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MERCURY EMISSION CONTROL BY WET SCRUBBER WITH SUPER STATIC MIXER

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Background & Objectives

- Mercury emission from various combustion sources will be regulated near future in Japan.
- Japan experienced the severe damage in 1950s.
- Some mercury removal tests such as powdered activated carbon injection (PAC) into flue gases have been tried over the past few years.
- However, the PAC injection has some drawbacks such as high cost, narrow working temperature window, and insufficient capacity of adsorption.

Therefore, alternative techniques having low cost and high efficiency are desired.

Mercury partitioning and emission

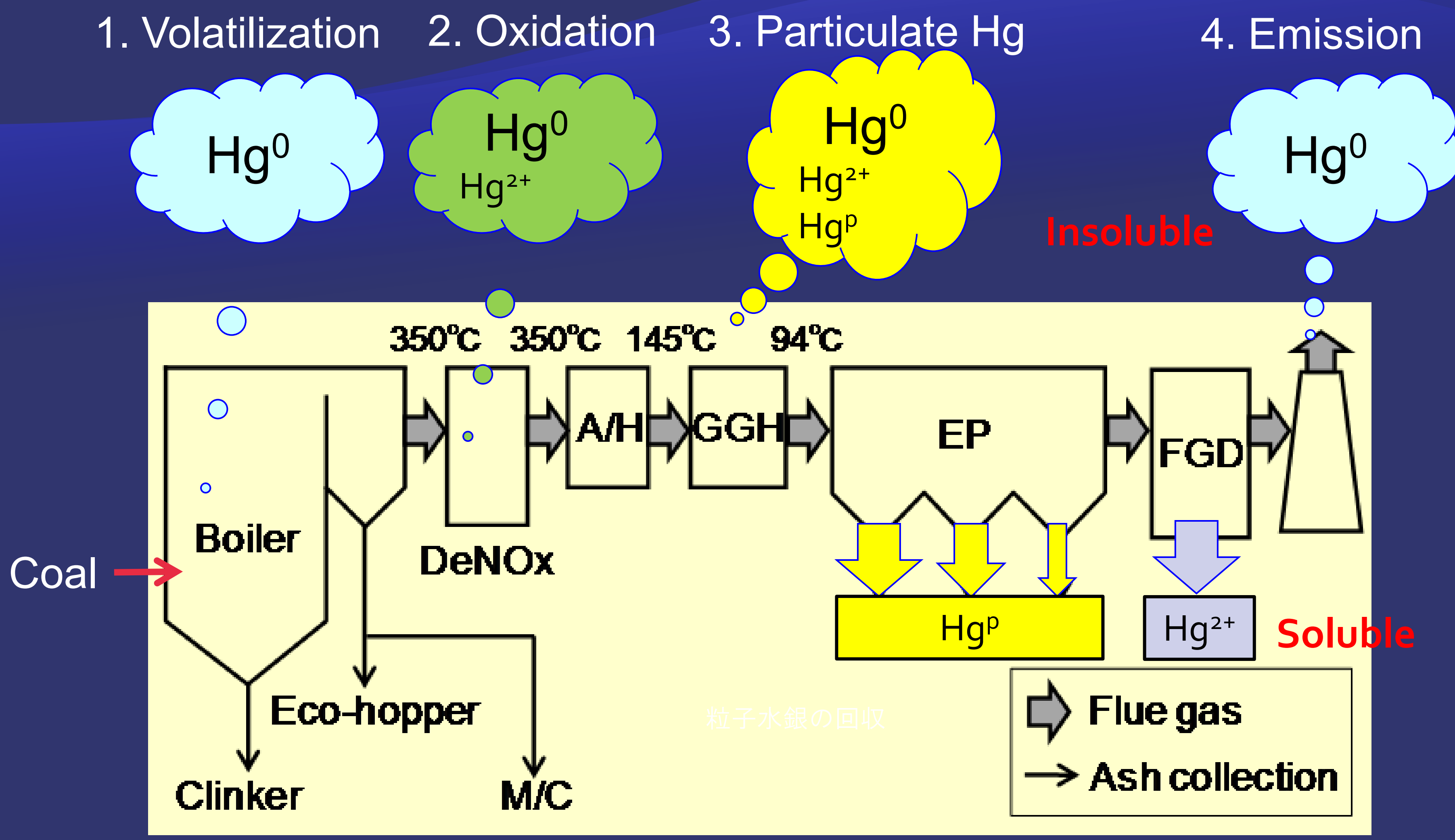


Fig.1 Mercury partitioning in a typical pulverized coal fired power plant and its emission.

