Development of a new disinfection device using Pernitric acid solution

Principal Investigator

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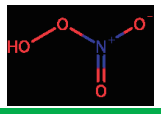
Project Outline

Sterilization by Peroxynitric acid (PNA)



Name	Peroxynitric acid (PNA)
Formula	HNO_4 ($HOONO_2$)
CAS number	26404-66-0

It has been known to exist, but has no applications due to its instability.

There has never been a paper or patent on the use of PNA for sterilization, making it the world's first and only technology [1].

Patent

Sterilization method, preparation for sterilization, and device for producing bactericidal liquid

Patented in Japan, US, UK, Germany, Italy, France, Spain

[1] S. Ikawa, A. Tani, Y. Nakashima, K. Kitano, Journal of Physics D: Applied Physics, 405401(2016).

Chemical synthesis

$$HNO_2 + H_2O_2 \rightarrow \underset{\text{peroxynitrite}}{HOONO} + H_2O$$

$$HOONO + H_2O_2 \rightarrow \underset{\text{PNA}}{HOONO_2} + H_2O$$

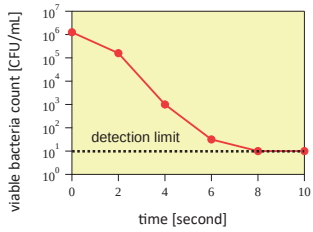
PNA synthesizer

[2] F. Raschig, Angewandte Chemie, 17, 1419 (1904).

Many types pf synthesizer can be provided ※~1M PNA

Sterilization of spore

6.5mM PNA



The D value (time to reduce the bacteria count by one digit) is 1.1 seconds, which is the highest level in the world.

Concentration of PNA

There is a need for disinfectants to be used at lower concentrations than can be harmful. Hydrogen peroxide at 3% is used as oxydol in disinfectants, but at concentrations on the order of 10% it can cause chemical burns, and at concentrations on the order of 90% there is a risk of explosion.

	PNA conc.	equivalent H_2O_2 conc.
undiluted solution	1,000 mM	10,000 %
Medical device sterilization	~10 mM	100 %
Disinfection	~2 mM	20 %

For fungicides, the ratio of fungicidal power to toxicity is important.

Safety studies with animals

	Acute oral toxicity test	Skin irritation test
animal	rat	rabbit
guideline	OECD TG420	OECD TG404
photo		

Sterilization level of disinfection can be applied to living organisms without any problem with 100 mM PNA (1,000% H_2O_2 equivalent).

Material compatibility test

Endurance testing with various materials
Sterilization, washing and drying process ~1000 times

No damage to SUS, O-rings, medical device parts, etc.

Comparison with other bactericides

using spore solution

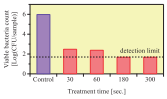
	PNA 1M $HOONO_2$	Oxydol 3% H_2O_2	Antiformin 6% NaClO	Peracetic acid 6% CH_3COO_2H
relative bactericidal activity	3300	1	9.6	400
cost [JPY/L]	1100	1200	28000	27000
cost [JPY/L/bactericidal activity]	0.33	1200	2900	68

PNA solution is odorless.

Unprecedentedly high sterilizing power (equivalent to 10,000% H_2O_2) at low cost

Disinfection of a skin contamination model (pig skin)

Sterilization of vegetative cells (*Staphylococcus aureus*) was simple. Spray jet of PNA solution was applied to pig skin contaminated with spores (*Bacillus subtilis*).



The evaluation criteria for disinfectant efficacy are ~2LogR

The world's first successful sterilization of spores on skin contamination models to the detection limit using disinfectants at concentrations that have been confirmed safe in animal studies

The world's first disinfectant, PNA has an excellent ratio of safety and disinfecting power, and can be applied to various fields from biological disinfection to medical equipment sterilization. The basic patent has been granted in Japan and overseas. Currently, we are building a consortium for research and development of PNA application (http://www.ppl.eng.osaka-u.ac.jp/pna/), in which several companies are participating, and we are looking for new companies to join us.