed coconut shell AC and crushed coal-based AC. Moreover, Quantitative-PCR (Q-PCR) was performed to determine abundance of AOA. In the result, 1.2x107 copies/g-dry were detected in spherical coconut shell AC (AC4), however 4.0x106 copies/g-dry were detected in coal-based AC (AC3) ($p<0.05$). This report describes the applicability of the spherical coconut shell AC to biological AC filtration for advanced drinking water treatment. .



Relation between decreasing rate of NH_4-N and contact volume



Abundance of AOA and AOB *amoA* genes

高度浄水処理におけるヤシ殻系球状活性炭の生物活性炭としての適用性

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水 ing 株式会社

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ヤシ殻を原料とした高性能球状活性炭を高度浄水処理用に新たに開発した。ヤシ殻系球状炭はヤシ殻系破砕炭と比べ 3 倍のメソポア及びマクロポアを持つ。生物活性炭としては、硝化反応の立ち上がりがヤシ殻系破砕炭及び石炭系破砕炭と比べ早かった。さらに、アンモニア酸化古細菌(AOA) の付着量を評価するため、Q-PCR 法を用いて現存量(amoA コピー数)を調べた。その結果、ヤシ殻系球状炭(AC4)では 1.2×107 copies/g-dry であったのに対し、石炭系活性炭(AC3)では 4.0×106 copies/g-dry であった($p<0.05$)。本発表では、高度浄水処理におけるヤシ殻系球状炭の生物活性炭としての適用性について述べた。

(B2-4)

Manganese removal in BAC facilities without ozonation in water purification plants

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We surveyed the manganese removal process by a biological activated carbon (BAC) treatment without ozonation. The survey results showed that D-Mn was not detected in the water treated by the aged BAC beds, but high concentration of manganese was detected by the new BAC bed. A follow-up survey indicated that a BAC bed needs six months to obtain manganese removal functionality. In the next survey, we measured the quantity of adhered manganese (ad-Mn) in the GAC beds and RSFs. Before beginning operation of the Shinanogawa purification plant, we performed a test operation without BAC treatment, and mangaese removal was required during the test period. However, after six years of operation, the quantity of ad-Mn in the RSFs decreased to less than 0.3 mg/g. Based on these facts, we concluded that the quantity of ad-Mn decreased gradually because the concentration of D-Mn in water treated by RSFs was almost zero when the BAC facility obtained manganese removal functionality.

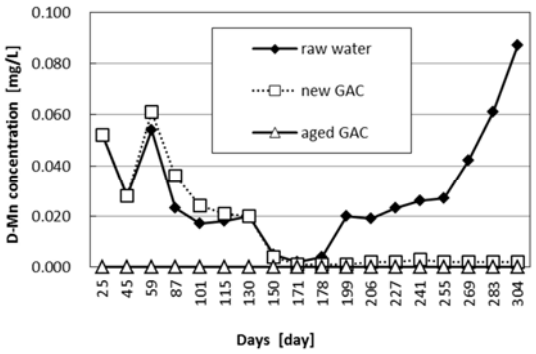

Figure1 Variation in soluble manganese from raw water and the outflow from new and aged BAC facilities when D-Mn was monitored for a year at a GAC facility.

オゾン処理のない生物活性炭処理を有した浄水場におけるマンガン除去

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オゾン処理のない生物活性炭処理による溶存マンガン除去プロセスに関して調査した。調査した結果として，溶存マンガンは，経年炭の処理水で検出されなかったが，新炭の処理水で高濃度のマンガンが検出された。調査を続けた結果，生物活性炭がマンガン除去の機能を得るまでに6ヶ月の期間が必要であることが分かった。次の調査として，活性炭とろ過砂のマンガン付着量を測定した。信濃川浄水場が稼働する前において，生物活性炭処理なしで試運転を行っており，マンガン除去は，試運転中において行われていた。しかしながら，6年後の急速ろ過池のマンガン付着量は，0.3mg/g より減少していた。以上のことから，活性炭吸着池がマンガン除去の機能を得た時，急速ろ過池によって処理されるマンガンがほとんどゼロになるために，急速ろ過池のマンガン砂は，徐々に減少すると結論付けた。

(B2-5)

Deterioration Mechanisms of Granular Activated Carbon in Fluidized-Bed Contactor with Biological and Physical Effects

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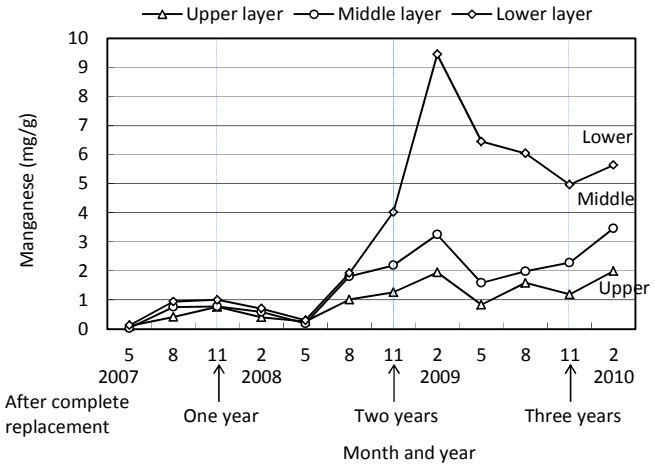
Hanshin Water Supply Authority investigated the deterioration of Granular Activated Carbon (GAC) in different layers of fluidized-bed contactor. In the upper layer, the grain diameter of GAC was small and its iodine-adsorbing potential decreased. In the lower layer, the grain diameter of GAC was large and the amount of accumulated manganese was also large. This was because of the deterioration and erosion of GAC resulting from the exposure to ozone, and the separated small-diameter GAC grains moved to the upper layer. The formation of the mud balls was probably due to the agglomeration of GAC in the presence of polymers produced by rhizopods.



生物学的作用と物理学的作用が共存する流動層活性炭処理における活性炭の劣化状況

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活性炭流動層における層毎の活性炭の劣化状況について調査した。活性炭は、上層部ほど、粒径が小さく、ヨウ素吸着性能の低下が見られ、下層ほど粒径が大きく、マンガンの付着が多く見られた。これは、オゾンの接触等により、劣化・摩耗した小粒径の活性炭が上層部へ移動したものと考えられた。マッドボールの原因は根足虫類が算出したポリマーによる凝集と考えられた。

(KL2)

A Review of Biologically-Based Drinking Water Treatment Processes for Organic Micropollutant Removal

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Organic micropollutants are increasingly being detected in the world's drinking water sources. The need exists for sustainable drinking water treatment options to remove these pollutants. The research studying biotechnologies, such as biological filtration and managed aquifer recharge is growing. This review compiles removal efficiencies observed in biological drinking water systems to reveal the extent of such technologies' effectiveness for a range of organic micropollutants.

Table 2.1 Organic micropollutant removal efficiencies in biological filters and managed aquifer recharge.

		Biological filter				Managed Aquifer Recharge			
Type	Compound	Inf. Conc. (ng/L)	Removal (%)	RT (min)	S	Inf. Conc. (ng/L)	Removal (%) A.W., P.W.	RT (d)	S
Nonpoint Sources									
Gasoline Additive									
	Benzene					28	<0-61, 66	10.5-28	n
	Ethylbenzene					18	11-79, 79	10.5-28	n
	Hemellitene					34	58-85, 87	10.5-28	n
	MTBE					178	25-50,	15-70	a
	Naphthalene					8	<0-61, 75	10.5-28	n
	o-Xylene					12	<0-62, 65	10.5-28	n
	Pseudocumene					100	76-93, 94	10.5-28	n
	Toluene					117	4.3-86.3, 87	10.5-28	n
	Benzo[a]pyrene	94	89[S], 89[A]	2	u				
Naturally Occurring									
	MIB	5-50	90	10	c				
		100-200	46	7	d				
		50	50	2-7 d	l				
		600	>90	60	m				
		84	93[a], 99[b]	7.9[a], 15.8[b]	z				
Pesticides									
2,4-Dichlorophenoxyacetic acid (2,4-D)		171	68[a],77[b]	7.9[a],15.8[b]	z				
	Acetochlor	266	8[a], 17[b]	7.9[a], 15.8[b]	z	1460-4350	72-98	6	w
	Aldicarb	31	49[a], 72[b]	7.9[a], 15.8[b]	z				

(Continued)

有機性微量汚染物質除去の生物浄化処理に関するレビュー

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世界各地の飲料水源で有機性微量汚染物質は検出されだしている。この汚染物質を除去する持続可能な浄化処理が必要とされている。生物ろ過や地下水涵養などによるバイオテクノロジー研究が盛んに行われだした。このレビューでは生物浄化処理での有機性微量汚染物質の有効な除去効果についてまとめた。

(A3-1)

Slow sand filtration process model for removal of microorganisms

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A new Slow Sand Filtration Process Model for removal of microorganisms has been developed into an interactive computational tool. Operational conditions, such as filter bed depth, filtration rate, water temperature, grain size of the sand and age of the Schmutzdecke, can be set to predict removal of bacteriophage MS2 and E. coli as process indicators for removal of enterovirus and Campylobacter. These predictions can be conducted as a function of time, accounting for time-variable operational conditions. A Beta distribution is fitted to the fractions of microorganisms that pass slow sand filtration. It is demonstrated how the Beta distribution parameters can be used as integral part of Quantitative Microbial Risk Assessment for the production of potable water from surface water with the computational tool QMRAspot.

$$\ln\frac{C}{C_0} = -\frac{3}{2}\frac{1-n}{d_c}\left(\alpha\eta_{0,d_p,d_c,u,T,n}z + f_0 T\left(1-e^{-\alpha f_1 a}\right)\right)$$

微生物除去の緩速ろ過モデル

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a:National Institute of Public Health and the Environment, Bilthoven, The Netherlands b:Utrecht University, The Netherlands c:Waternet, Amsterdam, The Netherlands d:KWR Watercycle Research Institute, Nieuwegein, The Netherlands e:Het Waterlaboratorium, Haarlem, The Netherlands f:DUNEA, The Hague, The Netherlands g:Waterbedrijf Groningen, The Netherlands

微生物除去の新しい緩速ろ過モデルが対話式計算モデルを開発した。エンテロウイルスやカンピロバクターの除去の指数としてバクテリオファージMS2や大腸菌の除去を、ろ床の深さ、ろ過速度、水温、砂の粒子径、ろ過膜（生物膜：汚泥）の熟成度合などの管理状況で予測可能である。これらの結果は、運転経過時間とともに変化を予測できる。緩速ろ過を通過する微生物の分画状況は、ベータ分布と相応した。計算モデルQMRAspotで、表流水からの飲料水の生産における定量的微生物リスク評価にベータ分布指標が利用できる事を示した。

(A3-2)

Removal of anti-inflammatory compounds by ecological filtration

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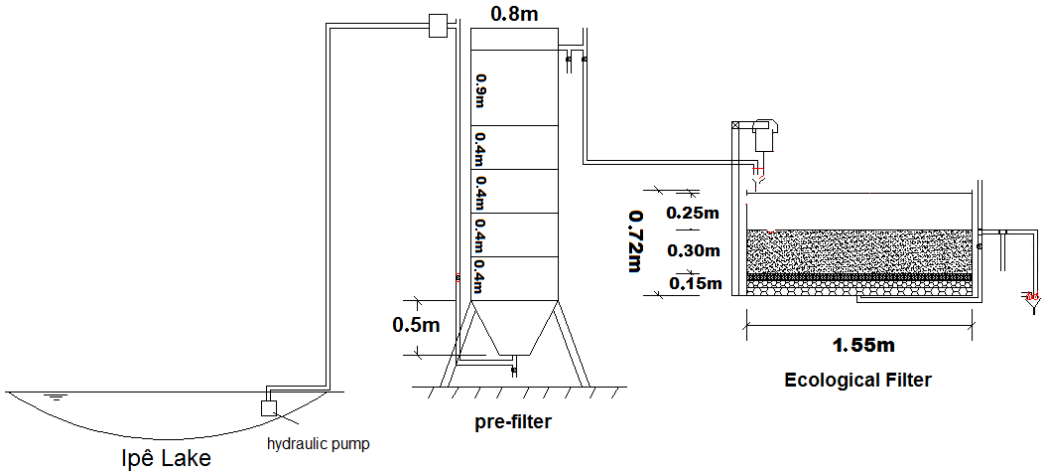
The use of the slow sand filtration, better known as ecological filter was tested to removal of anti-inflammatory compounds from water, (i.e. Diclofenac, Naproxen and Ibuprofen). The treatment system consisted of pre-filtration followed by ecological sand filter and the mixture of the three different compounds was added the afluent of the ecological filter. The filtration system operated during dry season (June-November 2012) in Brazil. The pharmaceutical compounds were determined by SPE (solid phase extraction) followed by HPLC (high performance liquid chromatography). In addition, turbidity, apparent color, true color, total and thermotolerant and coliforms were measured to further evaluate the water quality. The ecological sand filters showed to be an efficient process to remove Diclofenac, Naproxen and Ibuprofen in this study.



生物浄化法による抗炎症性剤の除去

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**** University College London, UK.*

緩速ろ過は生物浄化法として良く知られ、抗炎症剤（ジクロフェナク、ナプロキセン、イブプロフェン）の除去実験をした。前処理と緩速ろ過（生物浄化法）で３つの薬剤を添加する実験を行った。実験はブラジルの乾期（2012 年 6 月-11 月）に行った。薬剤は固相抽出で 高速液体クロマトグラフィー で測定した。また、水質は濁度、見かけの色、真の色、耐熱性大腸菌を測定した。本研究で生物浄化法による抗炎症剤の除去について示した。

(A3-3)

Removal of bromophenols by slow sand filtration

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We tried to remove bromophenols with a slow sand filter and compared the degradability and the structure. The phenols examined are phenol, catechol, and mono-bromophenols (MBPs), namely 2-BP, 3-BP and 4-BP; and di-bromophenols (DBPs), namely 2,4-DBP, 2,6-DBP, and 3,5-DBP. Bromophenols (BPs) with low removal rates were also examined for removal under ultraviolet lamp (UV) irradiation and the relationship between degradability and molecular orbital properties of the phenols was estimated. The order of removability with a slow sand filter of examined phenols was catechol > phenol ≥ 4-BP > 3-BP > 2- BP > 2,4-DBP, 2,6-DBP > 3,5-DBP. After 5 min of UV irradiation, the initial concentrations of MBPs and DBPs of 20 mg per liter were almost removed. The decrease in the dissolved organic carbon concentration suggests mineralization of MBPs and DBPs. Bromide ions were released along with the decrease of BPs examined. Molecular orbital calculation suggests that the electrophilic frontier density and HOMO energy may be related to the degradability of BPs under UV irradiation.

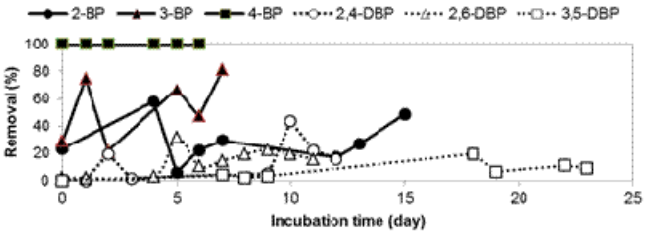

Figure Removal rates profile of BPs by a slow sand filter.

緩速ろ過によるブロモフェノール類の除去

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臭素化フェノールの緩速ろ過による除去性を検討するため、フェノール、カテコール、3 種類のモノブロモフェノール（以下 BP）、3 種類のジブロモフェノール（以下 DBP）の除去実験を行った。除去率は、カテコール＞フェノール≥ 4-BP ＞ 3-BP ＞ 2- BP ＞ 2, 4-DBP, 2, 6-DBP ＞ 3, 5-DBP の順であり臭素が少ないほど除去性は高く、3. 5-DBP が最も除去されにくかった。UV 照射による BP 類の分解性についても報告する。

(A3-4)

The Countermeasure against the Increase of Disinfection By-products Concentration by Humic Substances at a Water Purification Plant Using a Slow Sand Filtration System

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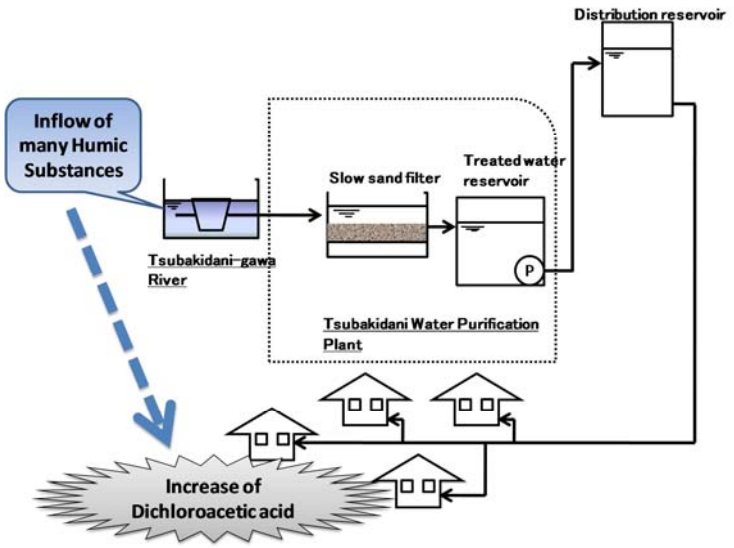
Dichloroacetic acid (DCA) was detected in high concentration in the tap water supplied by a water purification plant using a slow sand filtration system. DCA is a kind of disinfection by-product considering that it was derived from the humic substances due to the fallen leaves. The correlation between some factors (DCA, TOC, chromaticity) was investigated and the appropriate operation and maintenance method at a water purification plant with a slow sand filtration system when DCA is in high concentration were established.



緩速ろ過浄水場におけるフミン質による消毒副生成物濃度の上昇への対策について

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緩速ろ過方式による浄水場の給水栓水から高濃度のジクロロ酢酸が検出された。ジクロロ酢酸は、消毒副生成物の一つで、天然由来のフミン質が原因であると考えられた。これに対し、ジクロロ酢酸、ＴＯＣ、色度の関係を調査し、ジクロロ酢酸が高濃度となる際の適切な処理と維持の方法を確立した。

(B3-1)

Gravity-driven biological membrane filtration for small-scale drinking water treatment: effects of water quality and membrane type on the process efficiency

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Recent studies have shown that low pressure membrane processes (MF or UF) operated by a hydrostatic pressure (less than 100 mbar) can maintain stable permeate fluxes at 5 – 10 L/m2.hr for months to years without any intensive membrane cleanings. This so-called gravity-driven membrane (GDM) process can be a promising tool for drinking water production where drinking water infrastructures are not available. The objective of this study was to understand the effects of water quality and membrane type on the performance of GDM process (flux and permeate water quality), with an aim of further optimizing the GDM process. GDM units with two different scales (Fig. 1) employing a range of MF and UF membranes were constructed and applied to treat a lake water in dead-end mode by a hydrostatic pressure (65 mbar). Stable fluxes of 2.5 – 5 L/m2.hr were achieved after a few days and then maintained in the remaining operation period (over two months). The tested MF and UF membranes showed similar permeate flux levels regardless of membrane materials (i.e., PES, PVDF, and PTEF). Bacterial removal efficiency (determined by flow-cytometric and ATP methods) was found to be slightly higher for the UF (~ 99%) compared MF membranes (~95%). As a next step, a sewage-impacted surface water will be tested in the same GDM system to find out how the water matrices affect the flux and permeate water quality.