Mercury emission from a large scale plant

15%—95% mercury in raw coals are emitted to atmosphere.

High efficiency for mercury removal is desired.

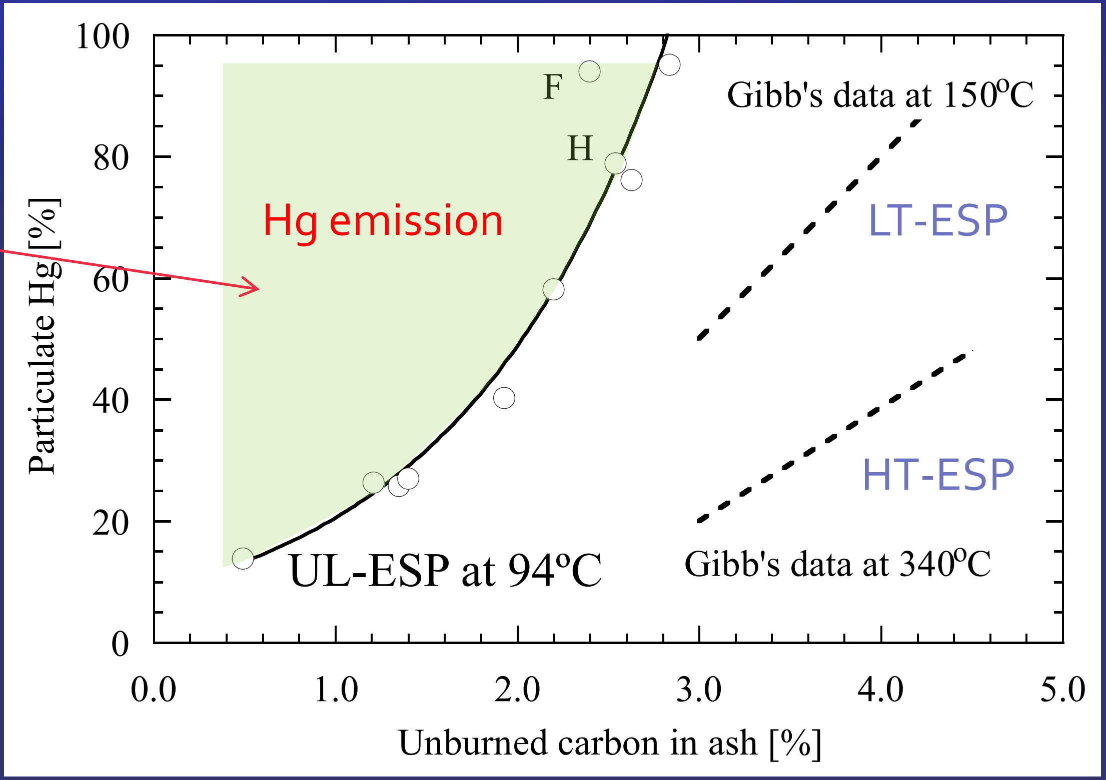


Fig.2 Relation between particulate mercury and unburned carbon in ash for various types of ESP. Data of UL-ESP were determined by ash analysis collected from a 1000 MWe power plant.

