Test Report

(Translation)

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Company Secret

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To: Protex Co., Ltd.

Test Report

(Translation)

Test (8L space) of deodorization effect by chlorine dioxide agent

北生発 26_0154 号

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1-15-1 Kitasato, Minami-ku, Sagamihara, Kanagawa, 252-0329 Japan
Kitasato Research Center for Environmental Science
Chief Director Toshihiro Ito

1. Test aims

   To confirm to what extent malodorous substance is eliminated by chlorine dioxide generating agent “nanoclo$_2$ portable type” and chlorine dioxide solution “nanlclo$_2$ spray”.

2. Client

   N a m e: Protex Co., Ltd.

   Address: 1-13-14 Hoshogaoka, Nishinomiya, Hyogo, 669-1112 Japan

3. Test institution

   N a m e: Kitasato Research Center for Environmental Science

   Address: 1-15-1 Kitasato, Minami-ku, Sagamihara, Kanagawa, 252-0329 Japan

   In charge: Biotechnology section of Bacteria department

4. Test term

   From May 29, 2014 to July 25, 2014

5. Test object

   Chlorine dioxide generating agent “nanoclo$_2$ portable type” (hereinafter called “nanoclo portable type”)

   Chlorine dioxide solution “nanoclo$_2$ spray” (hereinafter called “nanoclo spray”)

6. Malodorous substance

   ① Ammonia (odor like human waste, lavatory etc.)

   ② Trimethylamine (odor like rotten fish, pet etc.)

   ③ Methyl mercaptan (odor like rotten onion, kitchen etc.)

   ④ Isovaleric acid (odor like sweaty socks, shoes etc.)

   ⑤ Acetaldehyde (stimulating grassy smelling, cigarette etc.)

7. Reagent and equipment/instruments

   1) Main reagents

   - Ammonia solution (Kanto Chemical Co, guaranteed reagent for JIS))
   - 30% trimethylamine solution (Wako Pure Chemical Corp)
   - Methyl mercaptan standard solution (1 μg/μl benzene mixture) (Wako Pure Chemical Corp, malodorous substance test use)

- Isovaleric acid (Wako Pure Chemical Corp, special grade)
- Acetaldehyde (Wako Pure Chemical Corp, extra pure)

2) Main equipment/instruments
- 8L capacity test box (Risu Co, 22 x 32 x 15 cm)
- Stirring fan(Nagao Industry Inc, RDM6025S)
- Gas detector tube gas sampling pump (Gastec Corp, GV-110)
- Gas detector tube (Gastec Corp)
  - For ammonia (3L)
  - For trimethylamine (180L)
  - For methyl mercaptan (70L)
  - For isovaleric acid (81L)
  - For acetaldehyde (92L)

8. Test method

1) Test of "nanoclo portable type"

Test system is shown at photo-1.

In the 8L capacity test box, a stirring fan and a "nanoclo portable type" in usable condition were placed and the box was tightly sealed (photo-1).

Dripping malodorous substance onto the stirring fan, made the substance evaporate.

"10 minutes after the dripping" was set as experiment time "0 minute". And malodorous substance gas concentration was measured in course of time by gas detector tube.

2) Test of "nanoclo spray"

Test system is shown at photo-2.

In the 8L capacity test box, a stirring fan was placed and the box was tightly sealed (photo-2).

Dripping malodorous substance onto the stirring fan, made the substance evaporate.

10 minutes after the dripping, "nanoclo spray" (about 0.3 ml) was diffused once from the side hole of the test box, of which time was set as experiment time "0" minute.

And malodorous substance gas concentration was measured in course of time by gas detector tube.

