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発表要旨集

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生物脱臭用担体としての無機物質の評価

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１．緒言：充填塔式生物脱臭装置の充填担体は、コンポストやピート等の有機質系の資材が、水分の保持時間が長く、微生物に必要な栄養分が供給され易いことから主に用いられてきた。しかし、好気条件における分解や、臭気成分の分解生成物による劣化や蓄積した生成物の洗い流しによる性状の変化も長期の運転で問題となってきている。そこで、本研究ではこれらの現象が生じにくい、数種の無機質担体について、硫化水素 (H_2S) とアンモニア (NH_3) に対する非生物的除去能と生物的除去能を求め、有機質担体との比較から担体としての評価を行った。

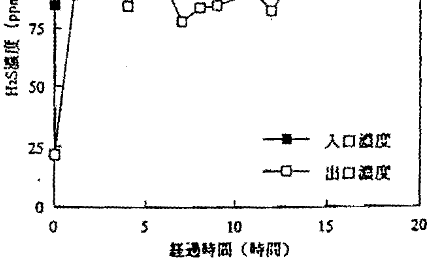
２．実験方法：用いた担体の概要と物理化学特性と通気時保水能を表－１に示す。

表－１　各種担体の概要と物理化学的特性

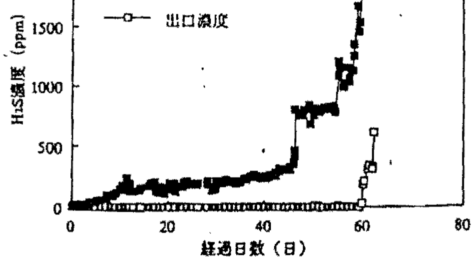
担体	概要	真密度 (g/cm^3)	気孔率 (%)	嵩密度 (g/cm^3)	充填密度 (g/cm^3)	pH (-)	最大含水率 (%)	通気時保水能 (%/day)
A	セラミック性多孔物質	2.31	79.6	0.47	0.25	6.4	62.8	-8.57
B	クリストバライト焼成物	1.59	42.6	0.91	0.66	8.2	35.5	-4.39
C	独立気泡集合体のガラス質被覆物	0.13	89.0	0.12	0.02	6.3	89.0	-3.26
D	黒ぼく土、くん炭、岩石粉末の混合造粒物	1.73	46.9	0.92	0.47	7.0	34.0	-6.28
E	廃棄物耐焼成物	1.43	59.9	0.57	0.70	6.4	33.1	-4.53

通気実験は、担体を 5 cm φ x 50 cm のガラスカラムに 18 cm 高さに充填した。通気保水能は、各担体を完全に吸水させ、100 h^{-1} で通気し、自然に乾燥していく過程を秤量して、直線的に変化する部分を１日当たりの変化率として求めた。非生物的脱臭能は含水させた担体を上記と同様に充填し、NH_3 (120 ppm, 119 h^{-1}) および H_2S (100 ppm, 119 h^{-1}) を通気し、入口と出口の濃度を測定し、湿った状態での担体による両ガスの除去量を求めた。生物的脱臭能は、好気性消化し尿汚泥に担体を浸し、上記条件で充填し、NH_3 および H_2S を所定の濃度と通気量に設定して通気し、入口と出口濃度を測定して、馴養させながら負荷を順次上昇させて行き、最大除去量を求めた。全ての通気実験条件と操作は、各カラムに対して可能な限り同一にした。また、生物的除去実験を行った H_2S 通気後のカラムの圧力損失を 100 h^{-1} で測定した。

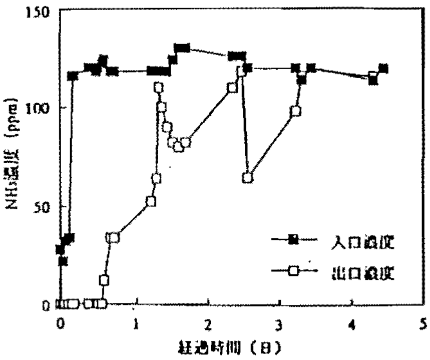
３．結果と考察：図－１ a、b と図－２ a、b に担体 A の H_2S と NH_3 の非生物的除去と生物的除去の経時変化を示す。