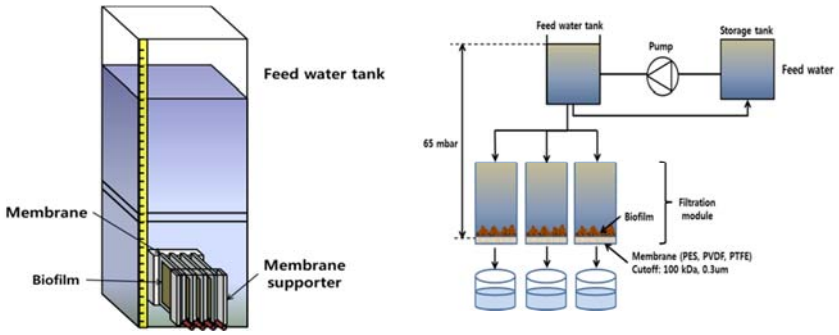

Fig. 1. Laboratory GDM units with different scales: left = flat-sheet membranes (surface area = 232 cm^2) immersed in a 98L container, right = membranes (surface area = 14 cm^2) in a filter-holder system.

小規模飲料水浄化処理のための自然重力式生物ろ過膜試験—水質と膜の種類の効果

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低水圧のMFまたはUF膜で洗浄なしで数カ月から数年間の実験を行ってきた。飲料水浄化施設がない地域では、重力式の膜処理は考慮に値する。本研究では、湖水を使って水質と膜の種類の影響と最適化を研究した。数日で、安定した負荷（2.5 - 5 L/m2.hr）になり、2カ月間以上維持できた。MF膜でもUF膜でも同じ効果であった。フローサイト法とATP測定で測定した細菌除去は、UF膜は（~99%）で、MF膜は（~95%）であった。下水の影響がある表流水でも、試験した。

(B3-2)

Comparison between different filter systems as a post treatment after tertiary ozonation

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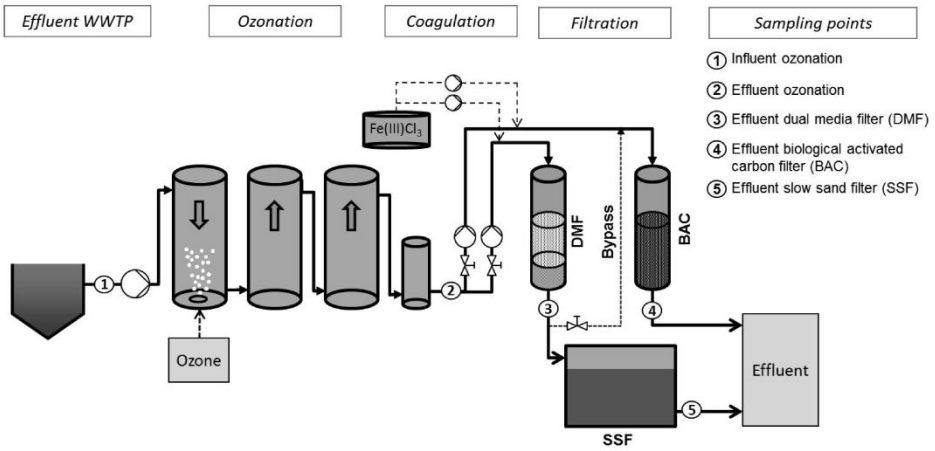
To cope with occurring traces of organic contaminants in the effluent of waste water treatment plants, ozonation is a suitable technical treatment method. However, there is an ongoing discussion about the necessity of a post-treatment of ozonation effluents to remove possible toxic ozonation by-products. This study compares a dual media filter (DMF) and a biological activated carbon filter (BAC), which were used for ozonation post-treatment, and were also designed as coagulation filters for tertiary phosphor removal. The results of this study demonstrate that both rapid filters performed similarly in respect to DOC reduction and oxygen demand, and could also be used for tertiary phosphorus removal without any impairments. A comparison of a serial mode of the DMF and the BAC with a slow sand filter, which was used as a surrogate for an infiltration pond, showed that this two-stage process could increase the degradation of the DOC, but was not able to remove the entire biodegradable DOC.



オゾン三次処理後処理としての様々なろ過方式の比較

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廃水処理施設からの廃水中に残存する有機汚染物質に対処するため、オゾン処理は適切な処理法である。しかしながら、オゾン処理で有害な副産物が生じる可能性があるので、更にオゾン処理をする必要性があるか議論されているところである。この研究ではオゾン処理後処理として用いる二層ろ過（DMF）と生物活性炭ろ過（BAC）、更に、三次処理としてのリン除去用凝集ろ過も考慮して比較実験をした。溶存有機物（DOC）の削減や酸素要求量に関しては急速ろ過と同様の効果があり、更に三次処理としてリン酸除去が容易にできる可能性があった。浸透池用の緩速ろ過と組み合わせた二層ろ過（DMF）と生物活性炭ろ過（BAC）の比較では、この二段行程でも溶存有機物（DOC）の分解を増加させたが、全ての生物分解性溶存有機物（DOC）を除去されなかった。

(B3-3)

Mechanisms of DOC removal from secondary effluents in a lab biofilter

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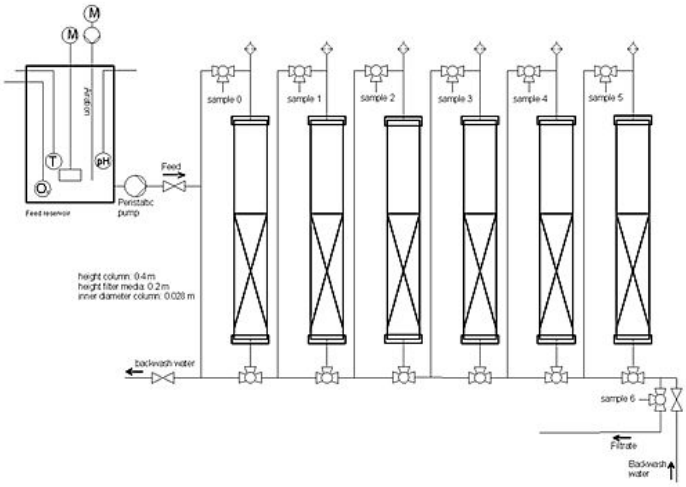
Technische Universität Dresden, Institute of Urban Water Management, Chair of Water Supply Engineering, 01062 Dresden, Germany

Biofiltration is an interesting process for pre-treatment of secondary effluents to reduce fouling in membrane filtration processes. Especially with respect to different DOC-fractions a detailed understanding of the removal mechanisms in biofilters is important. In the present study 15% of DOC were removed. For the biopolymer fraction removal was highest (65%) and seemed to continue while for low molecular weight substances removal was limited. The main removal mechanism was shown to be biodegradation. Oxygen consumption in the filter bed correlated well with DOC removal and corresponded to full oxidation of DOC to carbon dioxide. The concentration of bacteria decreased over the filter bed depth in the bulk and on the filter media. Biomass attached to the granular media was shown to be much higher than suspended biomass in the interstitial water. In batch adsorption experiments attachment of organics to the granular media could not be proven.



生物ろ過試験での二次処理水からの DOC 除去の仕組み

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生物ろ過は興味深い行程で、二次処理水の前処理として膜ろ過の付着汚れを減少させる。特に生物ろ過では、除去の仕組みを理解するために、種々の溶存有機物（DOC）分画を調べるのは、重要である。この研究では DOC の 15% が除去された。生物由来の高分子除去は 65％と高く、一方、低分子の除去は悪かった。除去の仕組みの大部分は、生物分解であった。ろ過塔での酸素消費と DOC 除去とは相関し、DOC は酸化分解し二酸化炭素（CO2）になる。細菌数はろ過塔のろ過材が深くなると減少した。ろ過材粒子に付着した生物現存量は、間隙水中に懸濁している生物量より多かった。 バッチでの吸着実験では、ろ材粒子へ有機物が付着することを証明できなかった。

(B3-4)

Bio- and membrane filtrations as two options for tertiary wastewater treatment

Vitaly Gitisa, Hila Shitrita, Amichai Feldera, Razi Epszteina, Ronen Naima, Martin Heijnenb, Nadine Siebdrathc, Wolfgang Uhlc

aBen Gurion University of the Negev, Israel; bInge GmbH, Germany; cTU-Dresden

The quality of tertiary effluents treated by biofiltration was better than the quality after MF and similar to the quality of UF membrane treatments. More than 70% removal of turbidity, phosphate and humics (the latter defined by LC-OCD), more than 90% retention of biopolymers (proteins and polysaccharides), 30 to 45% retentions of dissolved organic carbon (DOC) at 48 and 128 min EBCT respectively are the average values obtained during long runs. Biofiltration is a valuable option for a stand-alone tertiary treatment. It is an effective yet economically affordable, simple, robust, chemical free advanced treatment option. A combination of FeCl3 and UF provides a better feed for the RO quaternary treatment.

下水処理での生物および膜処理

Vitaly Gitisa, Hila Shitrita, Amichai Feldera, Razi Epszteina, Ronen Naima, Martin Heijnenb, Nadine Siebdrathc, Wolfgang Uhlc

aBen Gurion University of the Negev, Israel; bInge GmbH, Germany; cTU-Dresden

生物ろ過による三次処理水の水質は、MF 膜や UF 膜の処理水より良かった。長期間の実験で、濁度、リン酸、腐植（液クロで測定）は 70%以上除去され、生体高分子（蛋白質および多糖類）の 90%は、溶存炭素の 30～45%は 48 分と 128 分のろ過で保持されていた。生物ろ過は、3 次処理として特別のものです。それは、経済的に手頃な価格、簡単で堅牢な薬品処理でない処理としてまだ十分とは言えない。 FeCl3 と UF 膜との組み合わせは４次処理としての RO 膜より良いだろう。

(A4-1)

Switching on pesticide degraders in biological filters used in drinking water production

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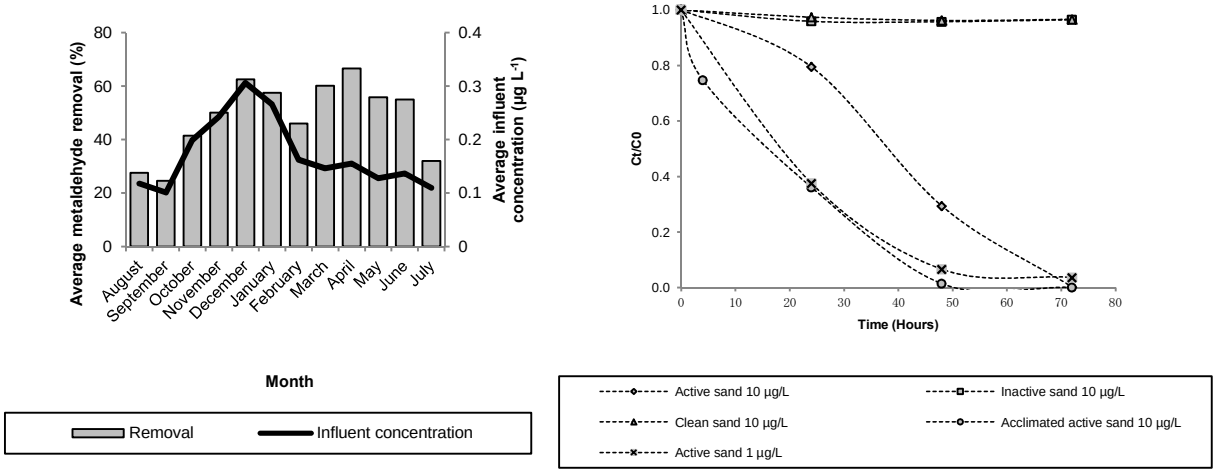
This study investigated the use of biological processes for the removal of the pesticide metaldehyde from drinking water. Analysis of data from a full scale site, alongside lab scale batch and column experiments identified some of the conditions required to obtain biological removal of metaldehyde. Metaldehyde removal appeared to be most effective in slow sand filters following a period of exposure to high concentrations of the pesticide (above 0.2 μgL-1). This was demonstrated in laboratory batch experiments where metaldehyde removal was accelerated following a period of dosing at higher concentrations than expected levels (0.5 μgL-1). Similarly, in column experiments significant metaldehyde removal was achieved only when the bioreactors were dosed with high metaldehyde levels, after which removal could be sustained for several days.



生物ろ過による水道水製造過程での殺虫剤分解能の促進

C. A. Rolph, B. Jefferson, R. Villa

Cranfield University, Bedfordshire, MK43 0AL, UK

飲料水から殺虫剤メタアルデヒド除去ために生物処理の利用について研究した。メタアルデヒドの生分解による除去について実際の規模、実験室でのバッチ実験、カラム実験の結果から条件を探った。メタアルデヒド除去は、高濃度の殺虫剤濃度(0.2 μgL-1 以上)で緩速ろ過が最も効率が良かった。室内のバッチ実験でメタアルデヒド除去は高濃度の負荷(0.5 μgL-1)でも促進した。カラム実験でも高濃度のメタアルデヒドが投薬された時のみ大量除去が成功した。その後、その除去能は数日間継続した。

(A4-2)

Bioaugmentation reduces negative effect of estrogens on coliform removal in slow sand filters

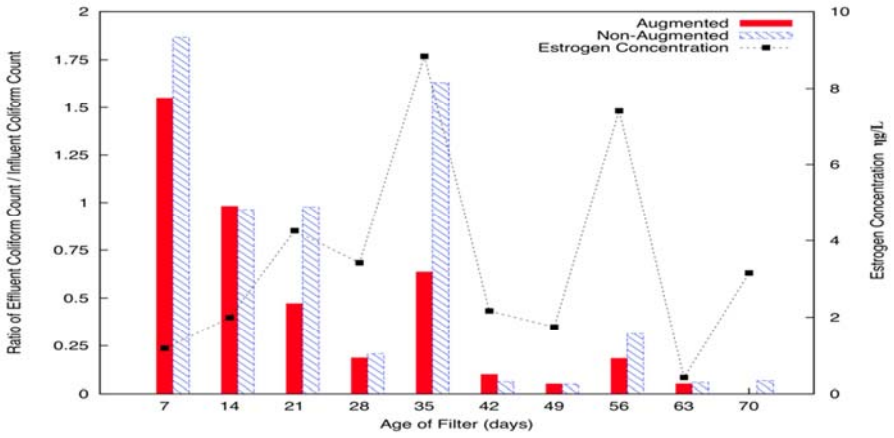
S. J. Haig, C. Quince*, G. Collins**, R. L. Davies*** and C. Gauchotte-Lindsay**

**School of Engineering, University of Glasgow, UK*

***School of Natural Sciences, National University of Ireland, Galway, Ireland*

****Institute of Infection, Immunity and Inflammation, University of Glasgow, UK*

Both the effect of natural estrogens (estone, estradiol and estriol), and the ability to improve estrogen removal using bioaugmentation with three estrogen-metabolizing bacteria, was examined in slow sand filters (SSFs). Concentrations of the natural estrogens determined by gas chromatography coupled with mass spectrometry (GC-MS) revealed that augmented filters removed significantly more estone and estradiol than non-augmented filters. Additionally, a positive correlation was found between coliform retention and estrogen concentration in non-augmented filters. This was explained by the toxic inhibition of protozoa, suggesting the functional implications (impaired coliform removal) that high estrogen concentrations might have in SSFs. Consequently, we suggest that high estrogen concentrations could impact significantly on water quality production, and in particular on pathogen removal. Monitoring and adapting the microbial community in SSFs will become an important element of water production and quality assurance in the future.



緩速ろ過の大腸菌除去においてエストロゲンのマイナス効果の削減

S. J. Haig, C. Quince*, G. Collins**, R. L. Davies*** and C. Gauchotte-Lindsay**

**School of Engineering, University of Glasgow, UK*

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緩速ろ過でエストロゲン分解細菌を添加し天然エストロゲン（エストロゲン、エストラジオール、エストリオール）の除去能を試験した。除去能は、分解細菌を添加した方が良いことをガスクロと質分析法(GC-MS）により確かめた。さらに大腸菌の捕捉も良かった。また、原生動物に対し毒作用を暗示していた。高濃度エストロゲンは水質向上、特に病原菌除去に大きく貢献すると言える。緩速ろ過内の微生物群集をモニターすることは、将来の浄化能力や水質向上に重要である。

(A4-3)

Development of Ecological Purification Unit for Producing Drinking Water from Organically Polluted Raw Water (BOD~30mg/L)

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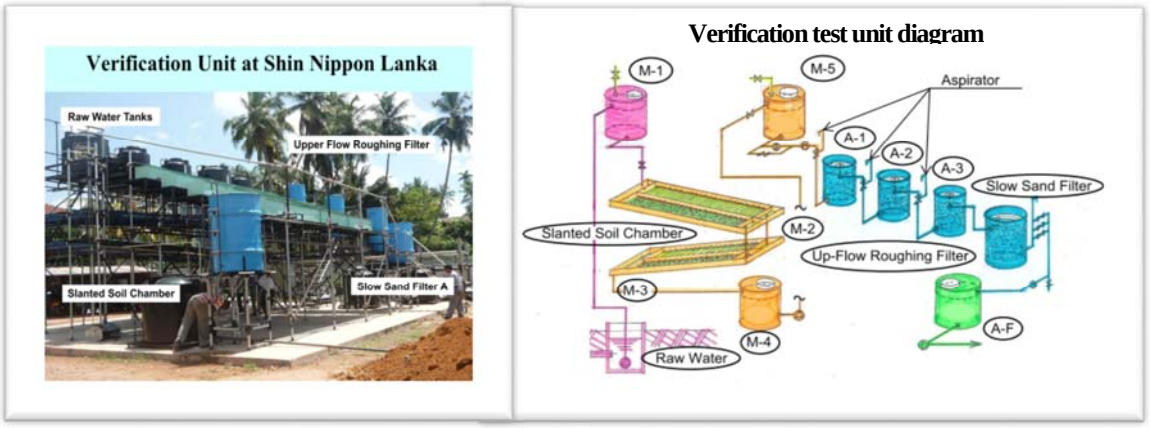
In inhabited islands of Maldives, the groundwater pollution is very serious due to underground seepage of domestic waste water. Pollution level (BOD) exceeds 30mg/L occasionally. Inhabitants drink rainwater collected on roofs, and use groundwater for daily purpose. But highly populated islands are water-hungry in dry-season. Groundwater consumption exceeds the rainfall and seawater invades and pollutes groundwater. Hence we propose to recycle living drainage with the water quality control system. The system circulates groundwater charged by rainwater and collects drainage through the perforated PVC pipes. This PVC pipe network will be installed underground beneath the roads and will store water. Collected raw water will be purified into drinking water by the Ecological Purification Unit (EPU) and supplied to each house. We have tested EPU at Shin Nippon Lanka in Sri Lanka, and proved the effectiveness for organically polluted water.