Photo-1 Test system of “nanoclo portable type”

Photo-2 Test system of “nanoclo spray”

9. Test results

Table 1, 2 and chart 1: Result of ammonia
Table 3, 4 and chart 2: Result of trimethylamine
Table 5, 6 and chart 3: Result of methyl mercaptan
Table 7, 8 and chart 4: Result of isovaleric acid
Table 9, 10 and chart 5: Result of acetaldehyde

Overall, as to “nanoclo portable type” and “nanoclo spray”, the concentration decrease of malodorous substance was confirmed.
As a part of cases, concentration decrease not recognized was “nanoclo spray” against ammonia and isovaleric acid.

Against ammonia, trimethylamine and isovaleric acid, “Nanoclo spray” decreased the concentration with shorter time comparing to “nanoclo portable type”.
Against methyl mercaptan and acetaldehyde, by contraries, “nanoclo portable type” decreased the concentration with shorter time than “nanoclo spray”.

Table 1: Measured value of ammonia (Unit: ppm)

Conditions	Time(hour)					
	0	0.5	1	2	4	20
①Natural attenuation	20	20	19	19	15	10
②nanoclo portable type	20	19	18	16	14	10
③nanoclo spray	22	3	3	3	2	2

Table 2: Residual ratio of ammonia (initial value = 100%)

Conditions	Time(hour)					
	0	0.5	1	2	4	20
①Natural attenuation	100%	100%	95%	95%	75%	50%
②nanoclo portable type	100%	95%	90%	80%	70%	50%
③nanoclo spray	100%	14%	14%	14%	9%	9%

※Test object: Chlorine dioxide generating agent “nanoclo$_2$ portable type”
Chlorine dioxide solution “nanoclo$_2$ spray”

※Test space: 8L test box

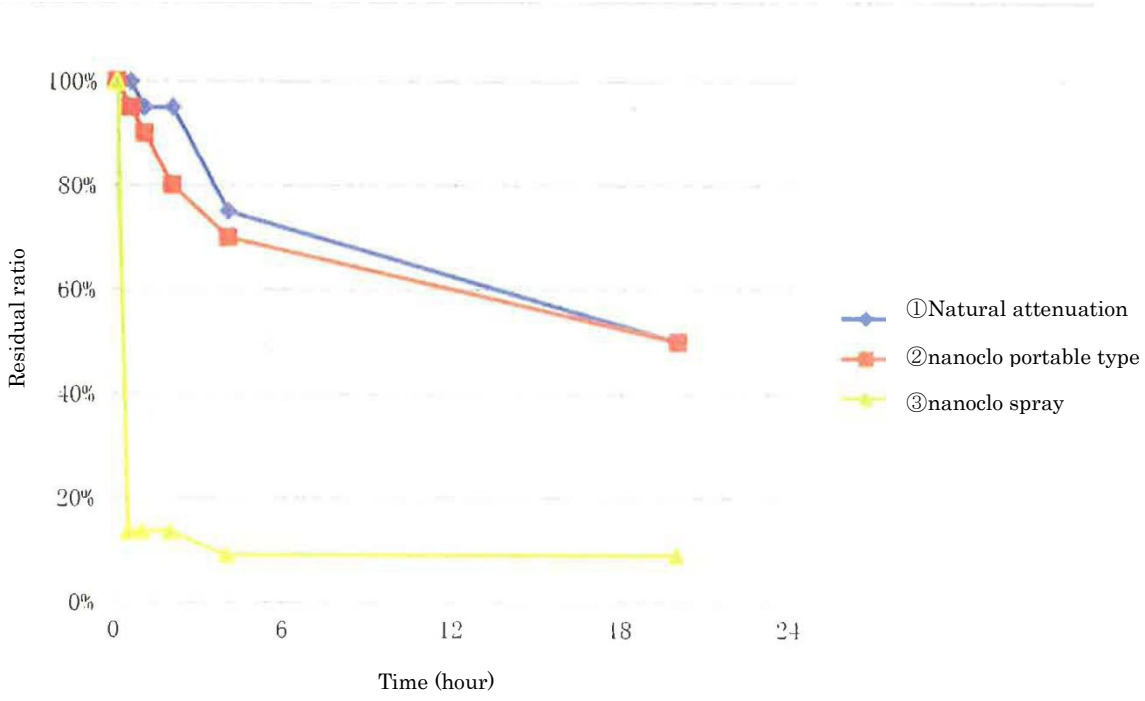

Chart 1: Residual ratio of ammonia

Table 3: Measured value of trimethylamine (Unit: ppm)

