Decomposition of Perfluorinated Compounds using Plasmas in Bubbles with Circulation of Exhaust Gas

Plasma within bubbles in water

WATER TREATMENT WITH PLASMA

PFOS (a type of PFCs)

- Have interfacial activity
- Used in semiconductor industry
- Act as a carcinogen

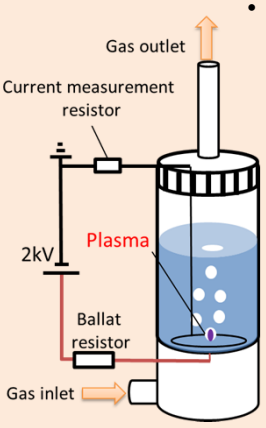
It's necessary to decompose

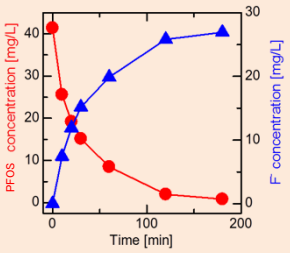
Targets		Techniques		
Substances	Bond	Ozone	AOPs[1]	Plasma
Humic acid	double bond	○	○	○
Dioxin-like compounds	single bond	×	○	○
PFCs[2] (Perfluorinated Compounds)	**fluorine bond**	×	×	○

[1] AOPs (Advanced oxidation processes) are chemical treatment procedures designed to remove organic materials by oxidation through reactions with hydroxyl radicals (·OH).
[2] PFCs are man-made fluorosurfactants and global pollutants. In May 2009 PFCs was included in Annex B of the Stockholm Convention on persistent organic pollutants.

PLASMA WITHIN BUBBLES

- PFOS can be decomposed by a plasma





Disadvantages

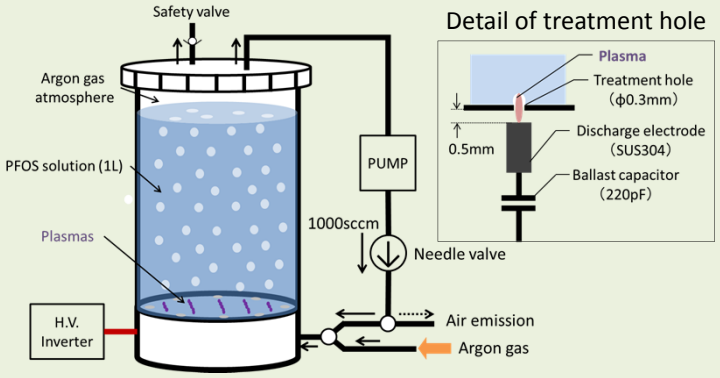
- Very minor treatment capacity
- Emission of greenhouse gases

Many plasmas generation with gas circulation is required.

Many plasmas generation with gas circulation

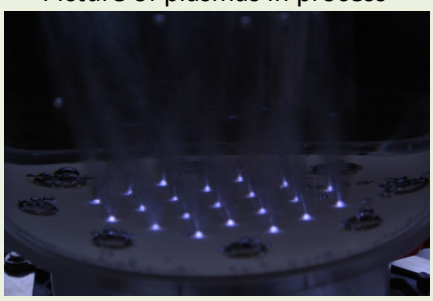
Experimental technique

— PFOS decomposition system with gas circulation —



	convetional	New reactor
Discharge method	DC	AC (20 kHz)
Treatment capacity	50 mL	**1000 mL**
Number of Plasma	1	**21**
Gas circulation	None	**Available**

Picture of plasmas in process



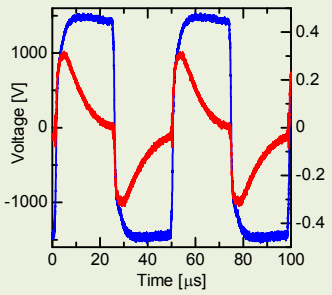
Experimental results

Experimental condition

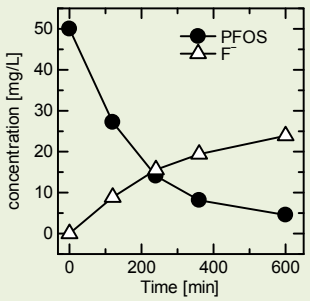
Target : PFOS solution
Quantity : 1000 mL
Initial concentration : 50 mg/L
Gas bubble : Argon (100sccm)
Inverter frequency : 20 kHz
Average Power : 114 W
Treating time : 600 min
Total input energy : 1140 Wh

Degradation of PFOS with 21-plasmas

Waves of voltage and current



Time dependence of PFOS conc.



- 21-plasmas can decompose 91% of PFOS in 600 minute.
- The treatment capacity is up to 20 times larger than conventional DC plasma reactor.
- Fluorocarbon gases contained in the exhaust gas are exposed to the plasma and can be decomposed.
- Gas consumption of argon is considerably reduced using circulation of exhaust gas.

We have successfully decomposed the large amount of PFOS solution with 21-plasmas.

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