有機汚染水(BOD-30)を飲料水に浄化する生物浄化ユニットの開発

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新日本空調（株）

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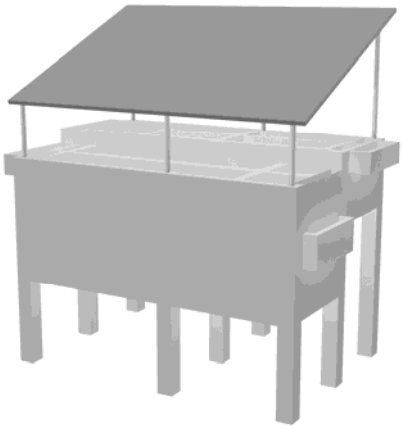
モルディブ共和国の離島では生活排水による地下水汚染がBOD 30mg/Lを超え、島民の生活は深刻である。島民は屋根に降った雨水を飲料水して、地下水を生活用水にしているが乾季になると飲料水不足に加え、地下水の消費量が降雨量を超え、海水が地下水に浸入している島もある。これに対して、我々は地中にPVCの穴明きパイプネットワークを敷設して、生物浄化ユニットによる生活排水のリサイクルシステムを考案した。その為に生物浄化ユニットを開発して地下水（BOD 30mg/L）を飲料水に浄化する実証試験をスリランカの新日本ランカ社で行い、その性能を検証した。

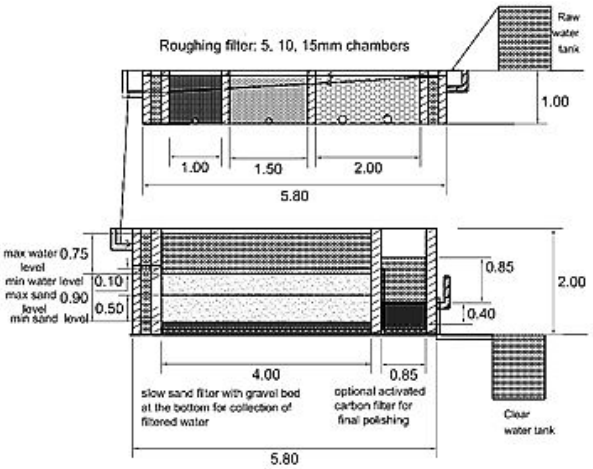
(A4-4)

Process Optimization of Solar Energy Based Slow Sand Filtration

Ronjon Chakrabarti, Martin Jekel*, Pankaj Kumar Roy**, Manisha Banik**, Gourab Banerjee**, Somnath Pal**, Asis Mazumdar**,*
**Department of Water Quality Control, Technical University Berlin, 10623 Berlin, Germany*
***School of Water Resource Engineering, Jadavpur University, Kolkata 700032, India*

The biological performance of the Slow Sand Filtration (SSF) process is influenced by aerobic conditions in the filter media. The dissolved oxygen levels of the raw water as well as continuous filtration rates are necessary for achieving constant aerobic conditions. Solar Energy Based Slow Sand Filtration have the disadvantage to provide their energy output for a limited daily time period which in addition changes accordingly with varying climatic conditions and yearly seasons. In order to run a SEBSSF, various process modifications and additional plant equipment need to be setup. The presented paper deals with the constructional design of the plant components and the optimization of the SEBSSF at a pilot site in the rural area of West Bengal, India.





太陽エネルギーが基本の緩速ろ過施設の改善

Ronjon Chakrabarti, Martin Jekel*, Pankaj Kumar Roy**, Manisha Banik**, Gourab Banerjee**, Somnath Pal**, Asis Mazumdar**,*
**Department of Water Quality Control, Technical University Berlin, 10623 Berlin, Germany*
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緩速ろ過処理の生物学的機能は、ろ材内の好気状態（溶存酸素濃度）によって影響を受ける。原水の好気的状態を維持するため、常にろ過を続けることが溶存酸素濃度を保つために必須である。太陽エネルギーが基本の緩速ろ過だが、1 日の日照の変化、気象による影響、季節による影響などの不利な状態がある。浄化機能向上のために、装置や施設の改良・改善などが必要費になる。本文は、インド、ベンガル西部での施設の構成などの改善・工夫について述べる。

(B4-1)

Performance of Ecological Purification System in Samoa

James Tamasese, Eiko Fuimaono**, Siatua Lautua****

**Engineer Lucky Construction, Samoa Former Urban Operation & Maintenance Engineer, Samoa Water Authority, **Urban Operations and Maintenance Water Engineer, Samoa Water Authority, ***Asset Management Specialist, Samoa Water Authority*

Slow Sand Filtration was introduced to Samoa in the late 1980's when the principles of Ecological Purification System (EPS) were yet to be completely understood. The physical design and operational procedures that came with the EPS Water Treatment Plants have been the primary causes of the many issues and failures on water supply services often experienced. In the recent years however, EPS has again been positively accepted owing largely to the strong EPS capacity building relationship between Samoa and Miyakojima, Japan. In saying that however, the transition to the new and improved EPS technology has been somewhat slow, as decision makers and funding restrict the necessary modifications to improve their performance. This paper discusses the issues, challenges and future direction for EPS in Samoa. It also looks at how the modifications to one specific plant, Malololelei system are changing attitudes and what more needs to be done to bring the Samoa Water Authority systems into the 21st century.

Overhauling in Malololelei WTP

Scraping at the Alaoa WTP

サモアの生物浄化法(EPS: Ecological Purification System)への理解

James Tamasese, Eiko Fuimaono**, Siatua Lautua****

**Engineer Lucky Construction, Samoa Former Urban Operation & Maintenance Engineer, Samoa Water Authority, **Urban Operations and Maintenance Water Engineer, Samoa Water Authority, ***Asset Management Specialist, Samoa Water Authority*

サモアでは、1980 年代後半に、緩速ろ過が生物浄化法 (EPS) の原理と理解される前に導入しました。浄水場の多くの問題は、設計や維持管理方法で、生物浄化法の仕組みの経験不足が原因でした。近年、宮古島と共同作業により、EPS は、再評価され、積極的に受け入れだした。新しく導入に当たり、遅いと言われ、少し、改良した。本論文では、今後のサモアでの EPS の方向性につい説明します。高度の影響がある Malololelei 浄水場での問題など、21 世紀のサモア水道公社で何が必要かについて解説します。

(B4-2)

Surface water treatment plant using ecological purification system in Bangladesh

Md. Mizanur Rahmana and Md. Joynul Abedin Zamanb
aPrinciple, Technical Training Centre, Nishindara, Bogra, Bangladesh
bWater Supply Engineer, Asia Arsenic Network, Jessore, Bangladesh

The ecological purification plants for a rural community were constructed in Bangladesh. The surface water treatment plant consists of a sedimentation chamber, upflow gravel filters and slow sand filter. The plant is operated by villager. How to solve the problems to keep suitable maintenance in rural area is described. This is a model example plant for rural water supply in Bangladesh.

バングラデッシュにおける生物浄化法での表流水の浄化

Md. Mizanur Rahmana and Md. Joynul Abedin Zamanb
aPrinciple, Technical Training Centre, Nishindara, Bogra, Bangladesh
bWater Supply Engineer, Asia Arsenic Network, Jessore, Bangladesh

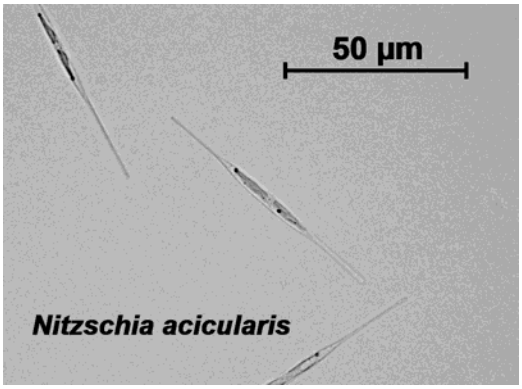
バングラデッシュで地方給水のための生物浄化法施設を建設した。表流水処理施設は、沈殿槽、上向き粗ろ過槽、緩速砂ろ過槽で構成しています。施設は、村人で維持管理しています。地方での適正な維持管理方法をどのように解決したかを解説します。この施設は、バングラデッシュでの地域給水のモデルです。

(B4-3)

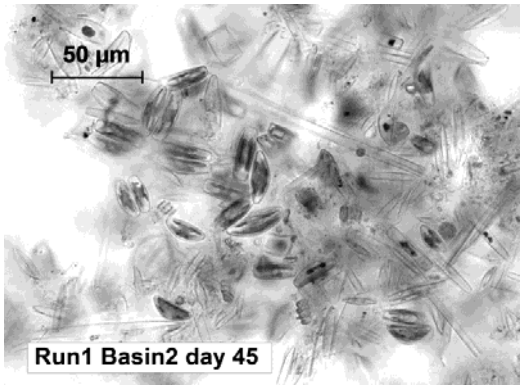
A study to further reduce the turbidity level of slow sand filtered water in Tanigahara water purification plant,Japan

Izumi TATENNO, Masaki SEKIYAMA, Nobuhiko KOBAYASHI and Suzue ARII
Tanigahara water purification plant ,Kanagawa Prefectural Public Enterprises Agency
2-6-1 Tanigahara, Midori-ku,Sagamihara 252-0113, Japan

In Tanigahara water purification plant (TWPP), the source of the water used in slow sand filtration (SSF) is from two artificial lakes (Sagami Lake, Tsukui Lake) and river-bed water. Some algae in water from artificial lakes sometimes results in an increase in the turbidity in the filtered water in SSF. To reduce the cause of filtered water turbidity we studied SSF full scale plant while using only river-bed water. Two runs were conducted; in May and in December of 2012. In both runs, the results varied from basin to basin. The best basin condition during the study was when *Cymbella* spp. predominated in the schmutzdecke. We could then raise the filtration rate while keeping the filtered water turbidity under our target of 0.05 degrees.



The algae causing filtered water turbidity in SSF



Cymbella spp. predominated in the schmutzdecke

谷ケ原浄水場の緩速ろ過方式におけるろ過水濁度低減化の検討

舘野泉・関山真樹・小林信彦・有井鈴江
神奈川県企業庁谷ケ原浄水場
252-0113 神奈川県相模原市緑区谷ヶ原2-6-1

谷ケ原浄水場の緩速ろ過方式では、ダム湖水(相模湖・津久井湖)と伏流水を水源としている。ダム湖水由来の藻類によっては、緩速ろ過方式においてろ過水濁度上昇の原因となることがある。このため、緩速ろ過方式の実施設において、ろ過水濁度の原因の低減化を目的に、伏流水のみでの運用を試みた。2012年5月と12月に2クール実施した。両クールで池毎に異なる結果となった。実験期間中に最も状況が良好だったろ過池は、生物被膜中に *Cymbella* spp. が優占していた。その時は、ろ過水濁度を管理目標の0.05度以下に維持しながら、ろ過速度を上昇させることが可能であった。

(B4-4)

Effect of sudden changes of slow sand filtration rate on number of bacteria and particles in effluent

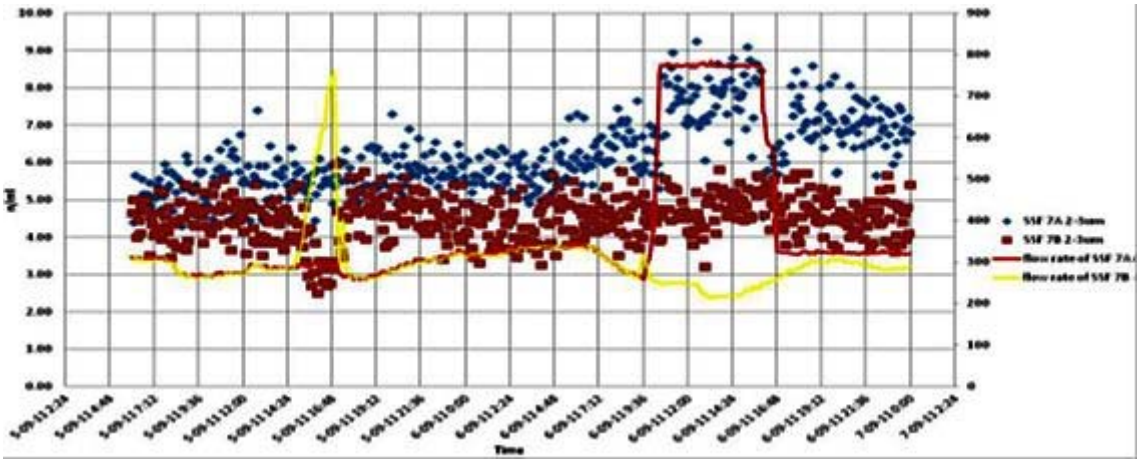
Willem A. Oorthuizen, Aleksandra Magic-Knezev**, Fei Cui****

**Dune water company Dunea, Zoetermeer, The Netherlands*

***Het Waterlaboratorium, Haarlem, The Netherlands*

****Delft University of Technology, Delft, The Netherlands*

The objective of this study is to measure the effects of different acceleration rates of SSF filtration velocity on total cell concentrations (TCC), adenosine triphosphate (ATP) Heterotrophic plate counts (HPC) and physical quality (turbidity and particle count) of SSF effluent. The acceleration rate of 0.12 m/h2 had no influence on turbidity, ATP concentration, plate count or particle count while the acceleration rate of 0.20 m/h2 caused a slight increase of the TCC. The acceleration rate of 0.70 m/h2 had an obvious negative influence on TCC and particle count, but not on ATP or heterotrophic plate count.



緩速ろ過水中の細菌数と濁りへの緩速ろ過速度の急激な変化の影響

Willem A. Oorthuizen, Aleksandra Magic-Knezev**, Fei Cui****

**Dune water company Dunea, Zoetermeer, The Netherlands*

***Het Waterlaboratorium, Haarlem, The Netherlands*

****Delft University of Technology, Delft, The Netherlands*

緩速ろ過の急激なろ過速度が、ろ過水中の全菌数、ATP、従属栄養細菌数、濁度、粒子数への影響測定を目的とした。時間当たり 0.12m/h の変化では、濁度、ATP、細菌数、粒子数への影響は無かったが、時間当たり 0.20m/h の変化では、全菌数で影響が少しあった。時間当たり 0.70m/h の変化では、全菌数と粒子数では明確に影響されたが、ATP や従属栄養細菌では影響されなかった。

(A5-1)

Reduction of water hardness with a compact slow sand filtration system

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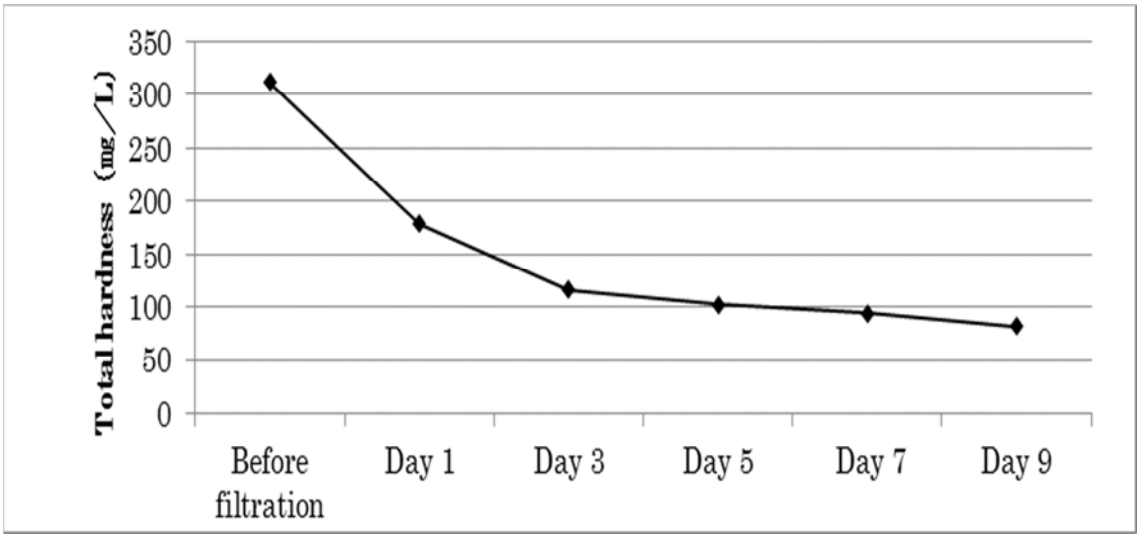
**Tokyo Kasei University, Japan*

***Oyalox Clean Servis Co., Ltd, Japan*

We examined the effectiveness of slow sand-filtration for reducing water hardness. We devised a small, pilot-scale, slow sand filtration system. First, we circulated the water samples through the three gravel filters only, and then measured the hardness of the water. The results showed that water hardness was markedly reduced by filtration through the gravel filters only. The amount of reduction in water hardness was found to correspond to the temporary hardness component of the water samples.



小型緩速ろ過装置による水の硬度の低減化

宮平理恵、矢嶋謙二、中川順一、小関正道

東京家政大学、日本

オーヤラックスクリーンサービス株式会社、日本

緩速ろ過により硬度を低減化する方法を検討した。実験は小型の緩速ろ過装置を作成しておこなった。このろ過装置の粗ろ過層部分のみに試料水を循環させてろ過し、ろ過後の試料水を採取して測定した。その結果硬度は低下し、低減した硬度の量は試料水の一時硬度と一致した。このように緩速ろ過では粗ろ過のみで、一時硬度が低減化できることが分かった。

(A5-2)

On the function of upflow roughing filter for slow sand filter – pilot experiment in Niigata, Japan

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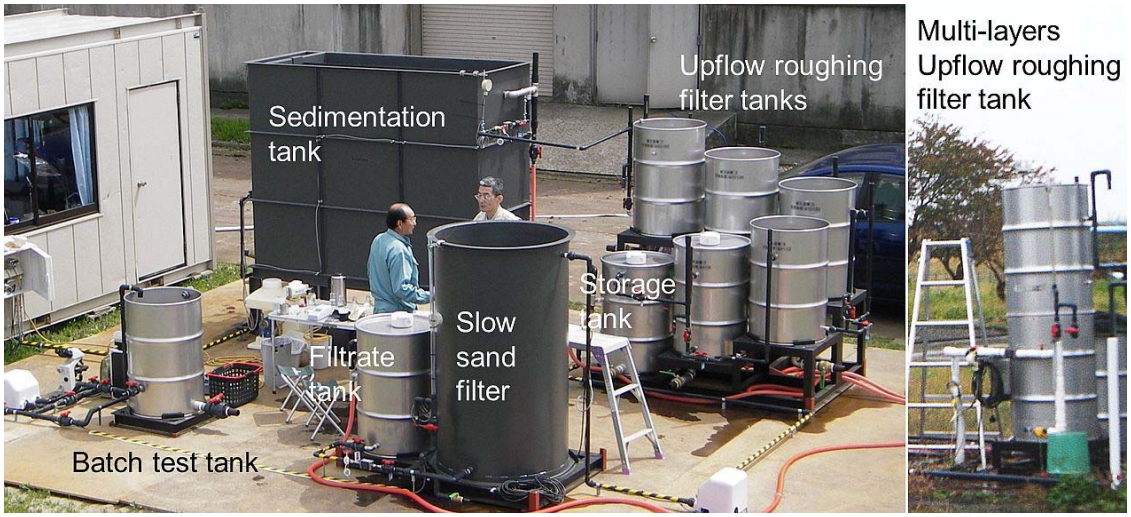
Pilot plant experiment of upflow roughing filters was done to reduce the load of suspended matter in surface water of rivers. Upflow roughing filter was effective to reduce the load. Function of roughing filter was mechanical trap system and biological function. It was estimated that about one month was necessary to develop the ecosystem. The system function and the maintenance technique were discussed.