Conditions	Time(hour)					
	0	0.5	2	3	4	17
①Natural attenuation	5.5	5	5	4.5	4.5	2.75
②nanoclo portable type	5	4	2.5	1.75	1.5	0.125
③nanoclo spray	5.5	0.5	0.5	0.5	0.5	0.25

Table 4: Residual ratio of trimethylamine (initial value = 100%)

Conditions	Time(hour)					
	0	0.5	2	3	4	17
①Natural attenuation	100%	91%	91%	82%	82%	50%
②nanoclo portable type	100%	80%	50%	35%	30%	3%
③nanoclo spray	100%	9%	9%	9%	9%	5%

※Test object: Chlorine dioxide generating agent “nanoclo$_2$ portable type”
Chlorine dioxide solution “nanoclo$_2$ spray”

※Test space: 8L test box

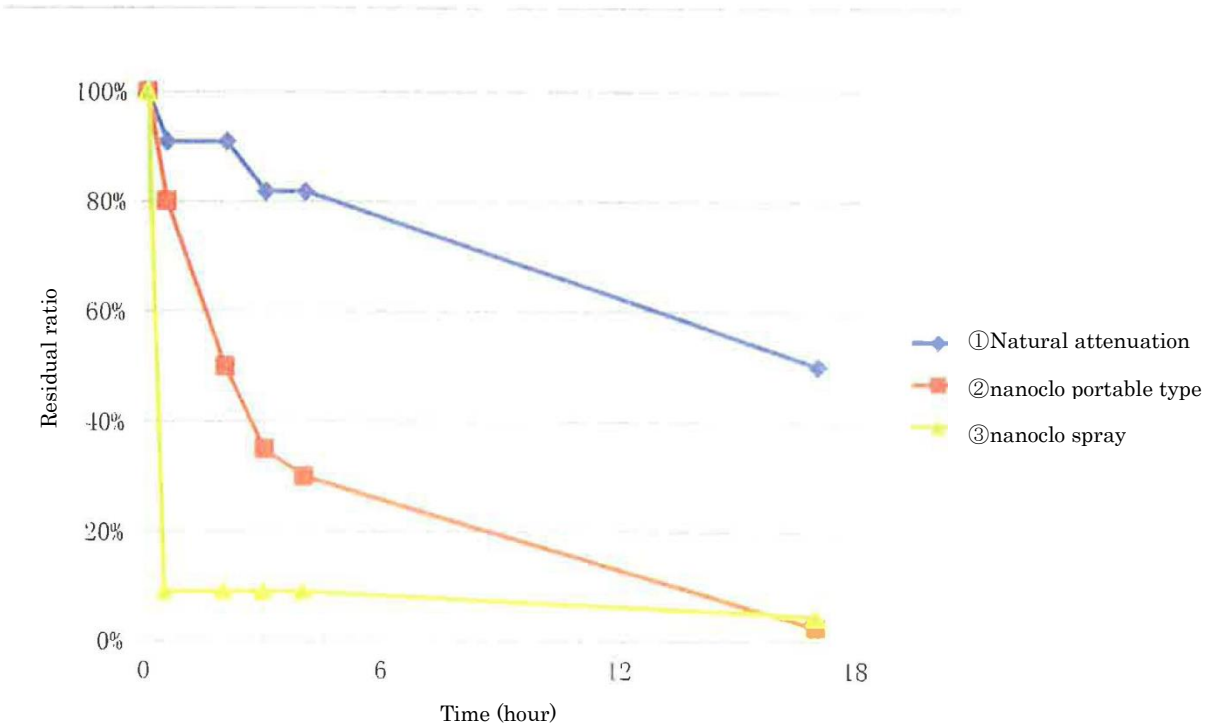

Chart 2: Residual ratio of trimethylamine

Table 5: Measured value of methyl mercaptan (Unit: ppm)

