第86回年会

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2021
3/22

FOULING CONTROL OF MF MEMBRANE WITH NANOBUBBLES

UFB (ultrafine bubble)

ナノバブルによるセラミック膜のファウリング抑制

Faculty of Science & Technology, Ryukoku Univ.

Professor Tetsuji OKUDA（奥田　哲士）

永井沙希、辻知晃、児嶋大輝（龍谷大）
中井智司、西嶋渉（広島大・院）

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Membrane Filtration

Membrane **pore** size with 10 nm～1 μm.
Removal of particles from water (solution) on the basis of **size**.

advantage

- Eco-friendly
- easy Maintenance
- Space saving
- universal Use

"Share" increasing

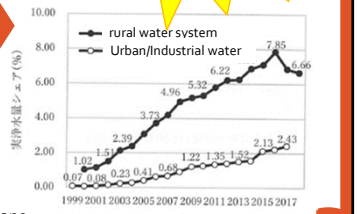

Fig. 1　Share of membrane
（水環境学会誌2021、２月号特集）
図４　全浄水量に占める膜ろ過浄水量のシェア

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However…

Problems

While filtration,
Accumulation of Fumic Substances and others
⇒fouling (pore clogging)

Fig.2　fouling removal

Usual washing (flushing & back washing) +
chemical washing（each few month – year）

⇐ **Water quality Deacrease**

Irreversible Fouling

Strong washing
→ cost, environmental load …

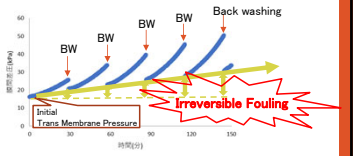

Fig. 3　Irreversible Fouling increase

Research topics:"foulant properties" "pretreatment" "new washing method" …

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UFB（ultrafine-bubble, nano-bubble : NB）

NB
Bubbles *under 1000 nm size*

- Surface properties
- Negative charge
- Stable in water (no-floatation)

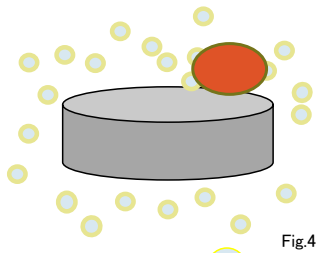
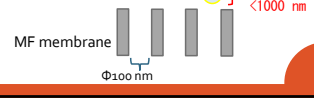


Fig.4
NB Behavior

Adsorption of NB, then detaching with Resistance to water flow
or
Jacking-up effect …



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第55回日本水環境学会年会　2021.3.10 online

逆浸透膜におけるスケール複合バイオファウリング制御へのナノバブルの適用とその洗浄効果

大野 正貴, 田代 和希, 小瀬 知洋, 川田 邦明 ：新潟薬科大学,
奥田 哲士：龍谷大学

Supplied water：複合ファウラント形成水
- *P. aeruginosa* 3.0~6.0 × 10^7 cfu/mL
- glucose 10 mmol/L
- Na_2SO_4 18 mmol/L
- $CaCl_2 \cdot 2H_2O$ 18 mmol/L

Filtration (operation mode)：circulation
- Flux decrease until 60% of initiral

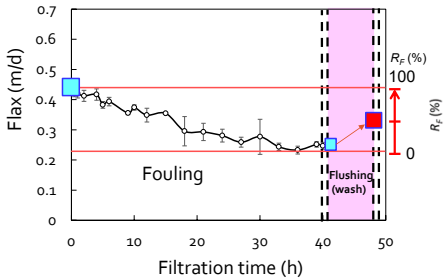

Fig.5 flax decrease.

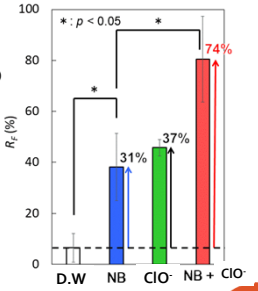

Fig.6 Effects of additives.

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Objective

Possibility of **fouling control** (removal) by using **nano-bubble**

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1）Washing method（flushing：filling phase or back-washing）
2）with Additional（ozone in bubble or activation of surface）

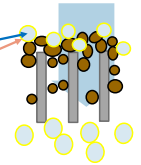

Fig.7 NB actions (Hypothesis)

Washing ability of NB
Effect of bubble properties on it

by TMP decrease (=washing)

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Experiments

Raw water

Seta fiver at Keiji-bypass.
Sieve with 38 ㎛, before MF.

Water Quality

Temperature and turbidly was analyzed at sampling.
Others are determined just before filtration.

