

No. QS3150

Decomposition Test Result of Chlorine Organic Compound by
Excimer Lamp 222

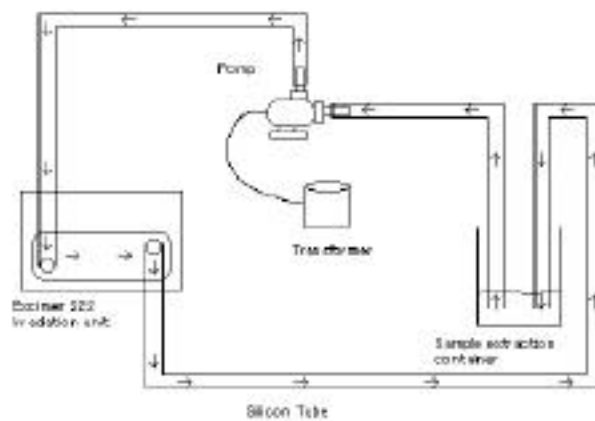
Period April 16th, 1998 to April 27th, 1998

Location Kanagawa Industrial Technology Research Institute

Quark Systems Co.

* System Outline

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Light source : Quark's Excimer Lamp 222nm Dia.18mm x L290mm One

Lamp power : 50W x 1

Irradiation Intensity : Apr.10mWcm²

Quartz Tube : Corning 7940, Transitivity 86%

Pump : Iwaki Corp Magnet Pump MD-15R

Tank material : Stainless Steel

Tank: 2.7 L.

* Tested material

- Trichloroethylene
- 1.1.1-Trichloroethane
- Chloroform
- Nitride group ion, Nitrite group

1. Trichloroethylene

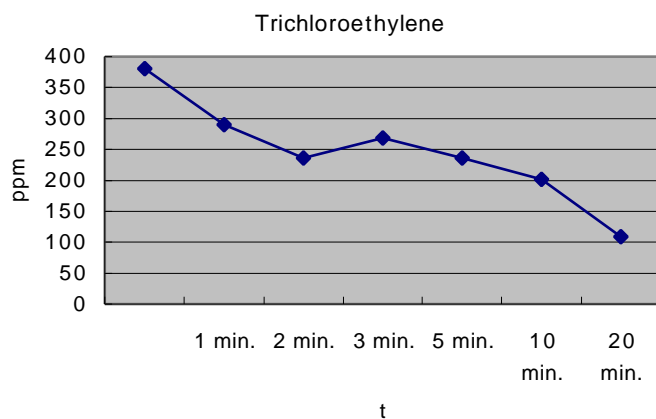
Flow : 4.8 l/min

Solution of silver nitride : silver nitride 0.5g dissolved into 100cc distilled water

Measuring point : before irradiated, 1 min, 2min, 3 min, 5 min, 10 min, 20min

Test method : Quantitative analysis by gas chromatograph mass spectrometry (GC-MS)

Time / Parameters	pH	ORP in mV	Silver nitrate	Density, ppm
Before irradiation	7.34	531		380.261
1min	5.65	538	Oxidation reaction	289.532
2min	no data	no data	no data	235.692
3min	5.3	557		267.997
5min	4.5	593		235.625
10min	3.9	627		201.095
20min	3.61	662		108.626



2. 1.1.1-Trichloroethane

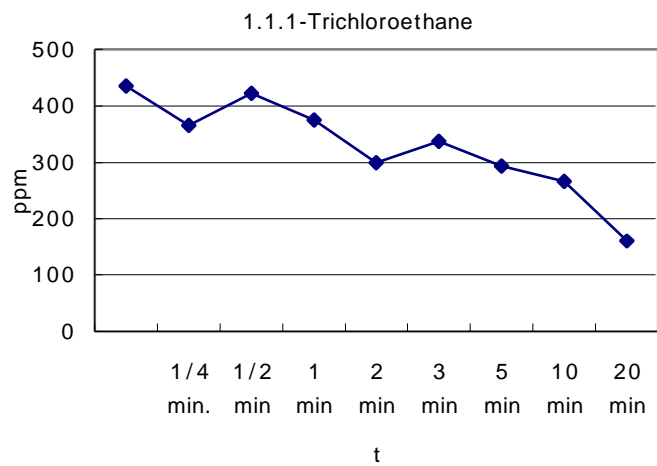
Flow 4.8 l/min

Silver nitride solution : Silver nitride (0.5g) dissolved into 100cc distilled water