Outline of Mercury emission control

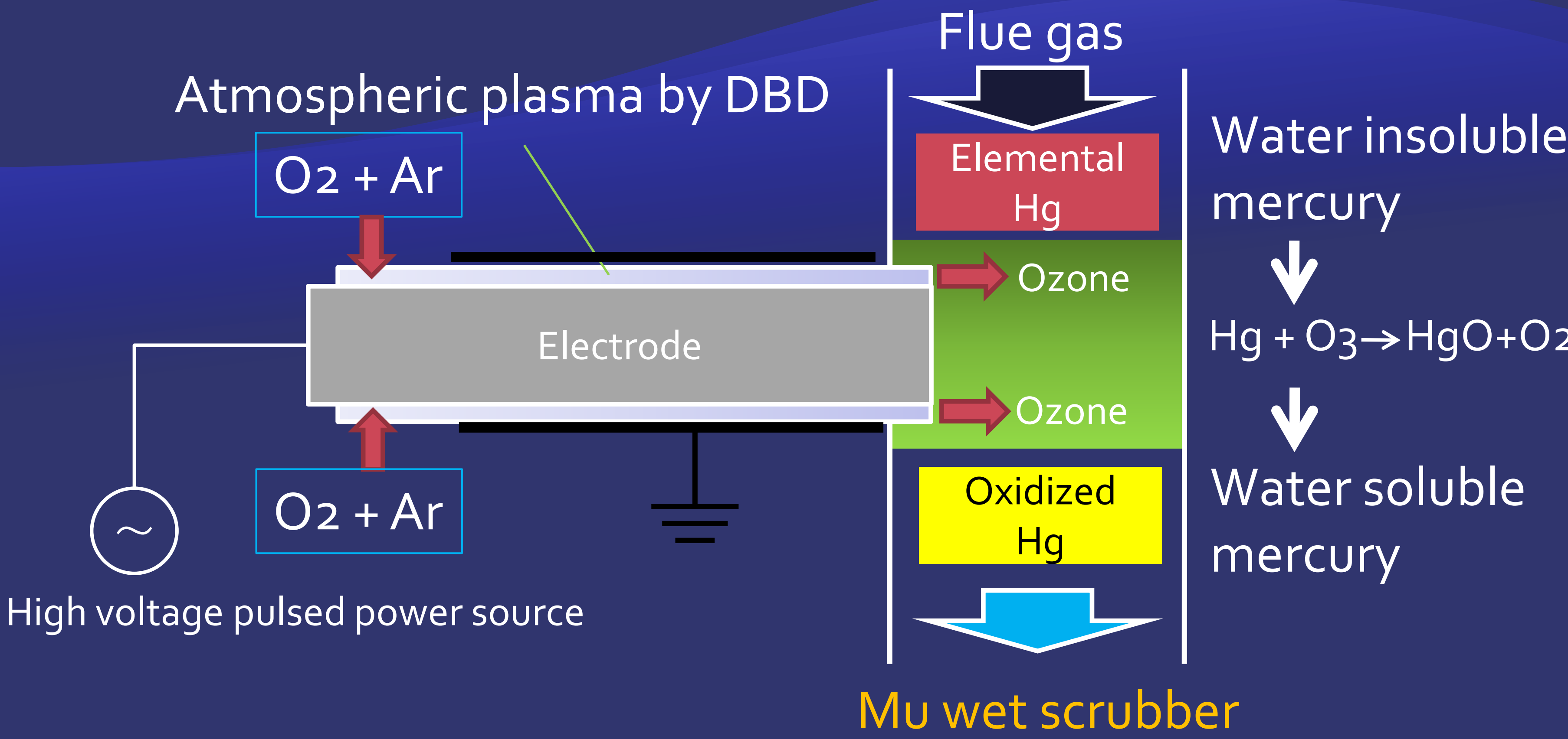


Fig.3 An outline of mercury emission control system by ozone injection.