Table 1 Raw water quality

採水日	10月27日	11月17日	12月15日
水温(℃)	18.1	15.5	10.0
TOC(mg-C/L)	1.51	1.43	1.55
pH	7.48	7.60	7.70
電気伝導度(mS/m)	14.78	14.77	15.55
濁度(NTU)	21.5	22.1	21.4

Fig.8 Point and picture of/at raw water sampling.

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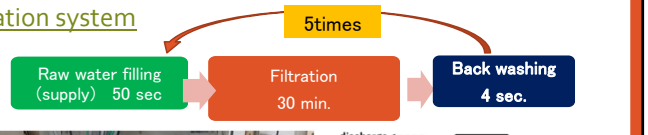
Filtration system



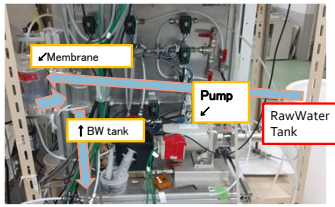


Fig.9 Semi-automatic-membrane filtration system

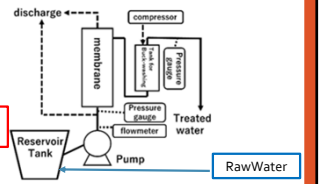


Fig.10 Schematic of membrane folw

Membrane pore size :0.1 ㎛, filtration area :0.041 m^2
Monolith ceramic membrane (micro filter)
(offered by METAWATER Co., Ltd.)

Fig.11

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experimental Design

Surface washing (filling)
Pore washing (Backwashing)

NB dispersion (generation)
Rotational-Flow method with air in 12 L tap water (10 min.)

Ozone-NB dispersion
Ozone gas use instead of the "air" during NB generation.

Tap Water

Ozone solution
(mili-size bubble)
bubbling 10 min.
to12 L tap water


Fig.12 NB generator (RF method)

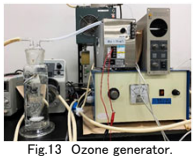
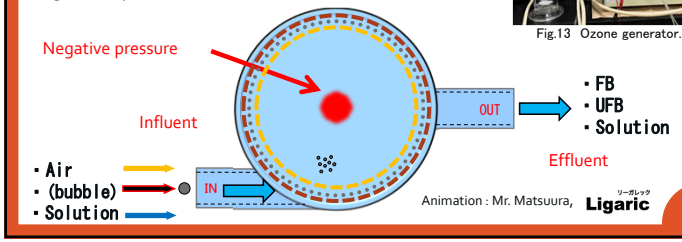


Fig.13 Ozone generator.

Fig.14 NB production with Rotational-Flow method



Animation : Mr. Matsuura, Ligaric

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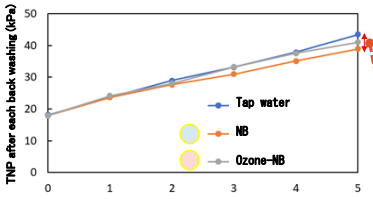
Results at backwashing

Ozone in babbles



Comariton with "tap water" only

Ozone-NB disperson : **8%**
NB dispersion : **17%**

Ozone conc. in gas : 0.6mg/L

IrF Inhibition ratio (%)

$$\left(1-\frac{\text{TMP increase in each washing method}}{\text{TMP icnrease in tap water washing}}\right)\times 100$$

Fig. 15 Effect of NB and ozone on it

Change "NB generation method" + NB activation

JP patent 6731586 (ultrasound method)

UV 30 mins

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Results activation of NB at backwashing

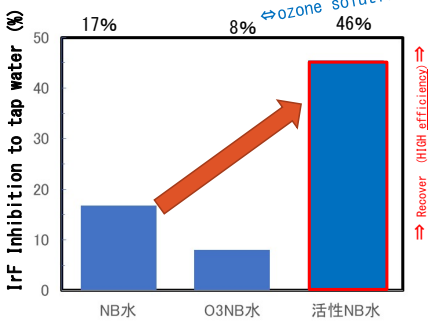

Fig. 16 Effect of ozone content or activation

Flushing :
NB dispersion at filling (not river water)
➡ 14%

mV	NB	Activation
ORP :	+414	→ +227
ζ potential :	-17±1	→ -25±1

※median, concentration was almost same.

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Conclusion

Decrease of IrReversible Fouling during 5 times (30 mins) filtration of river water

Back-Washing
about 20%

+ with ozone in bubble
almost no improvement

+ with activation of surface
about + 30%
⇔ Reduction effect? or Jacking-up effect?

Flushing
about 15%

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Acknowledge

Technical cooperation UFB generation, to activate UFB and to operate automatic membrane filtration system was supported by

Ligaric co.
Bubbletech INC.
METAWATER Co., Ltd. .

Thank you.

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