Measuring point : before irradiation, 15 sec, 30 sec, 1min, 2 min, 3 min, 5 min, 10 min, 20 min

Test method : Quantitative analysis by gas chromatograph mass spectrometry (GC-MS)

Time/Parameters	pH	ORP, mV	Silver nitride	Density, ppm
Before irradiation	7.8	367		434.902
15 sec	7.15	418	Oxidation reaction	365.303
30 sec	7.11	414		422.585
1 min	7.08	424		375.139
2 min	6.89	440		299.954
3 min	6.76	446		337.263
5 min	6.57	434		293.525
10 min	6.23	465		266.090
20 min	5.39	478		160.764



3. Chloroform

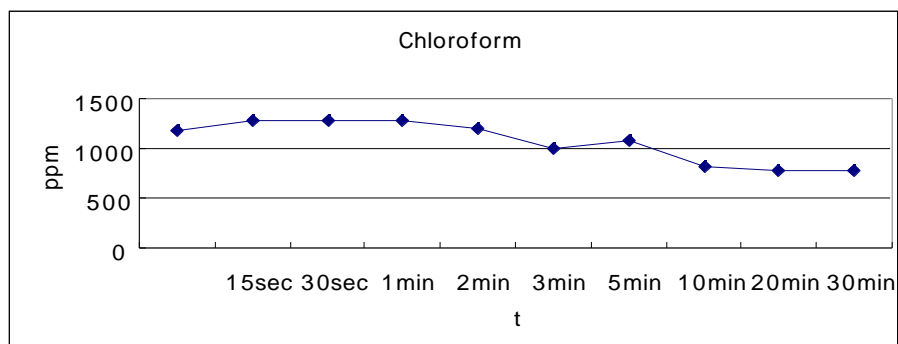
Flow 4.6 l/min

Solution of silver : nitride silver nitride 0.5g dissolved into 100cc distilled water

Measuring point : before irradiated, 1 min, 2 min, 3 min, 5 min, 10 min, 20min

Test method: Quantitative analysis by gas chromatograph mass spectrometryGC-MS

Time/Parameters	pH	ORP, mV	Silver Nitrate	Density, ppm
Before irradiation	7.3	548		1184.159
15 sec	6.40	558	Oxidation reaction	1271.765
30 sec	6.24	570		1285.625
1 min	6.15	560		1278.352
2 min	5.85	581		1203.784
3 min	5.54	594		994.404
5 min	4.97	617		1070.438
10 min	4.20	675		814.252
20 min	3.84	710		788.142
30 min	3.59	724		784.349



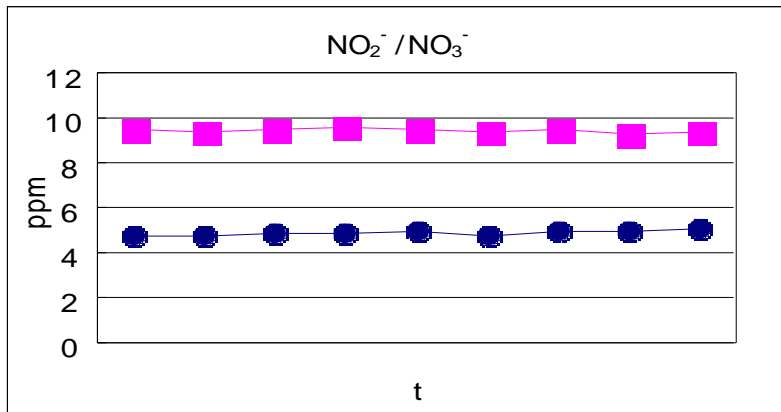
4. Nitrate group ion

Flow 4.8 /min

Measuring point : before irradiation, 5min, 10min, 15min, 20min, 25min, 30min, 45min, 60min

Test method : Absolute calibration curve analysis by ion chromatograph Analyzer (IC)