緩速ろ過のための上向き粗ろ過パイロット試験

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ＮＰＯ地域水道支援センター
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河川表流水を取水し、濁りの負荷を低減するための上向き粗ろ過実験を行った。上向き粗ろ過は、負荷低減に効果的であった。その機能は、機械的な作用と、生物学的な作用があった。粗ろ過槽での生態系が十分に発達するまでには、1カ月が必要だった。上向き粗ろ過の機能と維持方法について解説した。

(A5-3)

Biofilm development in upflow gravel filters in layers with a fabric cover

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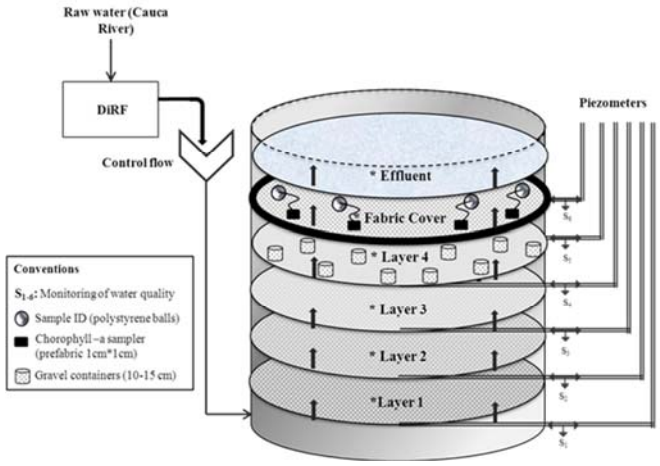
**Universidad del Valle, Facultad de Ingeniería, Instituto Cinara, Cali, Colombia*

*** JTF-Rotterdam BV, Rotterdam, The Netherlands*

****Delft University of Technology, P.O. Box 5084, 2600 GA Delft, The Netherlands*

Upflow gravel filters covered with filter fabrics were studied looking at chlorophyll-a and biofilm development. The main biological activity related to chlorophyll-a occurred in the filter fabrics and the top 15 cm of the gravel bed. The daily increase in the thickness of the biofilm on filter fabrics ranged between 0.0182 and 0.031 mmd-1; reaching a maximum thickness between 1.2 -1.35 mm. Biofilm thickness simulated by AQUASIM against chlorophyll-a indicate that a higher concentration of chlorophyll-a coincides with a greater thickness of the biofilm. Chlorophyll-a concentration stabilized at 3.8 gm-3 in the first and 4.2 gm-3 in the second run. A direct relationship was found between head loss in the filter fabric and the biofilm thickness. The study suggests that removal efficiency of TSS and turbidity for a layer of fabric cover of 0.56 cm may be equivalent to a gravel layer of 0.20 m with a gravel size of 3.2 mm at the top of the filter bed.



布で覆った上向き粗ろ過での生物膜の発達

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布で覆った上向き粗ろ過でのクロロフィル a と生物膜の発達を調べた。上の 15cm 層で、クロロフィル a に関係する生物活性が高かった。生物膜の発達は、1 日当たり 0.0182 および 0.031 mm の増加があり、最大膜厚は、1.2-1.35 mm であった。 バイオ膜の発達は、クロロフィル a の濃度と関係があり、AQUASIM により最大厚さ 3.8 gm-3 および 4.2 gm-3 になる推定された。損失と生物膜の関係があった。TSS の除去効率は布の厚さ 0.56 cm の場合、砂利径 3.2 mm、砂礫層 0.20 mと同等の効果が示唆された。

(A5-4)

Slow sand and slow biochar filtration of raw wastewater

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**Institute of Urban Water Management and Environmental Engineering, Ruhr- Universität Bochum, Bochum, Germany*
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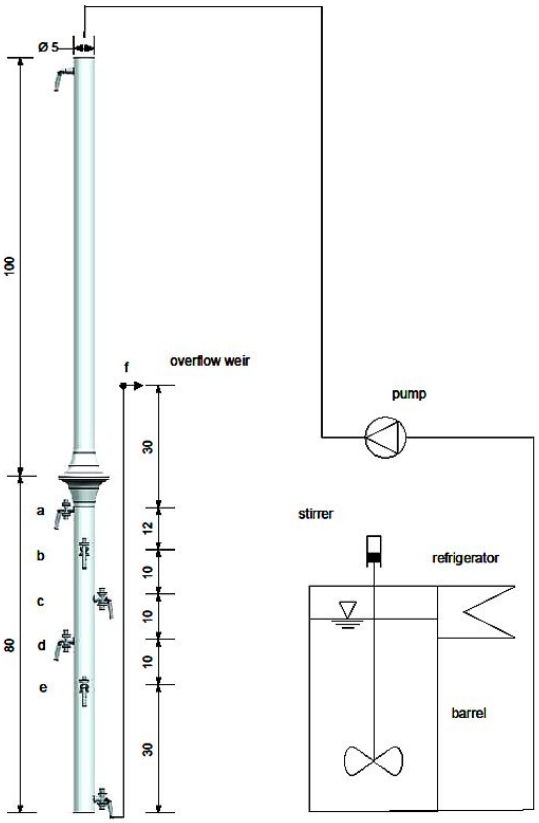
Slow sand filtration (SSF) is a well known water treatment. However less research is done in using raw wastewater with a very high total suspended solids (TSS) concentration for SSF. In this study, biochar (Feedstock: Miscanthus, d10 = 0.86 mm) was used as an alternative to sand (d10 = 0.58 mm) as filter media. Over a period of 70 days, each filter was fed with effluent from the grit chamber of a municipal wastewater treatment plant at a hydraulic loading rate (HLR) of 0.05 m/h. Removal rates for E. coli were in the range of 1 to 2 log10 units with slightly higher and more constant rates for biochar. Sampling at different filter depths indicated additional back hold of E. coli (around 0.5 log10 units) in deeper zones for biochar. Overall main removal took place within the schmutzdecke. Biochar achieved also better removal rates, especially at the beginning of the experiment, for main chemical parameters. Increase of supernatant water and therefore filter resistance was similar for all filters. The large grain sizes led to a formation of the schmutzdecke in deeper zones of the filter bed. Adsorption of faecal indicator bacteria and biofilm growth took place over the entire filter bed. This research confirms the suitability of biochar as alternative filter material in SSF of raw wastewater.



生下水の緩速ろ過と活性炭ろ過

K. Kätzl, M. Lübken*, K. Alfes*, S. Werner**, M. Marschner**, M. Wichern**
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緩速濾過は水処理技術として広く知られている。しかし懸濁物質が高濃度の生下水を緩速ろ過で処理する研究はほとんどない。この研究ではろ過砂（d10 = 0.58 ㎜）の代わりに活性炭（材質：ススキ d10 = 0.86 ㎜）を用いた。70 日に渡り、都市下水処理場の粗礫槽からの流出水をろ過速度 0.05m/h の負荷で流した。大腸菌除去は、活性炭ろ過では比較的高くまた安定し、1 桁から 2 桁（1～2log：10 分の 1 ～100 分の 1）の除去率であった。ろ過塔の異なる深さで採水したところ、深い場所でも、大腸菌は深い場所でも捕捉（約 0.5log）されていた。総体的除去は上部の生物活性汚砂（Schmutzdecke）内で行われていた。活性炭は、主要な化学成分に関し実験の初期に特に除去率が良かった。上澄水が増加し、全てのろ過カラムで、同じ様なろ過抵抗になった。大きな粒子だとろ過カラムの深くまで生物活性汚砂が形成された。糞便汚染指標細菌類の吸着や生物膜形成はろ過カラム全体で行われていた。この研究は、生下水処理で緩速ろ過用の砂ろ過材の代わりに、活性炭でも代用できることを確かめた。

(B5-1)

Development of Biological Roughing Filter as an Alternative to Coagulation-Sedimentation Process

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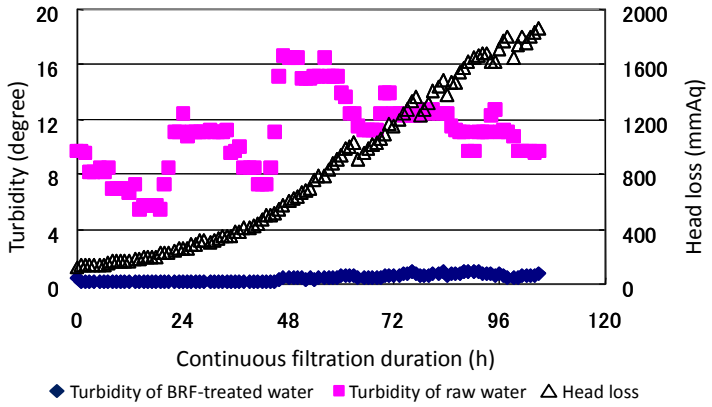
A biological roughing filter (BRF) that can be used as an alternative to the coagulation-sedimentation process was incorporated into a rapid coagulation-sedimentation reactor with slant-pipe to construct a pilot plant, and its performance was experimentally examined. The BRF realizes both biological treatment and solid-liquid separation, and the rapid coagulation-sedimentation reactor operates only when the turbidity of the raw water is 50 degrees or higher. Experimental results showed that the mean turbidity of the BRF-treated water was 0.6 degrees when the injection dose of aluminum sulfate was 15 mg/L, which was less than half that in the case of the coagulation-sedimentation process. Larger amounts of manganese and ammonium nitrogen, indices of the biological effect, were removed by the BRF than by the coagulation-sedimentation process, demonstrating that the developed process can be used as an alternative to the coagulation-sedimentation process.



凝集沈澱代替プロセスとしての生物高速ろ過の開発

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凝集沈澱代替プロセスとして、生物処理機能と固液分離機能を併せ持つ生物高速ろ過(BRF:Biological Roughing Filter)に、原水濁度が 50 度以上に稼働する傾斜管式高速凝集沈澱装置を組み合わせたパイロットプラント実験を行った。その結果、凝集沈澱プロセスの半分以下である 15mg/L の硫酸バンド注入率で BRF 処理水の平均濁度 0.6 度を得ることができた。生物効果の指標となるマンガン及びアンモニア態窒素の処理性も凝集沈澱プロセスを上回ったことから、本プロセスが、凝集沈澱代替プロセスとして適用が可能であることが示された。

(B5-2)

Up-flow Biological Contact Filter for Advanced Water Treatment System

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Water pollution from household wastewater and eutrophication due to a system failure may cause an increase in the concentration of ammonia nitrogen or surfactant, the generation of offensive odors and tastes including earthy musty odors, and an increase in the level of dissolved manganese, consequently leading to some purification troubles. Of the many types of water treatment, the up-flow biological contact filtration using granular activated carbon as filter media is the most effective towards removing these dissolved solids.

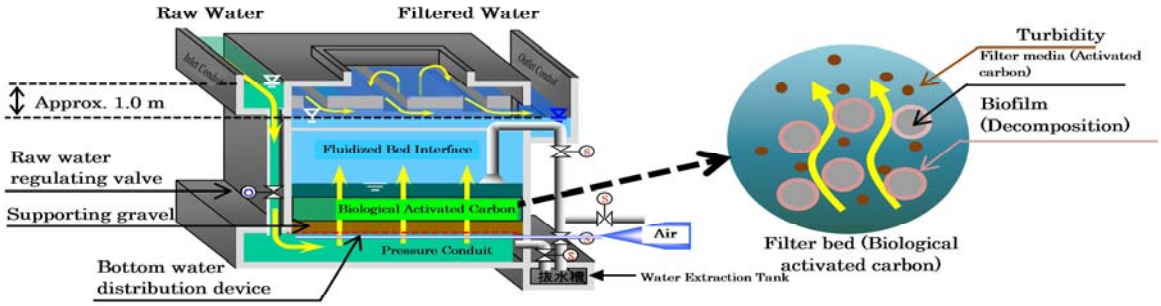

Fig. 1 U-BCF system

生物利用型高度浄水処理システム　『上向流式生物接触ろ過設備（U-BCF）』

倉橋教仁・佐藤良太・熊野晋・藤本瑞生・石丸豊
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生活排水による水質汚濁や故障における富栄養化などにより、アンモニア態窒素や界面活性剤の上昇、カビ臭などの異臭味の発生や溶存マンガン濃度の上昇といった浄水障害が起こる場合がある。これらの溶存物質を除去するには種々の方法があるが、粒状活性炭をろ材とする上向流式生物接触ろ過法が有効である。

(B5-3)

Living-Filter: an in-reservoir biofiltration system for phytoplankton reduction at the abstraction point

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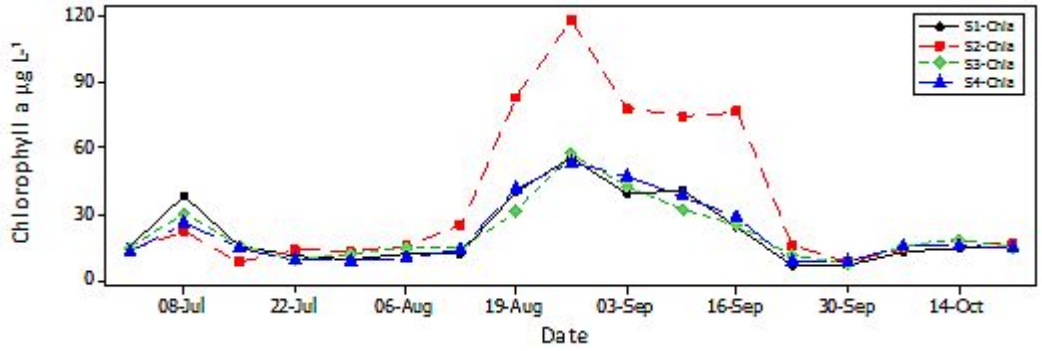
***Thames Water Innovation, Thames Water Utilities Ltd., Reading, UK ***Department for Continuing Education, University of Oxford, Wellington Square, Oxford, OX1 2JA, UK*

The Living-Filter (L-F), a hydroponic bed of floating-reeds, was designed by Thames Water and AquaticEngineering and installed in Farmoor II reservoir, Oxfordshire, in July 2012. The structure (1m H x 21m W x 10m L) supports plants of Phragmites australis, Phalaris arundinacea and Carex acutiformis, with a combined system of curtains and baffles. The aim is to reduce phytoplankton loading onto the water treatment works at the abstraction point, consequently reducing chemical dosage and minimizing costs. Weekly surveys were carried out from July – October 2013 to assess the physical, chemical and biological changes likely to be introduced by the L-F. Physicochemical and biological variables were measured at 16 sampling sites. Results show differences between sites in the L-F with a significant accumulation in chlorophyll a (Chla) (as a surrogate of phytoplankton biomass) levels in the L-F platform, although significant Chla reduction has yet to be seen at the abstraction point.



水耕栽培床（リビングフィルター）：貯水池内の取水点での植物プランクトン除去生物ろ過システム

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**Department of Engineering Science, University of Oxford, Parks Road, Oxford, OX1 3PJ, UK*

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浮かせたアシによる水耕栽培床（リビングフィルター）はテムズ水道会社とアクアティックエンジニアリング社により開発され、オクスフォード州のファームアⅡ貯水池に 2012 年 7 月に設置された。その構造は高さ 1m、幅 21m、長さ 10m で隔壁としきりがあり、アシ、クサヨシ、スゲが植栽されている。その目的は水処理での植物プランクトン負荷の削減と、薬品注入量と経費削減である。2013 年 7 月から 10 月の間、毎週、水耕栽培床の導入による物理的、化学的、生物学的変化を調査した。調査地点は 16 ヶ所で、物理化学的、また生物学的な項目を計測した。水耕栽培床内の場所により、クロロフィル（植物プランクトンの指標）量の蓄積に違いがあったが、取水点での水には、クロロフィル濃度の顕著な減少は確認されなかった。

(B5-4)

Effect of micropollutants on microbial activity determined by flow cytometry and ATP during managed aquifer recharge: Column study

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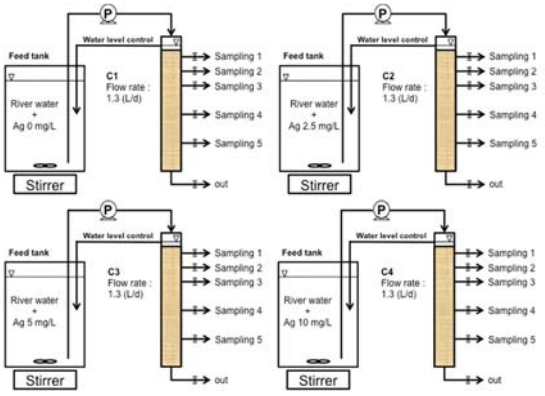
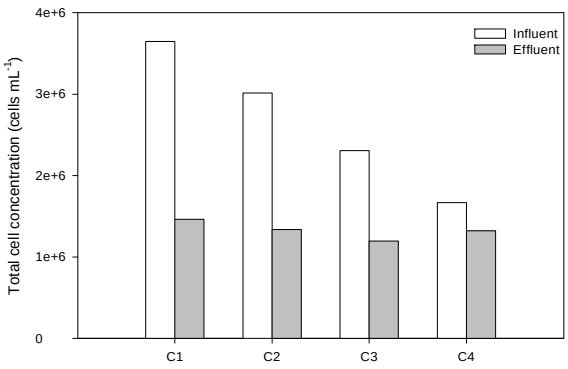
a Sejong University, Seoul, Republic of Korea, b The University of Sydney, Sydney, Australia, c K-water Institute, Daejeon, Republic of Korea, d Korea Institute of Science and Technology, Seoul, Republic of Korea

There is a need for a systematic study estimating the extent of microbial viability and activity affected by silver nanoparticles (AgNPs) that has been increasingly used in a wide variety of industries. Soil column experiments were conducted to investigate the impact of AgNPs dispersed in aqueous phase on the microbial activity affecting the performance of managed aquifer recharge treatment processes. This study addresses that necessity and assesses microbial toxicity of AgNPs that can result in deteriorated performance of managed aquifer recharge treatment processes.