Conditions	Time(hour)								
	0	0.5	1	2	3	4	5	6	7
①Natural attenuation	7.5	7	6.5	5.5	5	4.5	4.5	4	3.75
②nanoclo portable type	4	1	0.5	0.1	0.05				
③nanoclo spray	7	5	4	2.5	1.75	1.25	0.75	0.4	0.25

Table 6: Residual ratio of methyl mercaptan (initial value = 100%)

Conditions	Time(hour)								
	0	0.5	1	2	3	4	5	6	7
①Natural attenuation	100%	93%	87%	73%	67%	60%	60%	53%	50%
②nanoclo portable type	100%	25%	13%	2.5%	1.3%				
③nanoclo spray	100%	71%	57%	36%	25%	18%	11%	6%	4%

※Test object: Chlorine dioxide generating agent “nanoclo$_2$ portable type”

Chlorine dioxide solution “nanoclo$_2$ spray”

※Test space: 8L test box

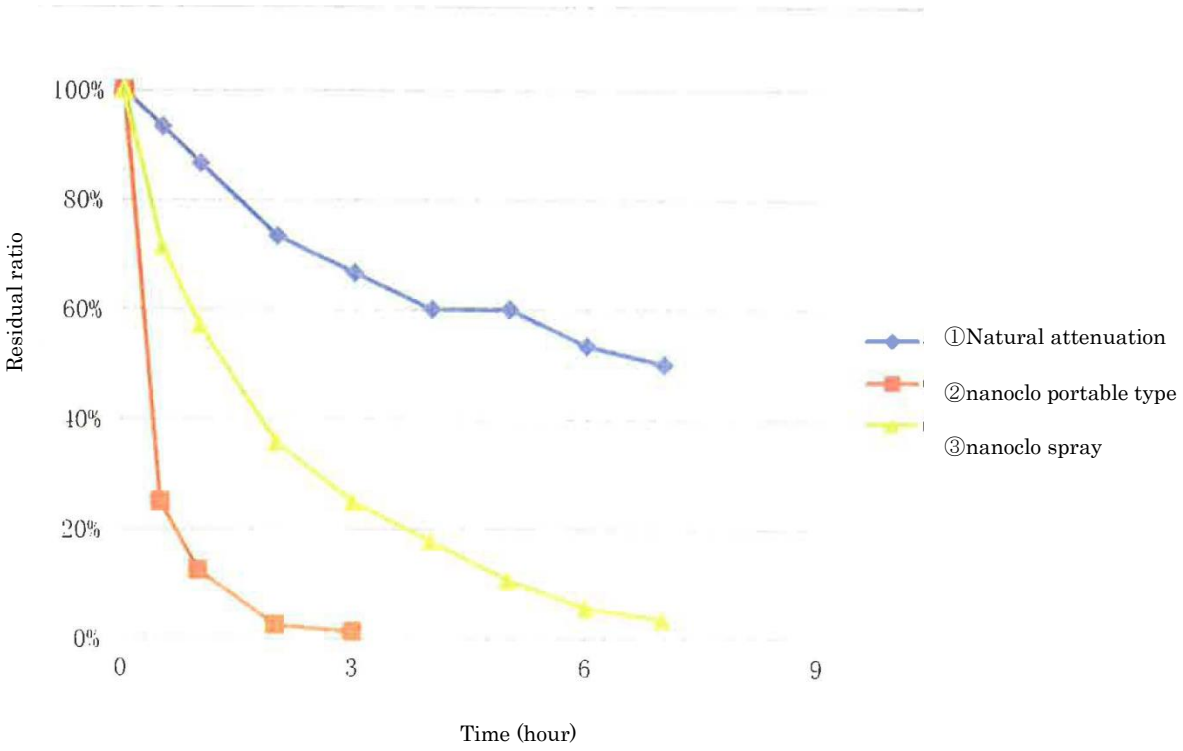

Chart 3: Residual value of methyl mercaptan

Table 7: Measured value of isovaleric acid (Unit: ppm)