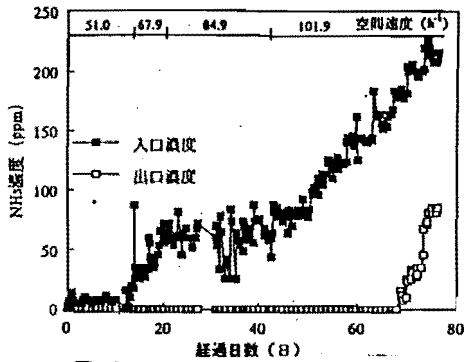
図－１ a　H_2S の破過曲線　(担体 A)



図－１ b　H_2S の生物的除去の経時変化　(担体A)



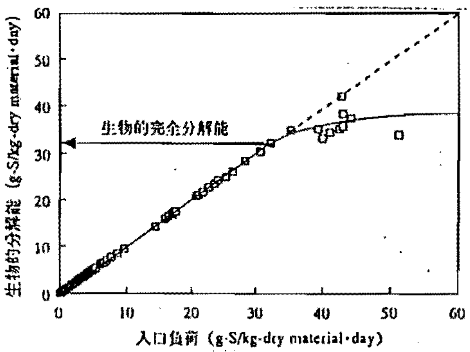
図－2a　NH_3の破過曲線　（担体 A）



図－2b　NH_3の生物的除去の経時変化　（担体A）

NH_3の非生物的除去量は、自由水への
容解量を差し引いて計算した。

図－3は、担体Aの生物的完全分解
能を求めた結果である。入口負荷に対
して、生物分解量をプロットし、100％
除去できる最大負荷量を生物的完全分
解能とした。NH_3の場合も同様にして
求めた。圧力損失の結果と併せて各担
体の測定値を表－2に示す。

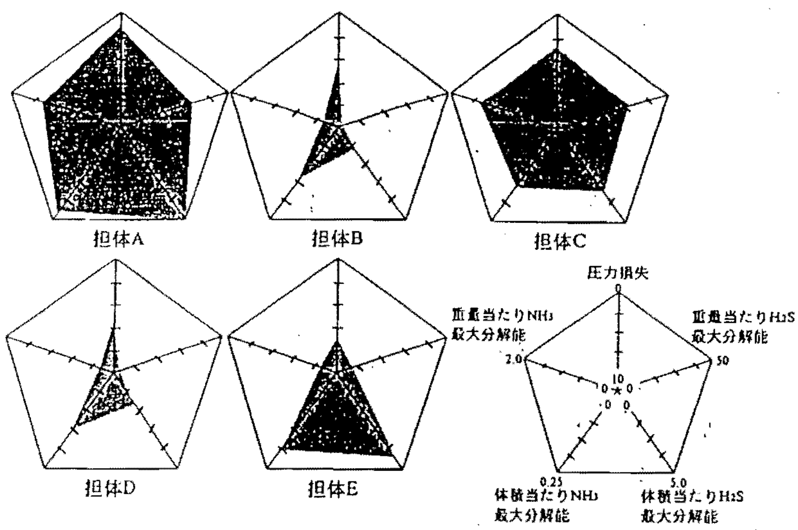


図－3　担体AのH_2Sに対する生物的分解能

表－2　H_2SとNH_3の非生物的除去量と生物的完全分解能

担体	非生物的除去量				生物的完全分解能				圧力損失
	H_2S		NH_3		H_2S		NH_3		
	(g-S/kg dry)	(g-S/l)	(g-N/kg dry)	(g-N/l)	(g-S/kg dry･day)	(g-S/l･day)	(g-N/kg dry･day)	(g-N/l･day)	(mmH_2O／m)
A	0.233	0.057	0.73	0.15	32.6	5.5	1.50	0.23	1.1
B	0.097	0.064	1.25	0.88	2.1	1.2	0.29	0.15	3.9
C	0.355	0.039	3.23	0.41	30.9	3.4	1.50	0.16	2.8
D	0.127	0.050	0.39	0.16	3.0	1.6	0.30	0.16	5.6
E	0.075	0.049	3.47	2.49	7.1	4.4	0.33	0.20	6.7

総合的に評価を行っ
た結果を図－4に示す。
今回行った実験では、
担体AおよびCが対照
として用いた有機担体
より優れた性能を示
した。以上の結果から、
H_2SとNH_3の生物的除
去能が優れている担体
は、総じて気孔率およ
び最大含水率が高い傾
向にあった。今後の課
題としては、実臭気で
の長期間の運転が必要
と思われる。



図－4　充填担体としての評価

Ammonia Removal Characteristics by Biofilter Using Inorganic Carriers Seeded with Nitrifying Bacteria Enriched from Night Soil Sludge

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...duction Ammonia removal by biofilters was conducted mainly using organic packing-materials as a carrier like peat (1,2) or wood bark (3), but inorganic packing materials (4,5) were rarely used. In this study, as inorganic packing materials, porous ceramic (A) and foamed inorganic material covered with glass layer (C) which was porous and light, were used. To shorten the acclimation period, nitrifying bacteria enriched from night soil sludge were applied to biofilters. The ammonia removal characteristics by A and C biofilters were investigated.