管理型地下水人工涵養中における、流動細胞計測による微生物活動及び ATP に対するミクロ汚濁物質の影響

Sung Kyu MAENG a, Hyunchul KIM a, Donghyun LEE a, Soryong CHAE b, Jaewon CHOI c, Il Hwan CHOIc, Kyung Guen SONGd,
a Sejong University, Seoul, Republic of Korea, b The University of Sydney, Sydney, Australia, c K-water Institute, Daejeon, Republic of Korea, d Korea Institute of Science and Technology, Seoul, Republic of Korea

多種多様な産業でますます使用されつつある銀ナノ粒子（AgNPs）の影響を受けた、微生物の生存率及び活動の範囲を推定する組織的研究の必要がある。管理型地下水人工涵養の処理工程に影響を及ぼす微生物活動に対する、水相に分散された AgNPs が与える影響を調査する土柱を用いた実験が行われた。この研究は、管理型地下水人工涵養の処理工程に悪影響を及しうる AgNPs の微生物毒性を評価し、この研究の必要性を示す。

(P1)

The Centenary Slow Sand Filtration in Nagoya City
- The Reconstruction of the Slow Sand Filters -

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Nagoya City Waterworks and Sewerage Bureau
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The waterworks of Nagoya City reaches the centenary in 2014. The slow sand filters in Nabeyaueno Water Purification Plant (WPP) had worked since the waterworks started in 1914. Because those facilities became too old for further use, they have been totally under reconstruction since 2010. The slow sand filtration process requires better quality raw water. Nagoya City Waterworks and Sewerage Bureau is committed to maintaining raw water quality through water resource conservation measures and continuing the slow sand filtration system that makes the best use of the high quality raw water.

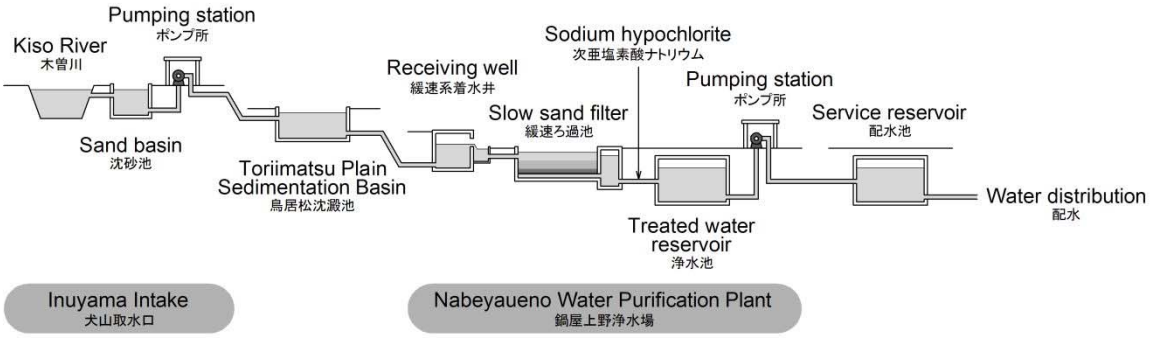

Figure 5　Slow sand filtration system of Nagoya City

百年を迎える名古屋市の緩速ろ過　～緩速ろ過池の更新～

奥山明里
名古屋市上下水道局
名古屋市中区三の丸三丁目１番１号

名古屋の水道は2014 年に給水開始 100 周年を迎える。鍋屋上野浄水場の緩速ろ過池は 1914 年の給水開始以来稼働し続けていたが、施設の老朽化が進み 2010 年より更新工事を行っている。緩速ろ過法は良質な水源がなければ採用できない浄水方式である。名古屋市上下水道局では、水源保全により原水水質を守り、その水源の良さを生かした緩速ろ過法を継続していく。

(P3)

A study of protistan movement speed and filtration rate in slow sand filter as an ecological purification system

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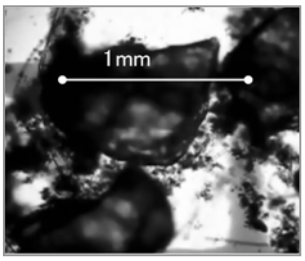
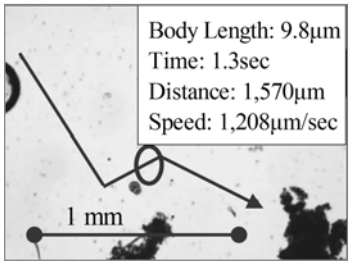
*** Community Water Supply Support Center of Japan*

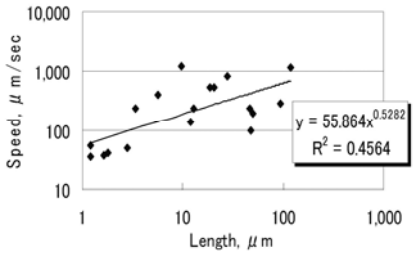
The filter rate of slow sand filter as an ecological purification system should be referred to the protistan movement speed. The fastest movement speed of protist was 1,208 μm/sec. The standard flow rate among the sand grains is 139 μm/sec calculated from the porosity 40 %. The first movement speed of protist was 8.7 times faster than the rate of water flow. The faster filtration rate of slow sand filter may be adopted on the movement speed of protists.



Filter sand



Movement of protist



body length and movement speed of protist

生物浄化法としての緩速ろ過のろ過速度と原生生物の運動速度に関する考察

岩瀬範泰 ・中本信忠***

**株式会社 エヌジェーエス・コンサルタンツ 〒162-0067 東京都新宿区富久町6-8*

***NPO 法人地域水道支援センター*

緩速ろ過は生物浄化法であるため、原生生物の運動速度を考慮する必要がある。原生生物の運動速度で最も早かったのは、繊毛虫の 1,208μm/sec であった。標準ろ過速度 4.8m/day の砂層中の流速は、空隙率を 40%とした場合、139μm/sec となる。すなわち、最も早かった原生生物の運動速度は、砂層中の流速の 8.7 倍ということになる。原生生物の運動速度から見た場合、緩速ろ過のろ過速度はより速くすることができる。

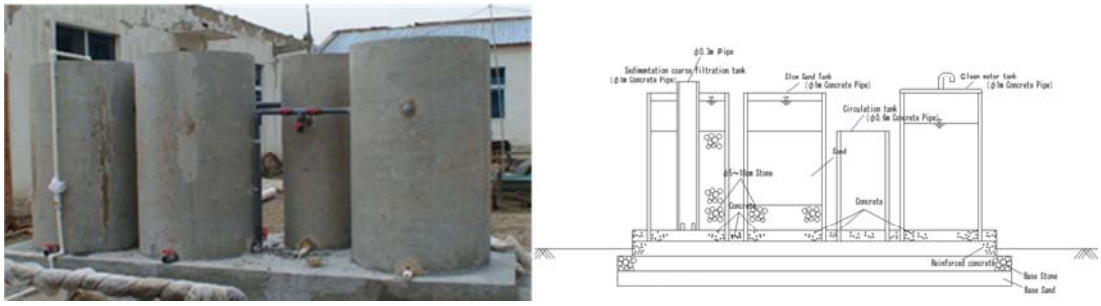
(P5)

Household Bio-Purification Device

Shengzhe Jin

Jiangsu Comfity Power Technology Co.,Ltd， CHINA

In this paper, I will introduce a Household Bio-Purification Device assembled from concrete pipes. This device causes the complete ecosystem cycle by naturally inducing the food chain through algae, small animals, micro-organisms, and photosynthesis.



家庭用生物浄化装置

Shengzhe Jin

Jiangsu Comfity Power Technology Co.,Ltd， CHINA

コンクリートパイプを使った家庭用生物浄化装置の解説です。この装置は、藻類、微小動物、微生物、光合成などの自然の生態系の食物連鎖を使ったものです。

(P7)

Analysis of bacterial community structures in slow sand filtration bed on different sites and soil depth by PCR-DGGE method

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Bacterial community structures in three sites of slow sand filtration bed were analyzed in different soil depth to find the reason of high turbidity problem in site M. Site M had homogeneous community in all layers and many bands in deeper layers, but the others had opposite results. In the sand bed of site M bacterial film seemed not to be grown sufficiently on surface, so high turbidity seems to be occurred frequently.

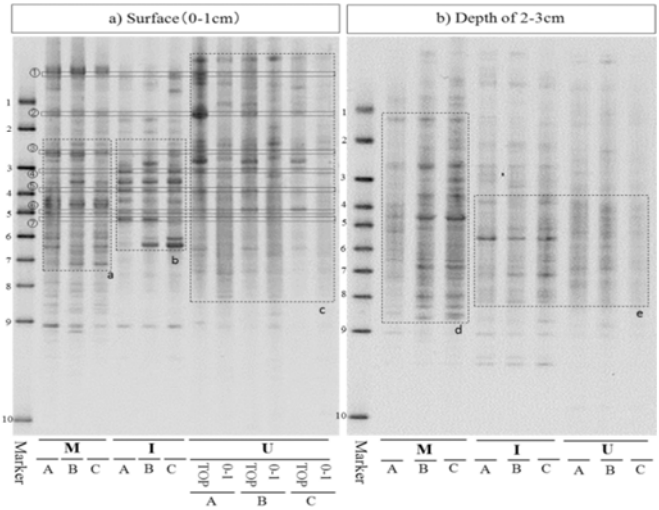

Fig. DGGE band patterns of eubacteria of soil on surface (a) and depth of 2-3cm (b) on site M, I and U. A, B and C mean replications. Surface soil of site M and I were on the depth of 0-1cm, and that of site U were the thin (TOP) and the other sand of 0-1cm. Outlined by dotted line (a)-(e) were the area of dominant marked in each site .①-③, ⑤, ⑥were common band in all sites, ④ and ⑦were that of in site I and U.

PRC-DGGE 法による地域・深度別の緩速ろ過砂の微生物群集構造の解析

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中部大学大学院応用生物科学科・応用生物学部

487-0027 春日井市松本町1200

濁度の上昇問題を有するろ過池を含む３ヶ所のろ過池において、深度別の微生物群集構造の把握を試みた。その結果、濁度上昇の問題を有するろ過池では深度による微生物の群集構造に明確な違いが認められず、問題が発生しないろ過池では深度による群集構造に違いが認められた。このことから、表層における十分な微生物膜の形成がなされていないために濁度上昇が発生する可能性を示した。

(P9)

The Silicon circulation hypothesis based on slow sand filtration/ecological purification system.

Shoichiro Inoue[a,b,c,d], Yoshitomo Mochizuki[a]

[a]Earth-techno CO.LTD,[b]Meiho-techno CO.LTD,[c]S'tem CO. LTD, [d]Hiyoshi CO.LTD,Japan

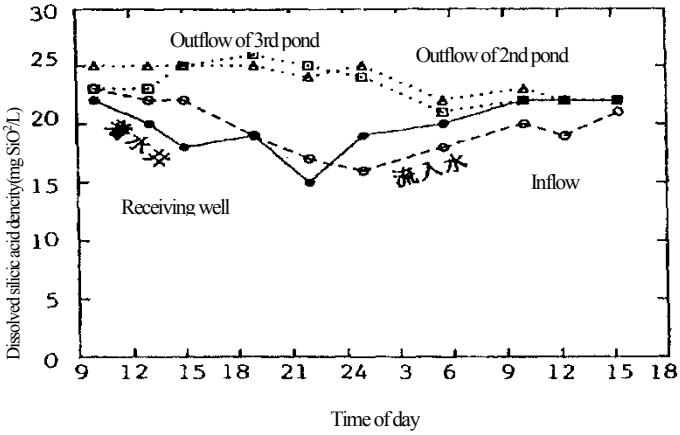
The quantity of silicate elution increases by the function of biofilm of slow sand filtration. I suppose this phenomenon to be "microbe weathering". The silicic acid which is not included in rainwater is recognized in the mountain stream. This is conformal when I think that it is the result of the function of microbe rising in the forest soil.

It is announcement, I argue about three following items and to assume it a problem proposal.

(1) About Si circulation hypothesis caused by the microbe weathering to read from past knowledge.

(2) About the Si concentration change in slow sand filtration facilities.

(3) About significance to increase Si supplies.



Someya water purification plant

Figure (left) The changes of dissolved silicic acid concentration in the second pond (three days after scraping) and the third pond (eleven days after scraping).

緩速生物ろ過／生物浄化法によるケイ素循環仮説

井上　祥一郎a,b,c,d, 望月　佳友a

a（有）アーステクノ,b（株）名邦テクノ,c（株）エステム,d（株）日吉

河川表流水を取水し、濁りの負荷を低減するための上向き粗ろ過実験を行った。上向き粗ろ過は、負荷低減に効果的であった。その機能は、機械的な作用と、生物学的な作用があった。粗ろ過槽での生態系が十分に発達

ケイ素の溶出量は緩速ろ過の生物膜層の働きによって増加する。筆者はこの現象を微生物風化と呼び提唱する。林学分野では、雨水中に含まれないケイ酸は森林の渓流水中に含まれることが認められている。これは森林土壌中での微生物活動の働きの結果であると考えられる。以下に、３つの項目について発表の論点を上げ、問題提起とする。

(1)　過去の知見による微生物風化によるケイ素循環仮説

(2)　緩速ろ過施設におけるケイ素濃度変化

(3)　ケイ素供給を増加させる意義

するまでには、１カ月が必要だった。上向き粗ろ過の機能と維持方法について解説した。

(P11)

The iron and manganese removal process: Its microbial habitats and functions

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Biological iron and manganese removal is a variant of slow sand filters (SSFs), enriching specific microorganisms of environmental origin alongside the same architecture as the ordinary SSFs consisting of sand layers. Since the reactor basically simulate the natural processes, possible dormant air-borne invertebrates may accidentally be contaminated with the water purification system as a result of diapauses to survive under harsh conditions.

除鉄（左）除マンガン（中）リアクターの砂層表面の様子と生息する糸状性細菌（右）

除鉄・除マンガンの生物過程–微生物の生息場所および機能

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***呉工業高等専門学校（現所属、ルネサンス・アカデミー株式会社、大阪市北区）*

生物学的な除鉄・除マンガン処理は緩速ろ過法の変法であり、通常の緩速ろ過池のような砂ろ過層を持ち、特定の環境由来の微生物を集積することで目的を達成する。基本的に自然の浄化過程を模倣しているため時に空気中から休眠状態にある無脊椎動物が混入してくることがある。これは、diapause（発生休止）と総称される微小動物が過酷な環境下でも生存し続けていくための仕組みである。

(P13)

Case studies of slow sand filtration / ecological purification system in small scale water supply

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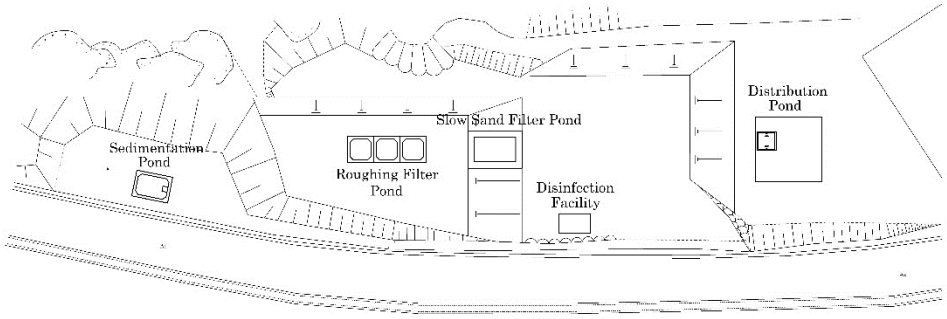
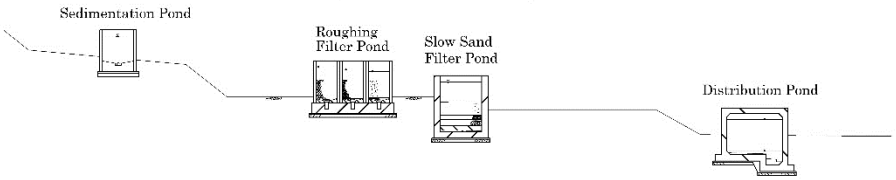
*** Community Water Supply Support Center of Japan, 655-96, Hirano, Kita-ku, Okayama 701-0151, Japan*

We developed five small water treatment plants in rural area, Okayama, Japan. Capacity of water demand in each plant ranged 10 to 20 m^3 / day. Upper limit of a burden per family was 1,200 thousand yen. Filtration rate of upflow roughing filters was set to 12 to 20 m / day. Filtration rate of slow sand filter was set to 4 to 5 m / day. All facilities achieved the quality of drinking water criteria of Japan.

General Layout



Cross-section



小規模水道における緩速ろ過の適用事例

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[1)] 三恭コンサルタント株式会社，701-0131 岡山市北区花尻みどり町 4-122

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岡山県の農村地域に５箇所の小規模水道施設を築造した。地域ごとの給水量は 10～20 ㎥/day である。負担額は 1 世帯で 1,200 千円を上限としている。上向き粗ろ過のろ過速度は 12m/day から 20m/day となるようにした。緩速ろ過のろ過速度は 4.0～5.0m/day となるようにした。全ての施設で日本の水質基準を達成した。

(P15)

Refocus on slow sand filter in Kakuda city and Marumori town after Great East Japan Earthquake

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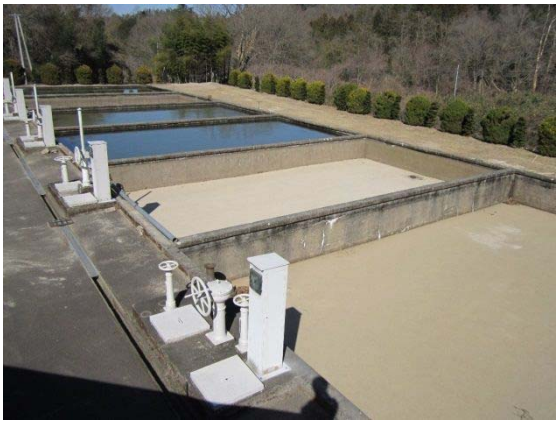
41Daibou Kakuda., Kakuda , Miyagi 981-1505 Japan
Takao, Nakashima, Marumori Town office, Miyagi Prefecture, Japan
120 Toriya Marumori, Igu , Miyagi 981-2192 Japan

Small water supply system had a plan to close in rural area in north east of Japan. After the great east Japan earthquake, small water supply system of slow sand filter plant was refocused as more reliable system in rural area. Slow sand system is reconfirmed that is simple and easy maintenance.