Conditions	Time(hour)								
	0	0.5	1	2	3	4	5	6	24
①Natural attenuation	13.5	13.5	10.5	7.5	6	6	6	6	3
②nanoclo portable type	9	9	9	7.5	4.5	4.5	4.5	4.5	1.5
③nanoclo spray	9	7.5	3	1.5	1.5	1.5	1.5	1.5	0.3

Table 8: Residual ratio of isovaleric acid (initial value = 100%)

Conditions	Time(hour)								
	0	0.5	1	2	3	4	5	6	24
①Natural attenuation	100%	100%	78%	56%	44%	44%	44%	44%	22%
②nanoclo portable type	100%	100%	100%	83%	50%	50%	50%	50%	17%
③nanoclo spray	100%	83%	33%	17%	17%	17%	17%	17%	3%

※Test object: Chlorine dioxide generating agent “nanoclo$_2$ portable type”

Chlorine dioxide solution “nanoclo$_2$ spray”

※Test space: 8L test box

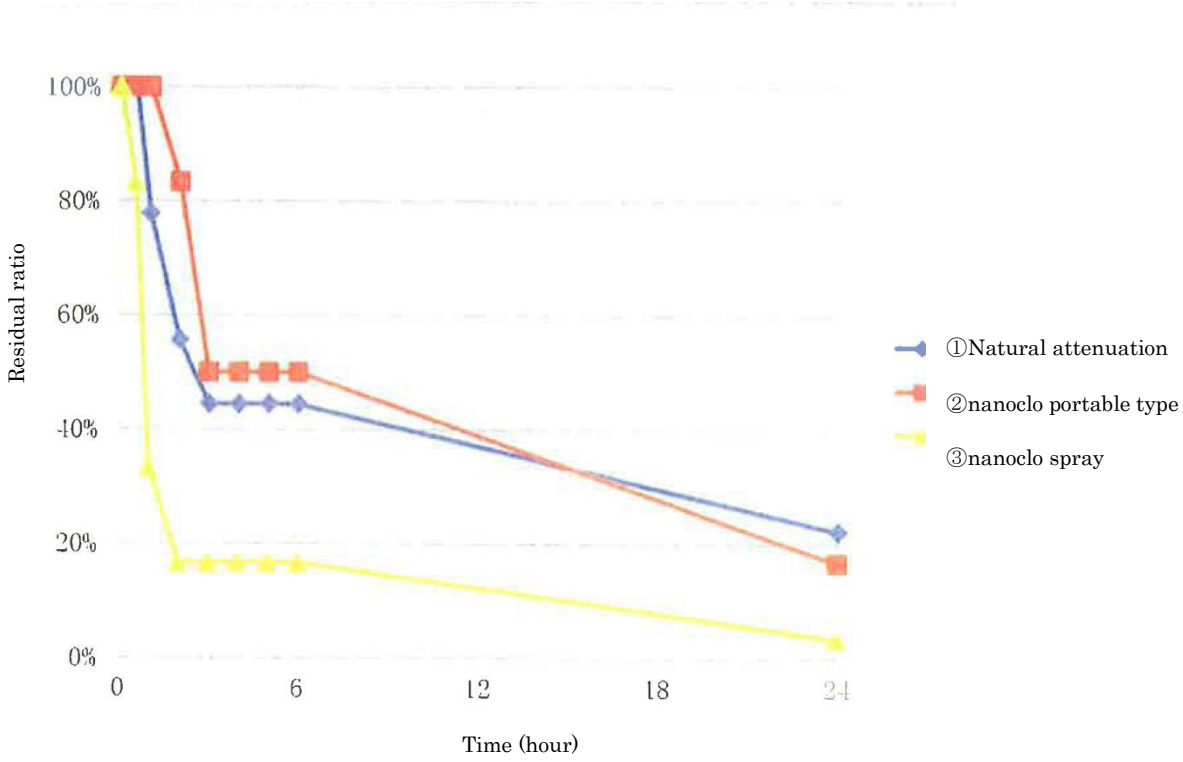

Chart 4: Residual value of isovaleric acid

Table 9: Measured value of acetaldehyde (Unit: ppm)