Materials and methods Nitrifying bacteria enriched in P-medium (6) for 10 days were harvested by centrifugation, washed, and then resuspended in P-medium. This suspension was applied to biofilters with A and C as a packing material. The initial cell number of nitrifying bacteria was at an average of 10^8 cells/kg-dry material. Characteristics of packing materials were previously reported (5). Condition of temperature, pH of packed bed, analysis of ammonia in air and analysis of nitrite and nitrate are the same as previously reported (2). The drain water was resprayed to the packed bed everyday. When the nitrite concentration reached about 8000 ppm, the drain water was disposed and the packed beds were sprayed with fresh P-medium without ammonium sulfate. The operational conditions and removal characteristics of biofilters are shown in Table 1.

Table 1. Operational conditions and comparison of ammonia removal characteristics of A and C biofilters seeded with nitrifying bacteria enriched from night soil sludge.

Packing material	Porous ceramic (A)	Foamed material (C)
Packing density (kg-dry material/L)	0.24	0.13
Ammonia gas flow		
Inlet concentration (ppm)	60 - 200	60 - 170
Flow rate (L/min)	0.4 - 1.6	0.4 - 1.4
Load (g-N/kg dry material/d)	0.26 - 2.87	0.24 - 2.29
Ammonia removal characteristics		
Complete removal (g-N/kg dry material/d)	2.1	1.5
Maximum removal capacity (g-N/kg dry material/d)	2.9	2.1
Average removal ratio (%)	95	88

Results and discussion We have shown high complete removal of ammonia by A and C biofilters seeded with sludge at 1.5 g-N/kg-dry material/d which reached in 60d (4). In this study, enriched nitrifying bacteria and high ammonia concentration were initially introduced to biofilters. Figures 1 and 3 show the result. About 80 ppm ammonia was introduced to the biofilters at load of 0.25 g-N/kg-dry materials/d for the first 2 weeks and then the load was increased gradually up to 2.87 g-N/kg dry A/d and 2.29 g-N/kg dry C/d (Figs. 1c and 3c), respectively. The acclimation period of both biofilters was observed at about 9d (Figs. 1a and 3a), which was faster than about 20d of acclimation period of peat (2) or activated carbon fiber (ACF) biofilters seeded with night soil sludge (2,4).

From the relationship between load and removal capacity (Figs. 2 and 4), complete removal of A and C was observed at 2.1 g-N/kg-dry A/d and 1.5 g-N/kg-dry C/d, respectively, which reached in 17d (Figs. 1c and 3c). In A and C biofilters seeded with sludge (4), complete removal at 1.5 g-N/kg dry material/d reached in 60d. The physical characteristics of A and C are almost similar (4), but the ammonia removal characteristic of material A is better than that of C (Table 1), indicating that affinity of enriched nitrifying bacteria on the porous of packing material A is higher than C.

References : (1) Hartikainen, T., Ruuskanen, J., Vanhatalo, M., and Martikainen, P.J. 1996. *Environ,Technol.*, 17:45-53. (2) Yani, M., Hirai, M., and Shoda, M. 1998. *J.Ferment.Bioeng.* 85(5) (in press). (3) Weckhuysen, B., Vriens, L., Verachtert., H. 1994. *Appl.Microbiol.Biotechnol.*, 42:147-152. (4) Yani, M., Hirai, M., and Shoda, M. 1996. *Proceed.Ann.Meet.Odor.Res. 9th in Japan*; (5) Kamamoto, M., Yani, M., Hirai, M., and Shoda, M. 1997. *Proceed. Ann.Meet.Odor.Res. 10th in Japan*; (6) Lewis, R.F. and Pramer, D. 1958. *J.Bacteriol.*, 76:524-528.