Keywords Slow sand filtration; refocus; earthquake; small system



SLOW SAND FILTE OF ODA WPP

WPD IN MARUMORI TOWN

東日本大震災後の宮城県角田市と丸森町での緩速ろ過への再認識

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中島孝雄　宮城県丸森町建設課　981-2192　宮城県伊具郡丸森町字鳥屋120

日本の東北地方にある小規模水道は、閉鎖される計画があった。しかし、東日本大震災後、緩速ろ過による小規模水道は、農村地域では信頼性が高いと再評価された。緩速ろ過は簡単で、維持管理が楽であると再確認された。

キーワード：緩速ろ過、再認識、地震、小規模

(P17)

Small slow sand filter system for rural area in Bolivia

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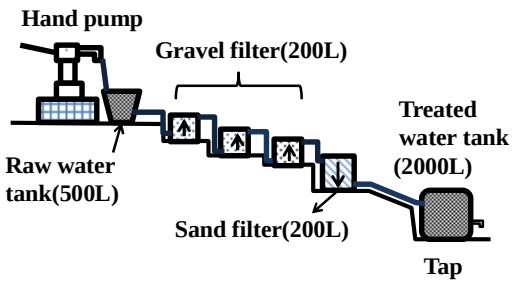
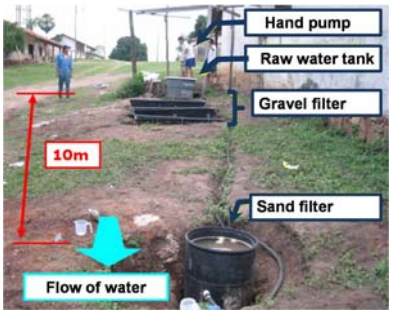
***Santa Cruz Prefecture PROASU-JICA,Bolivia,(Currently,SUIGEN S.R.L,Bolivia) Miguel Rodriguez, No.39 Santa Cruz de la Sierra Bolivia

**** Assistant representative of Japan International Cooperation Agency (JICA) Bolivia Office (Currently, JICA headquarter), 5-25 Niban-cho,Chiyoda-ku, Tokyo Japan*

Slow sand filtration is sustainable technology for drinking water treatment in small communities. The purpose of this study is to prove feasibility of adequate technology for drinking water supply system in rural area in developing country. We introduced our pilot project of small slow sand filter system in Bolivian rural area. The results of water analysis and our observations about sustainability of slow sand filter are described.





ボリビア国の村落地域における小規模緩速ろ過システム

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小規模の村落地域において飲料水処理として緩速ろ過は持続的可能な技術である。この論文は、発展途上国の村落地域における飲料水処理の適正技術であることを示したものである。ボリビアにおける小規模緩速ろ過システムのパイロットプロジェクトの事例を紹介し、水質分析結果および持続可能性に関する考察を示す。

(P19)

pH conditioning using limestone with upflow gravel filters

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Neutral pH values from pH lower raw water in a Costa Rican village are reached by using upflow gravel filter in composition of 25 and 50% with limestone. Presence of alkaline composition in gravel and size particle is taking into account. Results of the study indicate that upflow gravel filter with limestone and gravel media to condition the pH will improve the biological processes of the slow sand filtration (photosynthesis, respiration, microbial growth). Another benefit is that it will increase the buffer capacity to neutralize acids from the disinfection process and it will protect the infrastructure of water supply systems.

TABLE CONDITIONS OF THE EXPERIMENT

Layers	Grain size (mm)	Thickness (m)	Type of aggregate*		
			Column 1	Column 2	Column 3
C1	3-6	0,3	L	L	L
C2	6-12	0,2	L	L	L
C3	12-18	0,2	L	L	Q
C4	18-25	0,3	L	Q	Q

**Limestone (L) and quarry aggregate (Q)*

上向き砂礫ろ過での石灰石を用いたｐＨ調整

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コスタリカの村落では、上向き砂礫ろ過を通すことでｐＨ値の低い原水を中性に処理している。砂礫層の２５％から５０％を石灰石で構成し、砂礫に含まれるアルカリ性の組成と砂礫の粒度が考慮した処理である。

今回の研究の結果から、ｐＨ調整のために石灰石と砂礫質を使った上向き砂礫ろ過では、光合成、呼吸、微生物の生育といった緩速ろ過の生物学的プロセスが改善されることが分かった。もう１つの利点として、石灰石と砂礫質を使った上向き砂礫ろ過により、消毒過程で発生する酸を中和する能力が向上することで給水インフラが保護されることも挙げられる。

(P21)

Slow-sand Filter with Biological Treatment for Seawater Desalination - Comparison of Filter Media Performance

A. Shrestha, S. Jeong, S. Vigneswaran, J. Kandasamy

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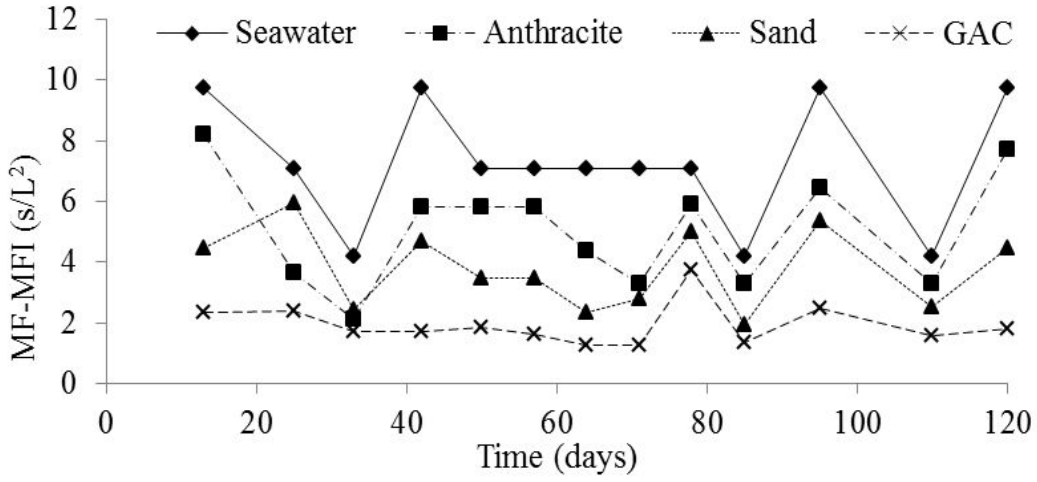
Slow-sand filter with biological treatment is an effective pretreatment method to remove organic matter and particulate matter from seawater. Slow-sand biofiltration performances were evaluated in terms of turbidity, different fouling indices, and dissolved organic carbon (DOC). The removal efficiencies of turbidity by the three slow-sand biofilters were similar with low headloss development. The fouling potential of treated seawater (filtrate) was evaluated using three different fouling indices such as microfiltration (MF-MFI), ultrafiltration (UF-MFI) and microfiltration at a cross flow (CFMF-MFI).



海水淡水化のための生物浄化法による緩速ろ過－ろ材性能の比較

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Faculty of Engineering and IT, University of Technology, Sydney, Australia

生物浄化法による緩速ろ過は、有機物質や微粒子物質を海水から除去するために効果的な前処理方式である。

緩速砂生物ろ過の性能は、濁度、様々なファウリング指数、溶存有機炭素（ＤＯＣ）の観点から評価した。濁度の除去効率は、３種類の緩速砂生物ろ過膜を用いて測定したところ、損失水頭の増加が抑えられるという点で類似していた。膜処理後の海水のファウリング発生傾向は、精密ろ過（ＭＦ－ＭＦＩ）、限外ろ過（ＵＦ－ＭＦＩ）、クロスフロー精密ろ過（ＣＦＭＦ－ＭＦＩ）の異なる３種類の修正ファウリング指数を用いて評価した。

(P2)

Water supply of a small community with a small slow sand filtration/ ecological purification system unit

Fumihiro KAZAKI
Oita Water and Life Association
1-10-5 Kanaikeminami,Oita, 870-0839, Japan

In order to contribute to ensuring the "clean water" in a small community located in mountainous areas where a public water supply is not in place yet, NPO “Oita Water and Life Association” have proposed a small-scale water supply suited to the local circumstances, We will help with the maintenance and management. Using the FRP compact unit, we have built a facility of slow sand filtration / ecological purification.
The important thing is that maintenance can also elderly regional and low-cost. Iron-manganese are rich in raw water by wells of this district. However, it has been able to clean by this facility.

小型緩速ろ過/生物浄化ユニットを用いた小規模集落の水道

加崎史啓　ＮＰＯおおいたの水と生活を考える会
870-0839 大分市金池南1-10-5

NPO おおいたの水と生活を考える会は、公営水道等が未だに整備されていない山間地域などの衛生的な水確保対策として、地域の実情に応じた小規模水道施設の提案と、その維持管理支援などの活動を行っている。
私たちは、小型の FRP 製ユニットを用いて、低コストで、地域の高齢者でもメンテナンスができる緩速ろ過／生物浄化法施設を建設した。
この地区の井戸による原水には鉄・マンガンが多く含まれているが、この施設によりきれいにすることができている。

(P4)

Installing a DIY- based home slow sand filter -Is it possible to make it without speciality?-

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Self-employment plumber, NPO member ,CWSC, Tokyo, Japan

Kawasaki 3-19-29, Shunan-shi,Yamaguchi Prefecture, 746-0001,Japan

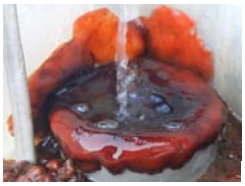
A trial of installing of small –scale water purification systems has so far been performed,since the biological purification process is easy to go without academic training in water engineering. Two cases have been introduced here in as evidence of private facilities made by the author ; this suggests that practice of slow sand filters could be actualized even on a DIY private basis. One of the cases applied to municipal tap water was occupied by chlorine-resistant fungi having gelled polysaccharide.

※The author thanks Dr.J.Takeuchi at Kure College for helping the English manuscript preparation.

Tap water-fed

mountain runoff-fed

chlorine-resistant fungi



家庭用の緩速ろ過浄化システムの試作・運用 –工学の基礎知識がなくとも浄水はつくれるか–

福岡秀昭

自営業（設備工事）ＮＰＯ地域水道支援センター会員

746-0001　山口県周南市川崎3 丁目19-29

生物浄化の仕組みは専門的な知識を要求されないため、小規模な実験装置を家庭に導入した。自作した２通りの装置を導入した事例をもとに、手作りでも緩速ろ過による浄化実験を行えることを実証した。水道水を原水とした装置では、塩素に抵抗するゲル状の多糖類を持つ菌類(fungi)が出現した。

※呉高専・竹内氏には英文原稿の準備に際して助力を戴いたので記して感謝します。

(P6)

Development of an Unmanned Operate System for a Slow Sand Filter / Ecological Purification System

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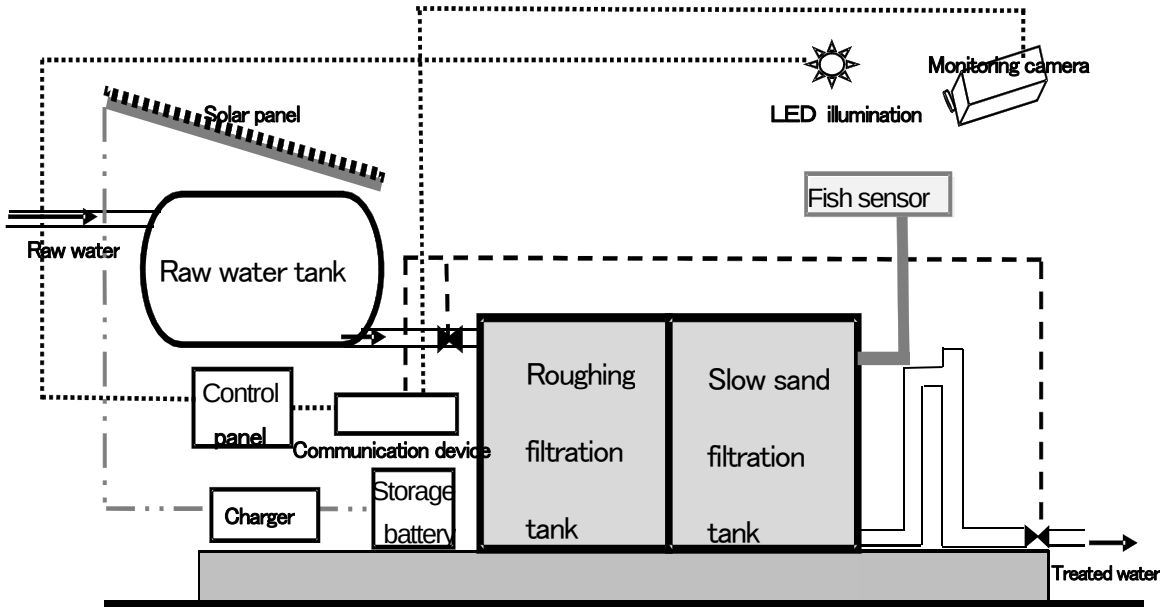
In order to meet various needs, the authors have developed moderate speed filtration facilities and their remote monitoring operation system (SCADA) that can become independent for energy demands only with electric power supplied by photovoltaic power generation. As a result of having performed an operation experiment using a pilot plant for 60 days, the system that was ecological superior in economy was demonstrated.



無人稼動緩速ろ過（生物浄化法）施設の開発

廣瀬丈巳
株式会社タケミ・コーポレーション　大阪府堺市

著者は、種々のニーズに対応すべく、エネルギー需要を太陽光発電の電力のみで自立できる、緩速ろ過施設とその遠隔監視操作システム(SCADA)を開発した。パイロットプラントを用いた稼動実験を６０日間行った結果、エコロジカルで経済性に優れたシステムを実証した。

(P8)

Enhancement of the efficiency of upflow slow sand filtration - Effect of combined application with a fiber filter unit -

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The upflow slow sand filtration system was modified by combined application of a fiber filtration unit above the sand bed of the conventional sand filter. The results obtained from pilot scale filtration experiments conducted for removing turbidity contained in river water from a dam reservoir and tracer particles of Cryptosporidium demonstrated clearly that the modification was very effective in alleviating the deterioration of the filtrate in turbidity induced by rainfall and by cleaning of the sand bed. Its effectiveness in lowering the levels of the tracer particles of Cryptosporidium in the filtrate was also confirmed.

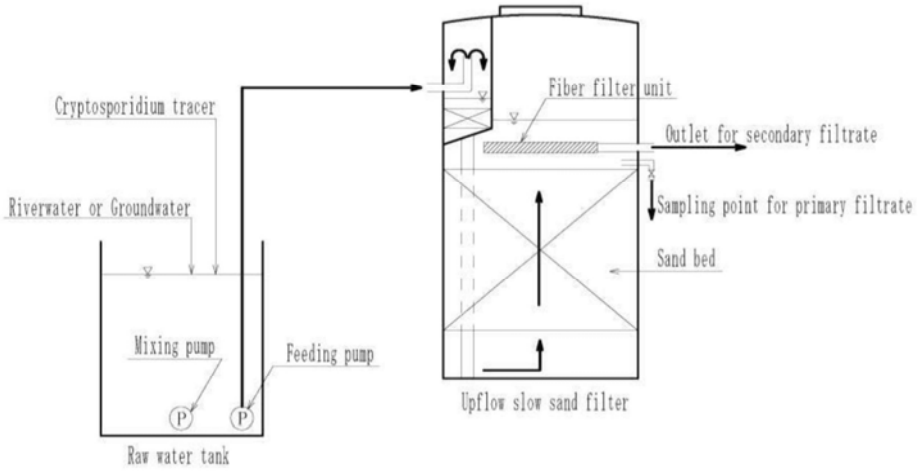

Figure Experimental setupof the modified pilot scale slow sand filtrationsystem.

上向流緩速砂ろ過法の高度化　－不織繊維ろ材の試用－

加藤達夫・尾崎一郎・岡田明彦
岡田産業株式会社
500-8367 岐阜市宇佐南4-17-10

上向流緩速砂ろ過法のろ過処理の高度化をめざして、従来の砂ろ過層上部に設置した不織繊維ろ過ユニットとの複合化実験を行った。ダム湛水河川水を原水とした濁質除去の結果は、パイロットろ過実験により降雨時や砂層洗浄直後の濁り軽減にも大変効果的であり、さらにクリプトスポリジウム代替蛍光粒子除去についても有効性が示され、より安全性を高めることが確認された。

(P10)

Utilizing structural equation modeling as an evaluation tool for critical parameters of the biosand filter in a pilot study in Para, Brazil

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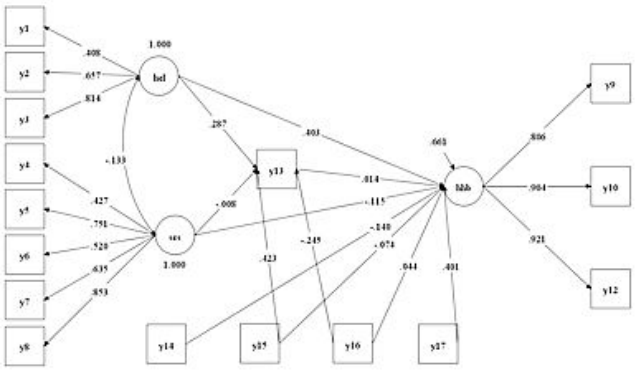
Biosand filters (BSF) have brought potable water to many communities throughout the world. A significant number of studies have shown the effectiveness of the filter if utilized properly. However, Divelbiss et al. 2013 investigated the BSF from a holistic view of the community. Results showed, while important, the BSF was not among the significant factors for health improvement. This pilot study, as part of a larger case study, investigated the issues behind these findings. Utilizing the SEM model that explained the complex system of interactions within the Guatemalan communities, several Brazilian communities along the Amazon River were studied. While further research is ongoing, it was found that the BSF, again while important, was not the largest factor in the improvement of health within the household. Socio-economic status and improved water source had the largest positive impact on health improvement. It was also found that additional water treatment had the highest negative effect of the usage of the BSF.

Figure 2 – Full Model with standardized parameter estimates



ブラジル、パラ州でのバイオサンドろ過器の試験研究における指標評価のためのモデルの利用

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飲料水のためのバイオサンドろ過器 は世界中の多くの地域で導入されている。多くの研究で適切に利用されている場合その効果は示されている。地域におけるバイオサンドろ過器に関する総合的見解を Divelbiss らは調べ、2013 年に報告している。 報告ではバイオサンドろ過器は健康改善の大きな要因ではなかった。この試験研究では大規模な事例研究として、これらの事実の背景にある問題について調べた。アマゾン川沿いの幾つかのブラジル人集落とグアテマラ人集落の間の複雑な関係を説明するため社会経済モデルが利用された。研究を遂行していた中で、家庭内での健康改善に関しバイオサンドろ過器は大きな要因でない事がわかった。社会経済状況と水源開発は健康改善のための大きな要因であった。更に他の水浄化処理にとってバイオサンドろ過器の利用はマイナスな影響は最もある事もわかった。

(P12)

Household Filter to Remove Iron and Nitrate for Drinking Water

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The research of household filtration took place in a dwelling area of Yogyakarta (DIY), Indonesia which has iron excess in groundwater used for drinking water. Nitrate is also prevalent especially in regions where family husbandries surround the wells. There are research in this area to overcome this problem for a healthier drinking water to alleviate groundwater quality for human consumption. The aquifer in general is also compared with thus of Ecuador.