Time/Parameters	pH	ORP(mV)	Density, ppm		Temperature (Celsius)
			NO ₂ ⁻	NO ₃ ⁻	
Before irradiation	5.21	592	4.755	9.480	22
5 min.	5.35	592	4.742	9.320	22
10 min.	5.46	561	4.870	9.473	22.5
15 min.	5.33	573	4.856	9.610	23
20 min.	5.28	543	4.930	9.465	23
25 min.	5.30	548	4.686	9.339	23.5
30 min.	5.24	541	4.933	9.455	24
45 min.	5.36	526	4.895	9.291	25
60 min.	5.24	532	5.039	9.347	26



$$N/NO_3^- = 14/62 = 0.226$$

$$NO_3^- 1000\text{ppm} \longrightarrow N=226\text{ppm}$$

$$10\text{ppm} \longrightarrow 2.26\text{ppm} \text{ Density} \times 2.26 = \text{Nitrogen Nitrate Density.}$$

$$N/NO_2^- = 14/46 = 0.304$$

$$NO_2^- 1000\text{ppm} \longrightarrow N=304\text{ppm}$$

$$5\text{ppm} \longrightarrow 1.52\text{ppm} \text{ Density} \times 1.52 = \text{Nitrogen Nitrate Density}$$

* Test Method

•Trichloroethylene, 1.1.1-Trichloroethan, Chloroform.

- 1 Inject dosage of substances into 3 litter of distilled water, then disperse and saturate it by ultrasonic.
- 2 Circulate the saturated solution in the equipment with pomp, and obtain a sample from the solution before irradiation.
- 3 Sample at the each plot points with counting irradiation time.
- 4 Measure pH and ORP of samples, and study reactivity by silver nitrate.
- 5 Obtain analysis samples with hexane, analyze it with GC-MS after the test.
 - 5-1 Make 1000ppm standard sample, analyze it with GC-MS, make the calibration curve.
 - 5-2 Conduct quantitative Analysis of samples below with GC-MS as new samples.

• NO_3NO_2

1. Pour NO_3^- 30ml and NO_2^- 15ml into 3 litter distilled water, and make NO_3^- 10ppm and NO_2^- 5ppm solution.
2. Circulate saturated solution in the system with pomp, sample it as a solution before irradiation.
3. Sample at the each plot points with counting irradiation time.
4. Measure pH, ORP of samples, and put a thermometer into the testing sample container, and conduct thermometry.
5. Analyze it with IC right after the test.
 - 5-1 Make NO_3^- 20ppm and NO_2^- 5ppm as standard samples, analyze it with IC, and make calibration curve.
 - 5-2. Conduct absolute calibration curve analysis with IC, as unknown samples.

* Test Result

As you can see on the analysis data, it does not have uniformity, because this was the first test as an actual water treatment system, and had some flaw on the test process.

However, as a good result, trichloroethylene and trichloroethane density became 1/3 in 20 minutes, compared to these before irradiation.

Compared to the graph 1, this result was same as one utilizing combination of titanium oxide film photo catalyst and a super voltage mercury lamps' irradiation.

However, because this test was interrupted in 20 minute, it is not sure how long it takes to decompose the substance completely. So, it would be determined in the next test.

As for chloroform, the density declined between 1 and 10 minutes.

After 10 minutes, it remained a certain density.

As a decomposition trial of inorganic compound, the excimer 222 irradiated nitrate group (ion) and nitrite group (ion) for one hour, the density did not changed, so that we could not obtained a good result.

We briefly report that we obtained such results as above from this test. We are planning to utilize the excimer 172nm in the next test. It will be conducted under same condition, and utilize same substances.

* Feature order of business

We would like to use experience, knowledge, and advice from experts in this test for tests in the future.

Our assignment

- 1 Making solution, which set substance density.
- 2 Longer irradiation time.
- 3 Maintaining the whole system clean and cleaning of containers.
- 4 Adequate flow and sampling method.
- 5 Analysis for wide range of substance such as by-products.
- 6 Improvement of sealing degree for the whole system in order to consider safety for the gas
- 7 Utilizing 172-nm center wavelength as illuminant.

Improvement of irradiation unit.

* Reference

1. Hiroshi Tougeda, Eiji Watanabe, Kazumi Kato : Race and Drainage, Photo Catalyst treatment with film catalyst for chlorinated organic compounds, April 1996.