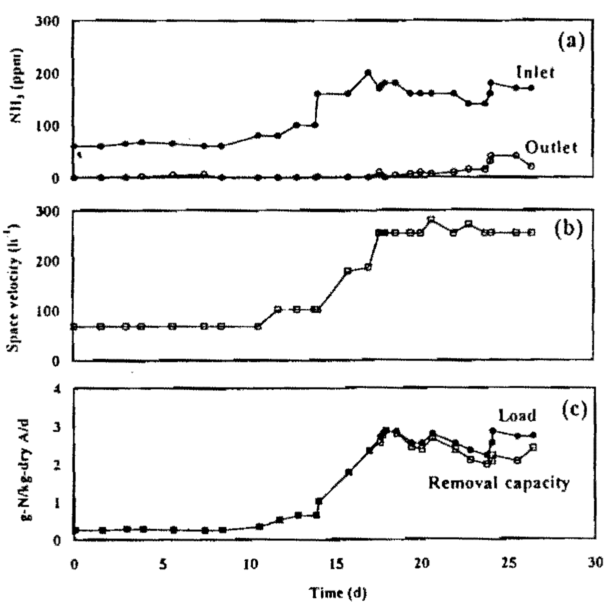

Fig. 1. Ammonia removal by A biofilter seeded with nitrifying bacteria enriched from night soil sludge : (a) inlet and outlet ammonia concentration, (b) space velocity, and (c) load and removal capacity.

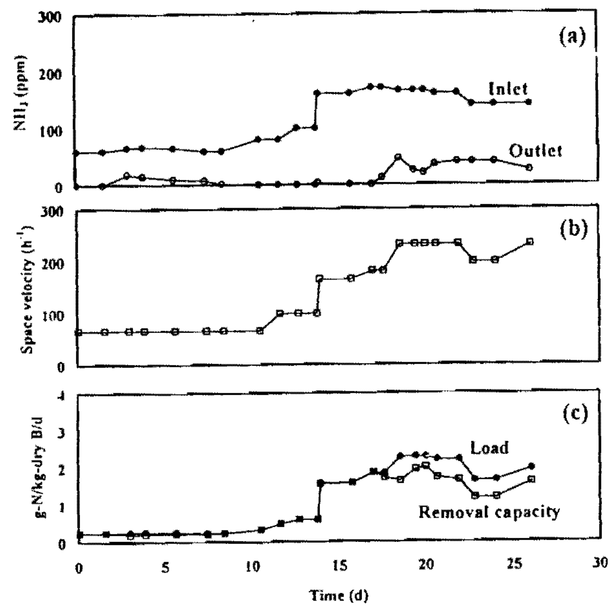

Fig. 3. Ammonia removal by C biofilter seeded with nitrifying bacteria enriched from night soil sludge : (a) inlet and outlet ammonia concentration, (b) space velocity, and (c) load and removal capacity.

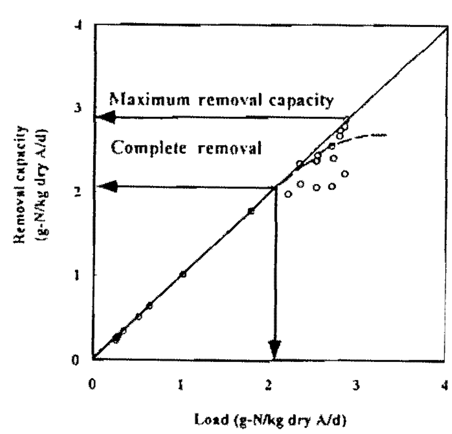

Fig. 2. Relationship between load and removal capacity of ammonia in A biofilter seeded with nitrifying bacteria enriched from night soil sludge.

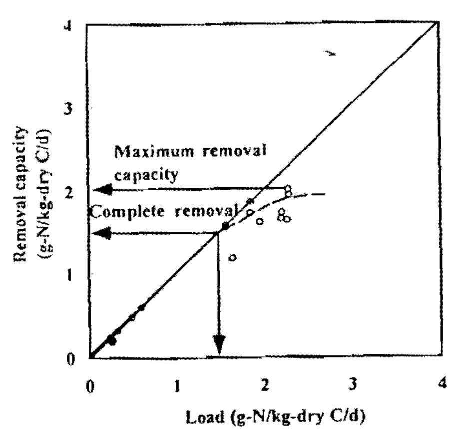

Fig. 4. Relationship between load and removal capacity of ammonia in C biofilter seeded with nitrifying bacteria enriched from night soil sludge.

Key word : ammonia removal, nitrifying bacteria, biofilter, inorganic carrier