The experiments using charcoal and sand as the main material for removal of Iron and nitrate in drinking water has been conducted in year 2005 to 2006. Afterwards, the filter is elaborated for more practical use for drinking water which contains Iron and also nitrate from wells. The results of the use of these filters are fine, with no more Iron and nitrate excess. Nitrate contains becomes less than 1 mg/l and total Iron does not exceed 0.3 mg/l. The color of water becomes neutral and odorless, if maintained at least once a month by brushing and washing the charcoal (activated carbon) filter and the polypropylene or Cartridge Carbon Filter.

鉄と硝酸性窒素除去用の家庭用ろ過器

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インドネシア、ジョグジャカルタ地下水利用地域での鉄含量が多い井戸水で、家庭用ろ過器の実験を行った。井戸の周囲は家庭排水の影響で窒素成分も多い。飲料水利用として健康問題があり研究が行われた。帯水層問題についてエクワドルと比較した。

鉄と窒素除去のため、活性炭と砂での実験を 2005 年から 2006 年に行った。ろ過器の工夫を重ね、硝酸は、1mg/l 以下に、鉄は、0.3mg/l を越えなかった。ろ過器の活性炭ろ過器の洗浄を少なくとも 1 カ月に一度すれば、色も臭いも無くなった。

(P14)

Change of Water Treatment Efficiency in the Transition from Granular Activated Carbon to Biological Activated Carbon on an Advanced Water Purification Plant

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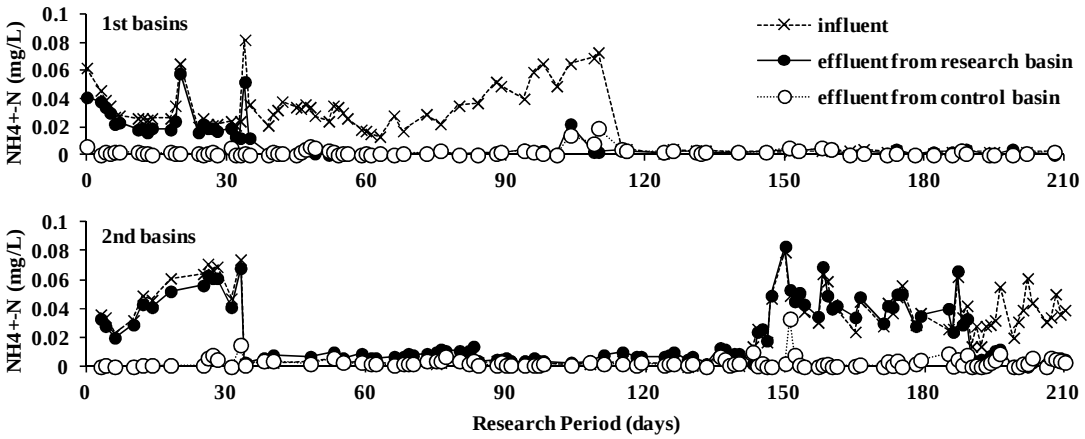
We investigated the change of water treatment efficiency in the transition to biological activated carbon (BAC) by comparing the results of water quality analysis about the renewal basins and the control basins. These results suggest that the transition to BAC in the biological process was dependent on influent water temperature and quality, but the transition in removal of organic matters was independent of influent water temperature and quality.



高度処理浄水場における粒状活性炭から生物活性炭への移行に伴う水処理性の変化

井上　宏隆、児玉　重孝、石橋　美幸、渡部　祐介
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活性炭を入れ替えた吸着池と既存の吸着池の水質を比較することにより、生物活性炭(BAC)への移行に伴う水処理性の変化について調査を行った。その結果、生物的処理過程におけるBACへの移行は流入水の水温や水質に影響を受けた一方、有機物の除去性能はほとんど影響を受けないことが示唆された。

(P16)

Biofilm Accumulation Characteristics of Heterotrophic Bacteria in Tap Water Produced by Biological Activated Carbon Process

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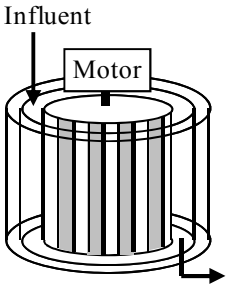
In order to evaluate the biological stability in a tap water produced by biological activated carbon process, a bench-scale reactor test using laboratory tap water was conducted for about 7 months. Based on material balances on heterotrophic plate count and assimilable organic carbon (AOC), the retention time of biofilm cells attached on the surface of polyvinil chloride wall and the growth yield of heterotrophic bacteria with consuming AOC were estimated.



Liquid volume	1.4 L
Surface area	2,300 cm^2
Diameter of drum	14 cm
Size of coupon	1 × 15 cm

生物活性炭により精製された水道水における従属栄養細菌の生物膜形成特性

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生物活性炭により精製された水道水の生物学的安定性を評価するため、実験室水道水を用いたベンチスケールリアクター試験を約7ヵ月間実施した。従属栄養細菌の菌体収支および生物同化可能有機炭素（Assimilable Organic Carbon, AOC）の物質収支に基づき、塩化ビニール表面における付着菌体の壁面滞留時間およびAOC消費に伴う従属栄養細菌の増殖収率をそれぞれ推定した。

(P18)

The Environmentally-friendly Effects of Biotreatments in Osaka Water Supply Authority

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The Osaka Water Supply Authority has been operating biotreatment in Mishima Water Treatment Plant (WTP) and Niwakubo WTP located in the lower areas of the Yodo River. The biological contact oxidation process has been running in Mishima WTP, and the biological contact filtration process in Niwakubo WTP. Removal of ammonium nitrogen in biotreatment enables the stable operation of residual chlorine control and the reduction in the dosage of sodium hypochlorite. The biotreatment proves to be effective to reduce dissolved manganese to the satisfactory level. It is also confirmed that turbidity can be reduced by biological contact filtration process in Niwakubo WTP, so the dosage of coagulant has been reduced.

	Ammonium nitrogen (%)	Dissolved manganese (%)
Average removal ratio in Mishima WTP from FY 2003 through FY 2012	79.8	93.5
Average removal ratio in Niwakubo WTP from Dec. 2005 through Mar. 2013	97.8	99.1

大阪広域水道企業団における生物処理導入の効果について

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大阪広域水道企業団では、淀川下流域に位置する三島浄水場及び庭窪浄水場において生物処理を行っている。三島浄水場では生物接触酸化処理が、庭窪浄水場では生物接触ろ過処理がそれぞれ稼働している。生物処理導入によりアンモニア態窒素が低減したことで、安定した残留塩素管理が可能になるばかりでなく、次亜塩素酸ナトリウムの使用量も低減することができた。また生物処理は、溶存マンガンを十分なレベルにまで除去するのに効果的であることがわかった。加えて庭窪浄水場の生物接触ろ過処理では、除濁効果も確認され、凝集剤の使用量を低減することができた。

(P20)

Removal of pharmaceutically active compounds in managed aquifer recharge: A laboratory experiment

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In this study, soil column experiments were conducted, in order to show the removal efficiency of pharmaceuticals in porous media simulating MAR systems. The columns were packed with sand of average diameter of 0.8~1.25mm to assess the attenuation of target pharmaceuticals. The sand columns were kept in a dark condition and a room temperature at 18℃ and 19℃. Most of pharmaceuticals such as Antibiotics and nonsteroidal anti-inflammatory drugs (NSAIDs), and steroid hormones generally exhibited over than 70% removal efficiencies in soil media. The results suggest that the MAR systems are appropriate process as pre-treatment step of water purification system.

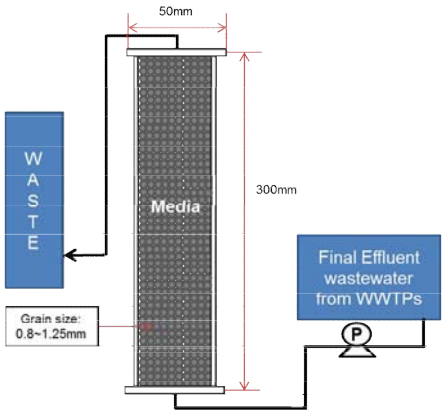

Figure 1. Schematic diagram of the soil columns

管理型地下水人工涵養による医薬的活性化合物の除去の室内実験

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School of Environmental Science & Engineering, Gwangju Institute of Science & Technology
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この研究では、MAR システムにより、多孔質体中の化学薬品の除去効率を示す土柱実験が行われた。対象化学薬品の減少を評価するために、土注に直径 0.8~1.25mm の砂が詰められた。砂柱は、暗い状態で室温 18℃ と 19℃ の部屋に置かれた。抗生物質や非ステロイド系抗炎症薬（NSAIDs）、ステロイドホルモンなどのほとんどの化学薬品は、多孔質体中において全体的に 70%を超える除去効率を示した。結果として、MAR システムが浄水システムの前処理として適切な工程であることを示唆する。

(A6-1)

Global review of the adoption, use, and performance of the Biosand Filter

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CAWST – Centre for Affordable Water and Sanitation Technology
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A biosand filter (BSF) is an adaptation of the traditional slow sand filter for intermittent use at households. Over 550,000 filters have been implemented in 55 countries, serving more than 3 million people. A summary of 32 BSF project reports from 19 countries showed on average 83% of households used the filter daily, 81% used separate storage containers for treated and untreated water, and the filter removed 90% of E. coli bacteria and 66% of turbidity. 96% and 94% of the users stated that the filter was easy to use and filter provided enough water for the entire household. The majority of reported problems with the BSF stemmed from lack of user education, poor manufacturing quality, and inadequate ongoing maintenance.

バイオサンド・フィルターの世界での適応、利用状況、及び性能調査

Dr. T.K.K. Ngai, B. Coff, D.L. Baker, R. Lentz
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バイオサンド・フィルター（BSF）は、従来の緩速砂ろ過装置を、家庭での断続的使用に対応できる構造としたものである。これまでに 55 万基以上の BSF が、55 カ国、3 百万人以上によって使用されてきた。19 カ国、32 プロジェクトの報告書を集計した結果、平均 83%の家庭で BSF を日常的に使用しており、81%の家庭でろ過水と未ろ過水を別々の容器に保存していた。また、BSF の大腸菌除去率は 90%、濁度除去率は 66%であった。96%の家庭が BSF の使用は容易であると回答し、94%が BSF で家族全員に十分な量の水をろ過できると回答していた。報告された BSF に関する問題は、主に利用者の知識の欠如、製造品質、及び不十分なメンテナンスが原因のものであった。

(A6-2)

Recent advances in household biosand filter design

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CAWST – Centre for Affordable Water and Sanitation Technology,
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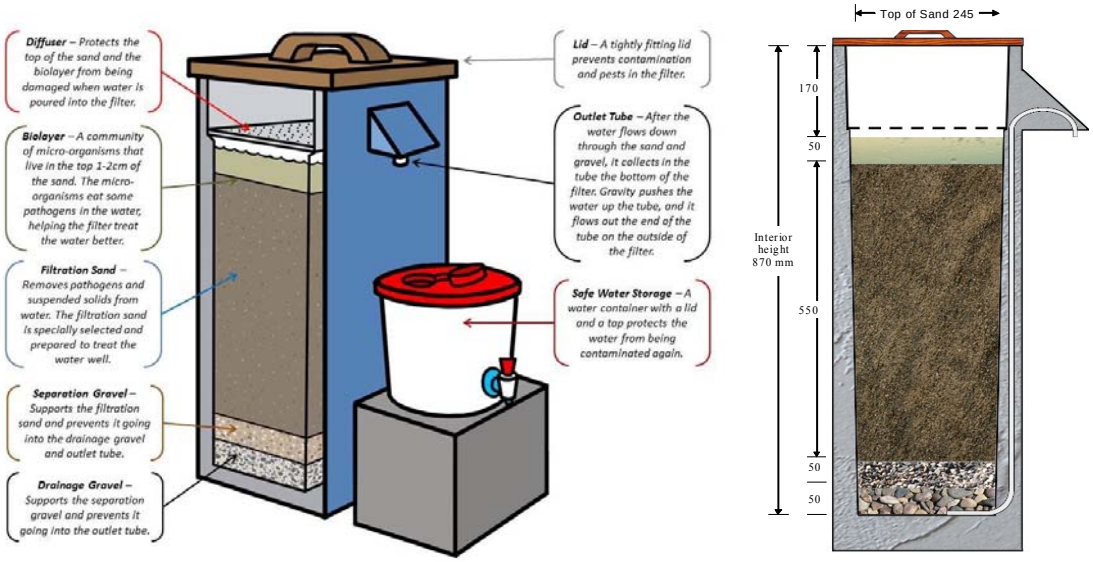
The biosand filter is an intermittent-flow adaptation of slow sand filtration technology developed over 20 years ago. Ongoing research, field evaluations, and understanding how the filter is used have led to advances in the design of the biosand filter as well as the specifications for the hydraulic loading rate, filtration sand, and pause period. Learning has also progressed in virus reduction, the importance of filter ripening, and the maintenance/cleaning of the biosand filter. Different methods of fabricating the filter body and diffuser basin are providing more alternatives for implementing biosand filter projects.



家庭用バイオサンド・フィルターの最近の設計上の進展

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バイオサンド・フィルター (BSF) は、緩速砂ろ過技術を間欠水流に対応できる構造としたものであり、20 年以上前に開発された。研究の継続、現地での評価検討、及び利用状況の理解により、BSF の設計、水圧加重やろ過砂、原水注入間隔の仕様に技術的進展がもたらされてきた。また、ウイルス除去、ろ過膜熟成の重要性、そして BSF のメンテナンス・洗浄方法に関する理解も進んだ。フィルター本体やディフューザーの組み立て法の多様化により、BSF プロジェクトの実行方法にも、より多くの選択肢が与えられつつある。

(A6-3)

Performance Optimisation of Household Biosand Filters

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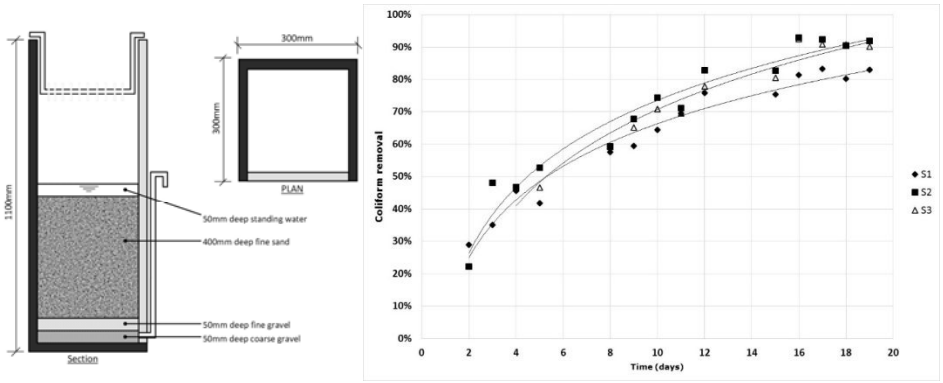
*** Web Earth PTE Ltd, 40 Carpenter Street, Singapore, 059919*

This work investigated two methods to optimize the design and performance of the household biosand filter. The first method to optimise the filter was by 'seeding' one filter with 50% of old sand from an existing biosand filter to speed up the maturation of the filter. The second method used was the addition of a tap to the outflow pipe, which would prevent the need for users to store water that had been filtered, thus removing the possibility of recontamination through storage. The seeded filter reached 99% coliform removal after 16 days, 10 days before the unseeded filter, demonstrating the important role of microbial community in water purification by slow sand filtration. Furthermore, the filter with the tap showed that it could still maintain significantly high coliform removal rates (99.2%, $p < 0.01$) even after pausing the flow of water.



家庭用バイオサンドフィルターの適正化

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**Department of Civil, Environmental & Geomatic Engineering, University College London, Gower Street, London, WC1E 6BT, UK*

*** Web Earth PTE Ltd, 40 Carpenter Street, Singapore, 059919*

家庭用バイオサンドろ過器を最適化するため、２つの方法を検討した。実験１は、ろ過器を早く熟成させるために、古い砂を種砂として５０％使用した。実験２は、貯水しているろ過水を原水に循環して加えた。種砂を加えたろ過器では、１６日で大腸菌除去は９９％になった。緩速ろ過では、微生物群集の役割が重要である。更に、一時的にろ過を中止しても大腸菌除去は維持(99.2%、$p < 0.01$)されていた。

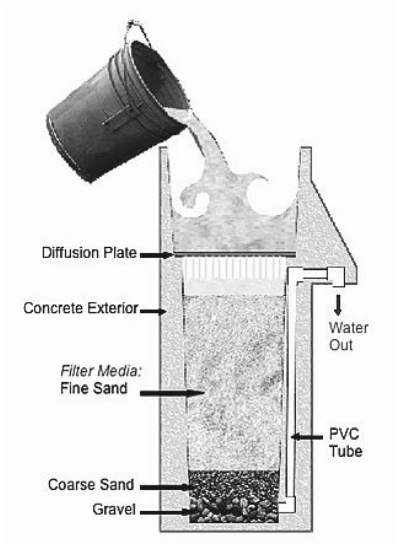
(A6-4)

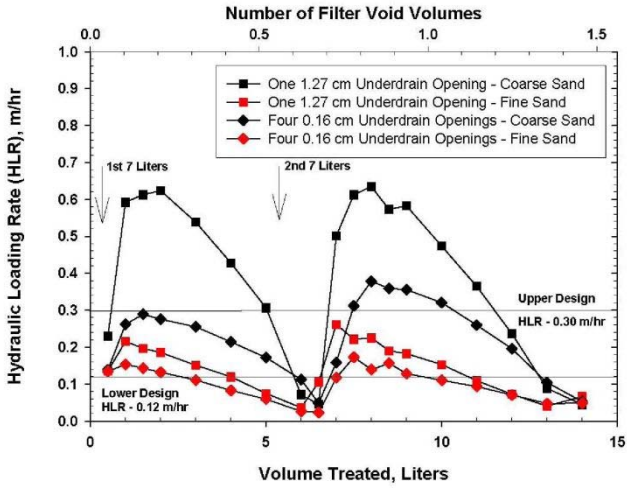
Optimizing intermittent slow sand filters (biosand) construction for more consistent microbial removals

K. Sawyer, C. Perron, M.R. Collins

Department of Civil & Environmental Engineering, University of New Hampshire, Durham, NH, USA

The intermittent slow sand filter (biosand filter) is a household-scale drinking water treatment system known for its simplicity and ease of use. This research examines several construction factors affecting the flowrate of the biosand filter, volume of water treated, and previous microbial loading to determine their effect on removal of microbes. It is recommended that more flow rate limiting modifications of the influent basket and the underdrain collection system be adopted, the volume of each charge of raw water applied to a biosand filter not exceed 70-80% of the filter's void volume, and that as much time as possible (>8 hrs) separate raw water charges of the biosand filter.