Conditions	Time(hour)					
	0	1	2	3	6	24
①Natural attenuation	24	24	24	24	24	20
②nanoclo portable type	24	20	18	18	16	8
③nanoclo spray	24	24	22	20	20	12

Table 10: Residual ratio of acetaldehyde (initial value = 100%)

Conditions	Time(hour)					
	0	1	2	3	6	24
①Natural attenuation	100%	100%	100%	100%	100%	83%
②nanoclo portable type	100%	83%	75%	75%	67%	33%
③nanoclo spray	100%	100%	92%	83%	83%	50%

※Test object: Chlorine dioxide generating agent “nanoclo$_2$ portable type”
Chlorine dioxide solution “nanoclo$_2$ spray”

※Test space: 8L test box

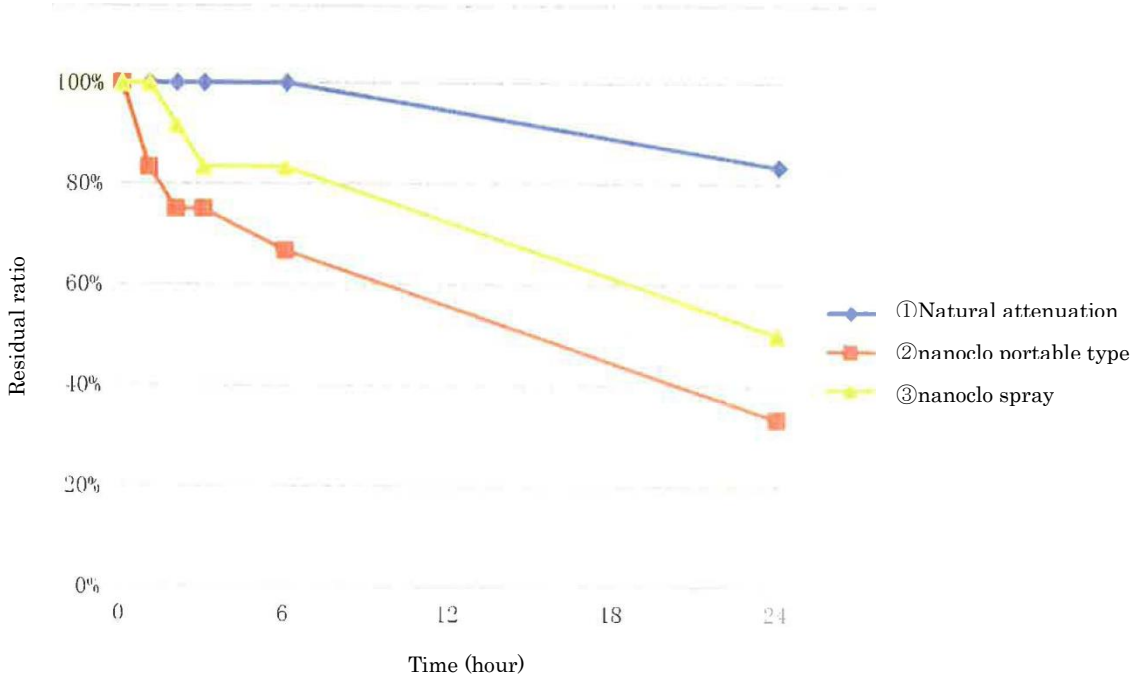

Chart 5: Residual ratio of acetaldehyde