間欠緩速砂ろ過器（バイオサンドフィルター）のより着実な微生物除去のための改善法

K. Sawyer, C. Perron, M.R. Collins

Department of Civil & Environmental Engineering, University of New Hampshire, Durham, NH, USA

家庭用の飲料水浄化装置の間欠緩速砂ろ過器(バイオサンドフィルター）はその簡単な仕組みと利用しやすさが知られている。この研究ではろ過速度、ろ過水量、直前の細菌負荷量が間欠緩速砂ろ過の細菌除去に影響するかを調べた。注入バケツによる注入速度を遅くらせる操作と下部取水法の改善、砂ろ過器の空隙容量の 70−80%を超えた原水を入れない事、また砂ろ過器に原水を注入は 8 時間以上間隔をあける事などが推奨された。

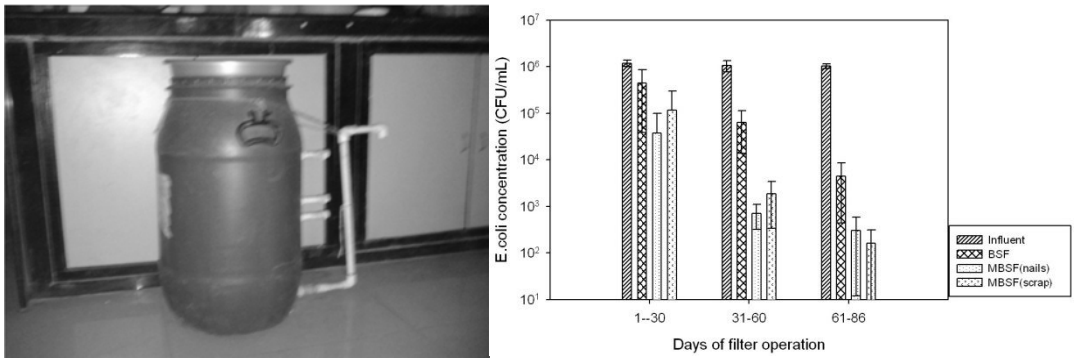
(A6-5)

Long-term performance evaluation of biosand filters modified with zero-valent iron

M. Mansoor Ahammed, Chaitali Solanki, Abhilash T. Nair

Civil Engineering Department, SV National Institute of Technology, Surat – 395007, India

Performance of two full-scale biosand filters (BSF) modified by introducing zero-valent iron (ZVI) in the form of iron nails and iron filing scrap was compared with that of BSF in a long-duration study spanning three months employing Eschericia coli and turbidity spiked water. Results of the tests showed that E. coli removal in both the modified filters was significantly better compared to that in BSF. Bacterial removal was always higher in modified filters by at least one-log unit. The E. coli removal continuously improved in all the three filters, and it reached a maximum value of about 4 log units in both the modified filters while the maximum removal observed in BSF was around 2.5 log units. All the filters showed good turbidity removal after maturation, and effluent turbidity was around 1 NTU when influent value was 20-25 NTU. Passage of water through the filters resulted in sharp decline in dissolved oxygen. The study thus indicated the potential of ZVI in improving the performance of biosand filters.



バイオサンドフィルターにおけるゼロ原子価鉄の添加の効果実験

M. Mansoor Ahammed, Chaitali Solanki, Abhilash T. Nair

Civil Engineering Department, SV National Institute of Technology, Surat – 395007, India

バイオサンドフィルター（BSF）へ鉄釘と鉄の スクラップ中のゼロ原子価鉄（ZVI）導入し、大腸菌と濁度の比較実験を３か月間、行った。大腸菌の除去は、通常の BSF より効果的だった。細菌除去も常に良好な結果であった。大腸菌除去割合は、通常は、2.５桁の除去であるが、鉄添加ろ過では、４桁の除去効果があった。全ての実験で、ろ過器が熟成すると原水濁度が 20−25NTU が、ろ過水は、約 1NTU と濁度除去効果は良かった。溶存酸素はろ過器の中で急激に減少した。この実験は、BSF 効果が鉄の添加で良くなることを示した。

(B6-1)

Use of water sensitive urban design systems for biofiltration of urban stormwater: laboratory biodegradation batch studies

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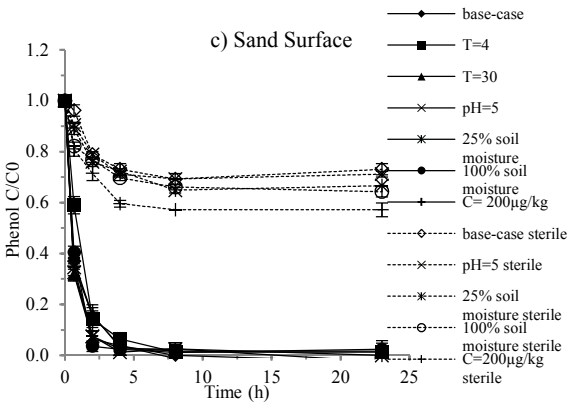
Water Sensitive Urban Design (WSUD) systems are a form of alternative biological filtration that is increasingly being used for stormwater management. To date, there is limited knowledge on the behavior of organic micropollutants in such systems and applicability to water reuse. In this study, biodegradation of a model micropollutant, phenol was investigated in the laboratory from two types of media typically used in stormwater biofiltration systems (also known as biofilters, bioretentions, and rain-gardens). Conditions, including temperature, pH, starting concentrations, moisture contents and redox conditions (aerobic and anaerobic) were varied to cover common environmental ranges. Ultraviolet absorbance at 254 nm (UVA) was also evaluated as potential surrogate for phenol biodegradation. Phenol examined in all types of soils was degraded biologically, with high percentage of removal (k = 0.125 - 1.26 h-1) and short half-lives (t1/2=0.550 - 5.54 h). The results indicated that the biodegradation rates were affected by temperature, soil moisture and redox condition. The highest biodegradation rates were achieved based on temperature 300C and with soil moisture of 100% under aerobic conditions. pH and initial phenol concentration had little impact on biodegradation of phenol in this study. Analysis of spearman rank correlation indicated that UVA reduction was significantly related to phenol biodegradation in Sand Deep soils under all conditions (P<0.01).

Characteristics of biofiltration soils used in this study.

	Loamy Sand Deep (LS-D)	Loamy Sand Surface (LS-S)	Sand Deep (S-D)	Sand Surface (S-S)
Bulk Density (g cm^{-3})	1.58	1.59	1.61	1.60
Total Organic Matter (%)	3.6	5.3	0.35	4.2
Total phosphorus (mg kg^{-1})	260	470	30	420
TN (mg kg^{-1})	1,200	2,000	300	1,400
NH_3 (mg kg^{-1})	1	2	< 1	3
NO_X (mg kg^{-1})	2	6	< 1	8
Sand (%)	92.8	91.4	99.4	95.3
Clay (%)	3.1	2.5	0.32	1.0
Silt (%)	4.1	6.1	0.28	3.7



都市型豪雨対策での生物ろ過の検討： 室内バッチ実験での生物分解

都市型豪雨対策の必要性が増加し、各種生物ろ過による都市型対応策が検討されている。現在までの対応策の中では、水の再利用、有機性微量汚染物質の挙動の知識が不十分であった。豪雨対策で通常考えられている生物ろ過系（生物ろ過、湿地利用、雨水利用庭園など）の 2 種類の素材を用いモデル微量汚染物質（フェノール）の生分解を室内実験で研究した。温度、pH、初期濃度、土壌湿度、酸化還元状態(好気性、嫌気性)などの条件は、通常の環境変化の幅で実験した。254 nm の紫外線吸収で、フェノール生分解性を評価した。フェノールは、様々な土壌で生分解され、高い除去率(k = 0.125 – 1.26 h-1）と短い半減期（t1/2=0.550 – 5.54 h)であった。生物分解率は温度、土壌の湿度と酸化還元状態に影響された。最も効率よく分解されたのは温度が 30℃、好気状態で湿度 100% の時であった。生分解には、pH と初期のフェノール濃度の影響は小さかった。全ての実験条件で、深層砂土壌でのフェノールの生分解と、紫外線吸収の減少とは、スピアマン順位相関の解析で、有意な関係があった。

(B6-2)

Exploring Sand and Bentonite - Enhanced Sand as Filter Media for Nitrate Removal

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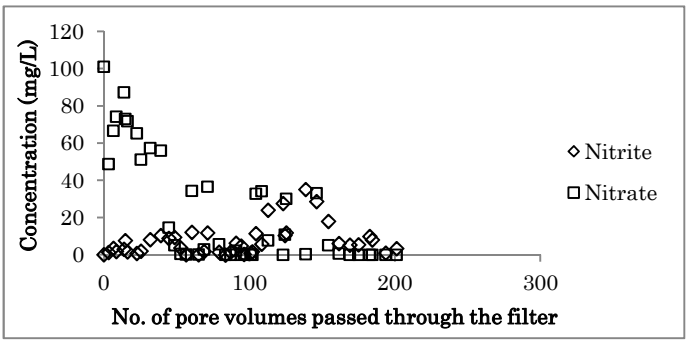
The denitrification of sand and bentonite enhanced sand in presence of easily assimilable organic carbon was studied. Filter columns were constructed using sand and bentonite-enhanced sand as filter media. The filtration rate was maintained at average value of 2.60 cm/h. The nitrate removal rates through both the filter media was assessed for solution containing 22.6 mg NO3–N/L concentrations while keeping C/N mass ratio as 3. For sand filter column, the nitrate removal efficiency reached the average value of 97.6% after passing 50 pore volumes of the nitrate solution. For bentonite-enhanced sand filter column, the average nitrate removal efficiency was 83.5%.The time required for effective operation for sand filter bed was 100 hours, while bentonite-enhanced sand filter bed did not require any maturation period as that of sand filter bed for effective performance.



砂とベントナイトでの硝酸態窒素除去

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分解性有機炭素存在下で、ベントナイトの効果を砂ろ過で硝酸態窒素除去を調べた。ろ過カラムは砂とベントナイトを使用した。ろ過速度は、2.60 ㎝/h で行った。硝酸除去は、 C/N 比は3 で硝酸態窒素濃度は22.6 ㎎ -N/L の濃度で行った。砂カラムの空隙率は50 で硝酸除去平均は 97.6% 。ベントナイトカラムでの除去平均は、83.5% だった。砂カラムが効果的になるまでは、100 時間が必要だった。フィルター層の効果的な操作に必要な時間は 100 時間、ベントナイトカラムは熟成時間は必要なかった。

(B6-3)

Reduction of the formation potentials of trihalomethanes (THMs) and haloaceticacids (HAAs) in reclaimed water by soil aquifer treatment

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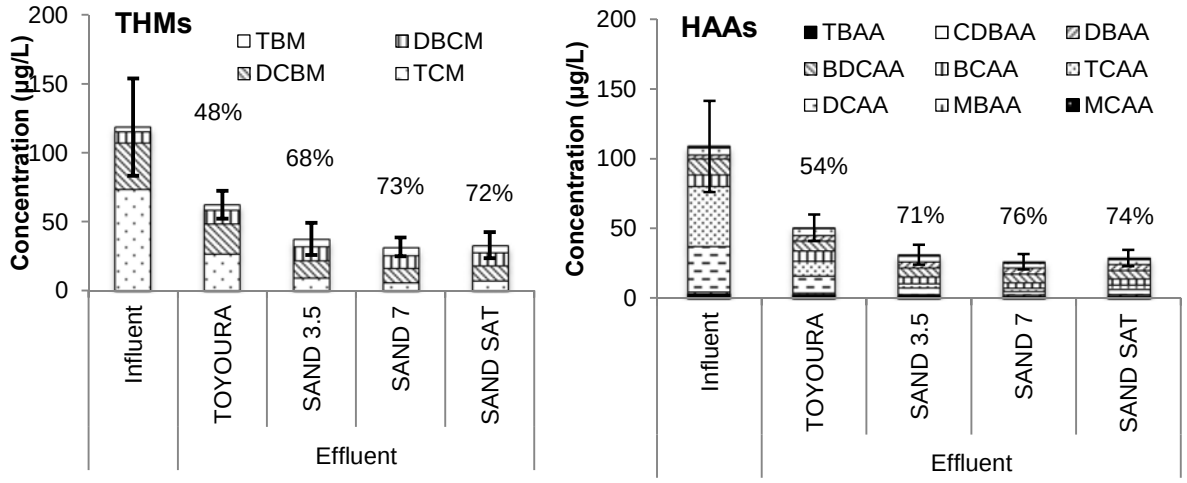
Lab-scale column experiments with different soils and retention time were performed to evaluate the feasibility of soil aquifer treatment (SAT) on the reduction of formation potentials (FPs) of trihalomethanes (THMs) and haloaceticacids (HAAs). The sand column with a hydraulic retention time (HRT) of 7 days showed the highest reduction level of THM and HAA FPs.



土壌浸透処理による再生水中のトリハロメタン（THMs）及びハロ酢酸（HAAs）の生成能（FPs）の減少

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トリハロメタン（THMs）及びハロ酢酸（HAAs）の生成能（FPs）を減少させる土壌浸透処理（SAT）の実現性を評価するため、様々な土と滞留時間における研究所規模の柱状実験が行われた。７日間の水理学的滞留時間を持つ砂層は、THM 及び HAA の FPs が最も高い減少レベルを示した。

(B6-4)

Removals of pharmaceuticals and personal care products in reclaimed water during soil aquifer treatment with different soil types, hydraulic retention time, and saturated condition

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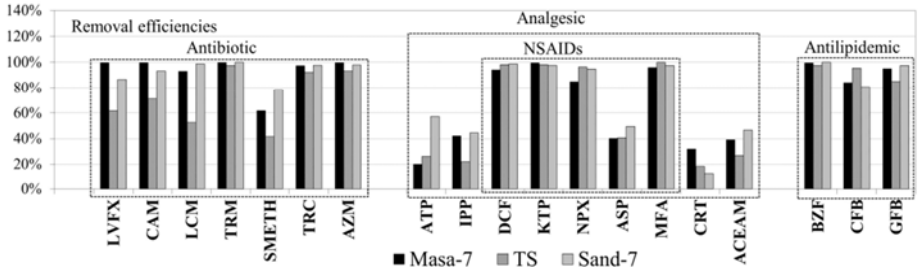
For controlling Pharmaceuticals and personal care products (PPCPs) in water reclamation, soil aquifer treatment (SAT) is an attractive way because of its low operational cost and stable performance. In this study, the removals of 30 PPCPs in SAT with Masa soil, sand and Toyoura sand with a HRT (Hydraulic retention time) of 7 days were compared. The three SAT columns could remove antibiotic PPCPs, and Masa soil performed best on the removal of antibiotic PPCPs. Also, most non-steroidal anti-inflammatory drugs were removed in the three kinds of columns probably through biodegradation. Increasing HRT enhanced the removal of acetaminophen, theophylline, crotamiton, and caffeine. Overall, most NSAIDs and most antibiotic could be removed under any conditions tested in this study.



地下浸透処理における土壌、水理学的滞留時間、飽和度による下水処理水の日用品由来医薬品の除去率

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地下浸透処理は、運転費用が安く安定した処理が可能であることから、下水処理水の日用品由来医薬品（PPCPs）の抑制に魅力的な方法だ。本研究では、真砂土、砂、豊浦砂を用い、水理学的滞留時間（HRT）を7日として、地下浸透処理による30PPCPsの除去率を比較した。抗生物質PPCPsは3つのカラムで除去することができ、真砂土による除去率が最も高かった。ほとんどの非ステロイド抗炎症薬（NSAIDs）も生物処理により3つのカラムでほぼ除去することができた。HRTの経過に伴い、アセトアミノフェン、テオフィリン、クロタミトン、カフェインの除去率は高まった。概して、非ステロイド抗炎症薬と抗生物質のほとんどは、本研究のどの条件でも除去が可能であった。

(B6-5)

Behavior of trace organic contaminants in soil aquifer treatment(SAT) process for reuse of secondary sewage effluent

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Fate of endocrine disrupting chemicals, Ethylenediaminetetraacetic acid (EDTA) and 1,4-dioxane, whose risks were concerned in the case when treated wastewater is reused for potable purpose, in soil aquifer treatment (SAT) was evaluated with various experiments. Using SAT columns and pilot scale reactors, which continuously received treated sewage effluent, it was cleared that bisphenol-A(BPA) was effectively removed; meanwhile, the removal of 1,4-dioxane by SAT was not so expected. Removal of EDTA was expected; however, the removal was limited (66% of removal ratio with 30 days of Hydraulic retention time). In order to made clear the treatment mechanism, adsorption and biodegradation characteristics were also investigated and evaluated quantitatively from the points of reaction kinetics. It was understood that BPA, E1, and E2 can be removed easily by biological reaction, whereas EDTA and 1,4-dioxane cannot be degraded biologically in the system. On the other hand EDTA can be adsorbed to the soil. These findings corroborate the results of SAT columns experiment, and can be used for mathematical models which express and predict behaviors of the chemicals in SAT.

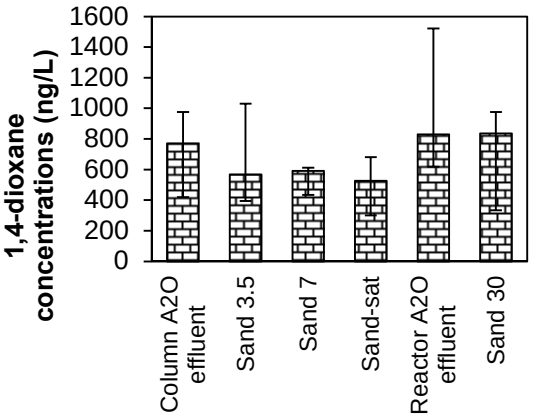

Figure 1 Concentrations of 1,4 DXN in the A2O effluent and SAT effluent.

下水二次処理水の再利用のための土壌浸透処理プロセスにおける微量有機汚染物質の挙動

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内分泌かく乱物質、EDTA、1,4-ジオキサン等の、飲用水として下水処理水を再利用する際に健康リスクが問題となる物質について、土壌浸透処理(SAT)プロセス内での挙動・消長を種々の実験を行い評価した。連続的に下水処理水を流入させた SAT カラム実験を行った結果、BPA は効果的に除去されること、一方で 1,4-ジオキサンの除去は困難であることが分かった。EDTA は除去できなくはないが、30 日の滞留時間においても除去率が 66%に留まることが示された。これら微量汚染物質の SAT による処理原理と除去効率を明らかにするために、吸着と生物分解性について、反応動力学的観点から定量的に評価した。BPA,、E1 および E2 は生物反応による分解がなされるが、EDTA と 1,4-ジオキサンは SAT による除去は期待できないことが分かった。EDTA の除去は吸着によりなされることも分かった。これらの知見を、SAT 内での物質動態を表現しうる数理モデルの動力学定数として活用した。