Advantages

+ Simple configuration
+ Low power consumption
+ Wide temperature window

Experimental Setup

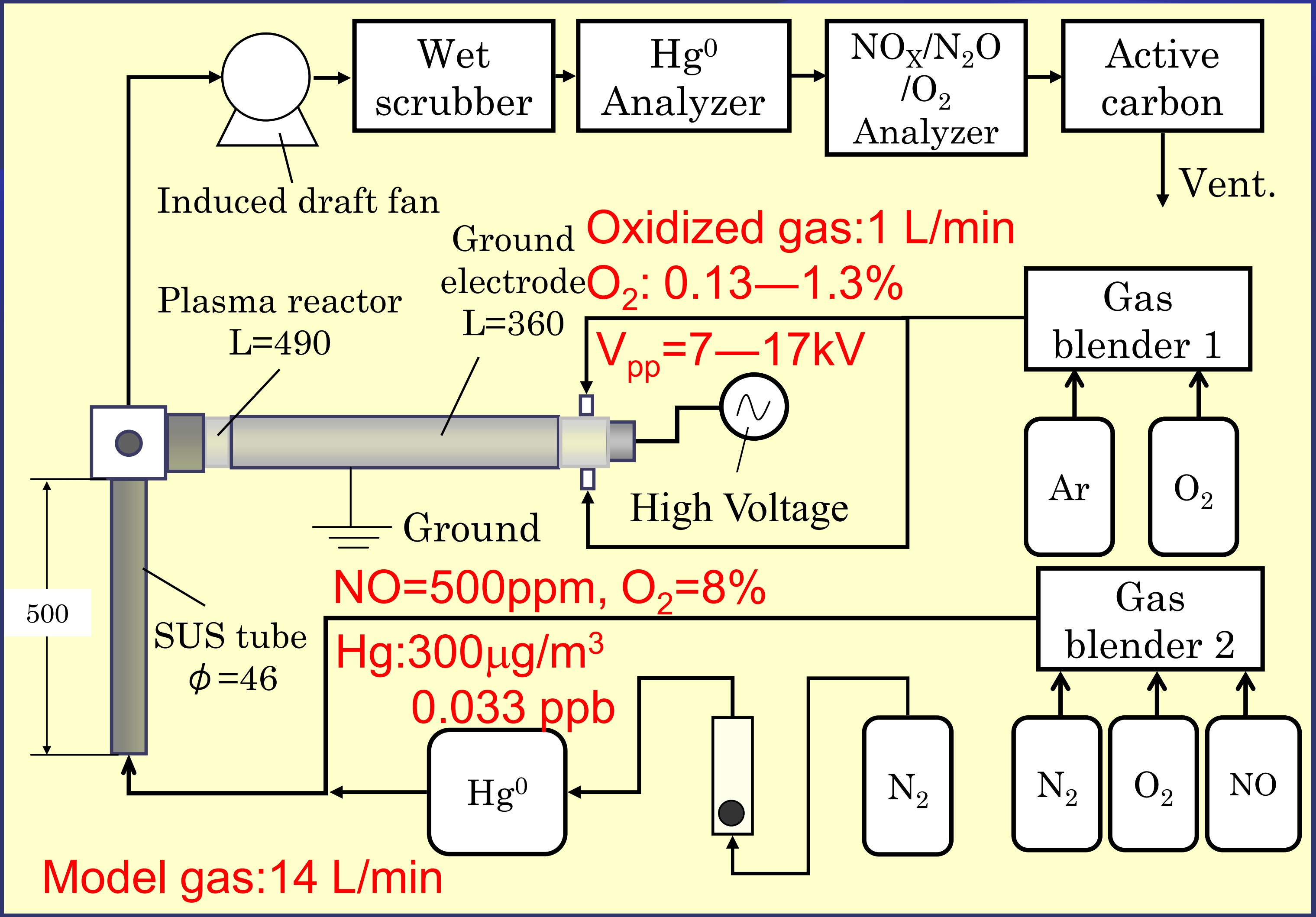
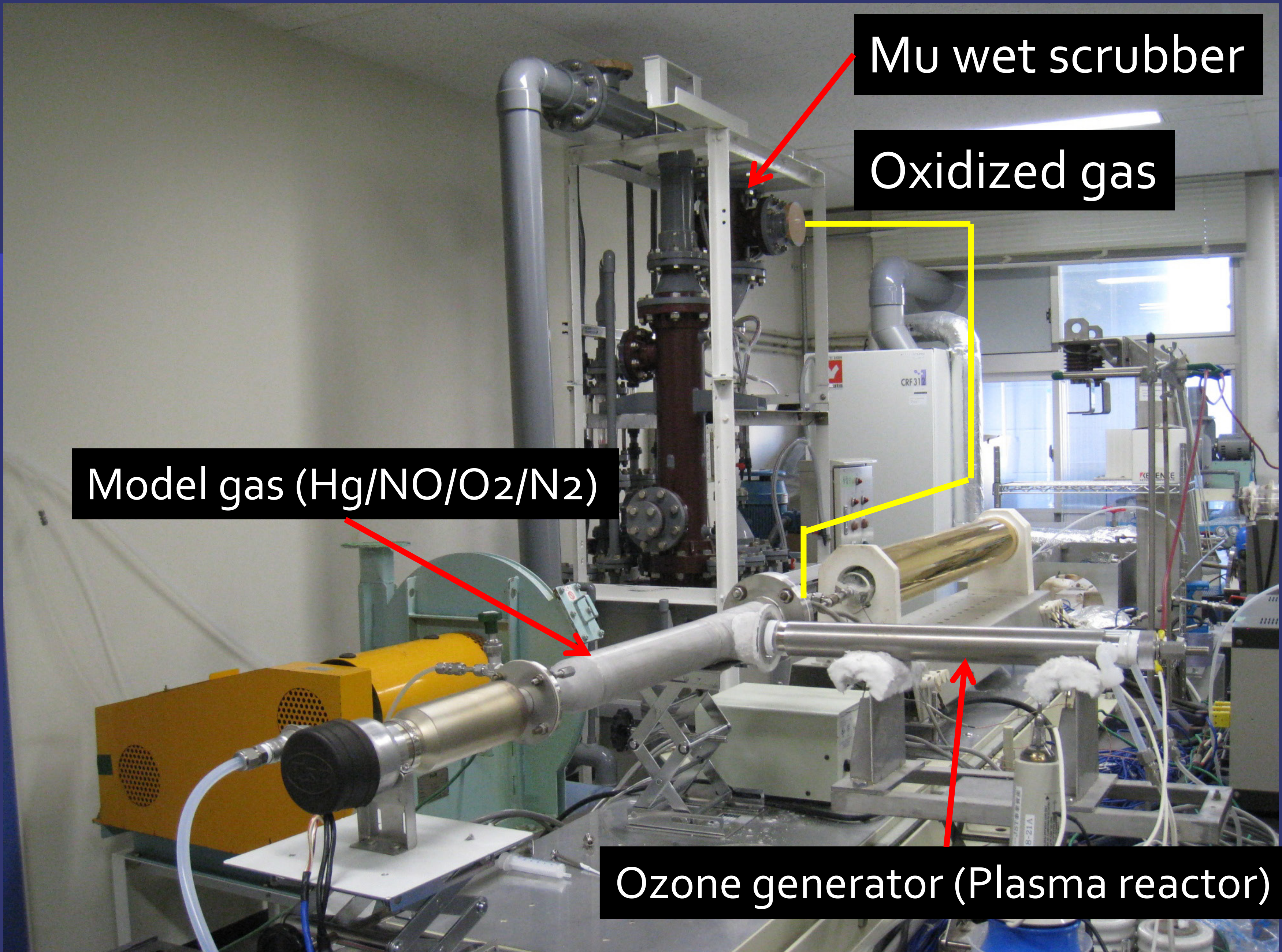
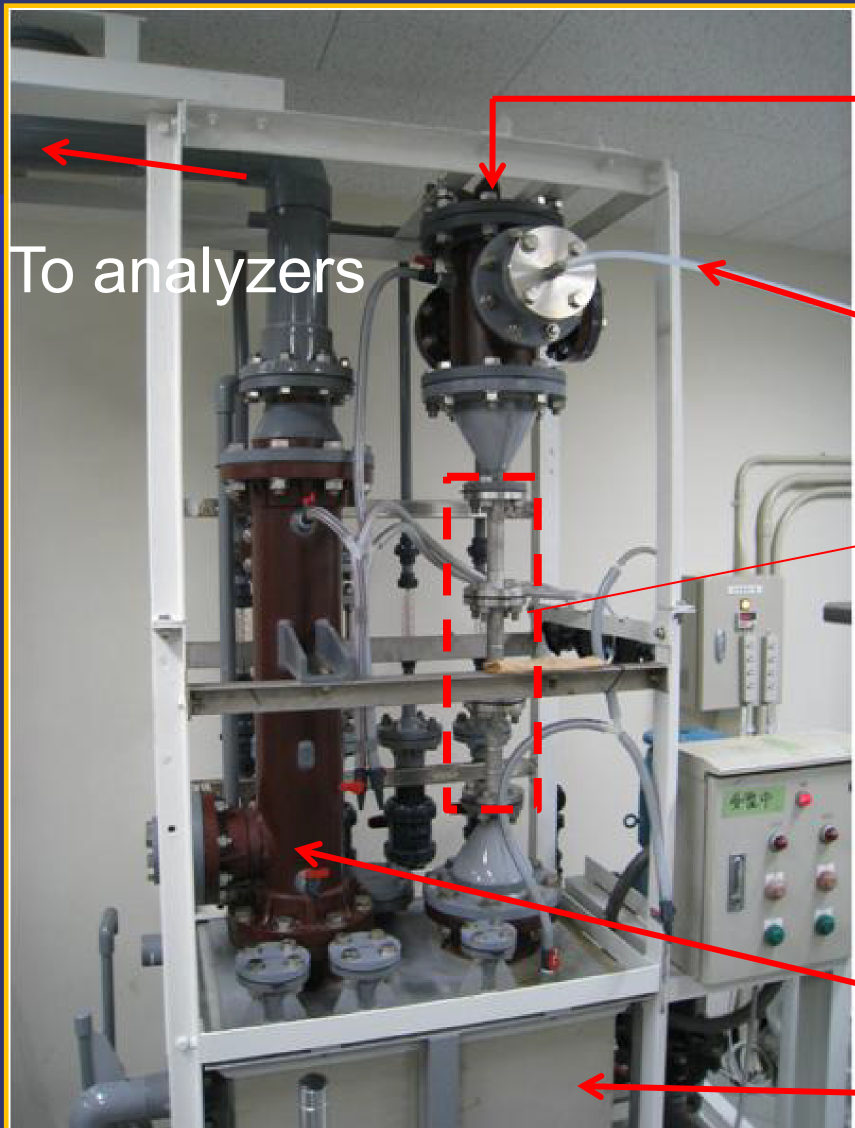


Fig.4 Test facility for mercury removal by O_3 injection and wet scrubber.


Mu wet scrubber
Oxidized gas
Model gas (Hg/NO/O2/N2)
Ozone generator (Plasma reactor)

Configuration of the Mu Wet Scrubber



Water feeder 1.5 L/min
(L/G ratio = 0.1)

Total flow
(15 L/min)

Static Mixer

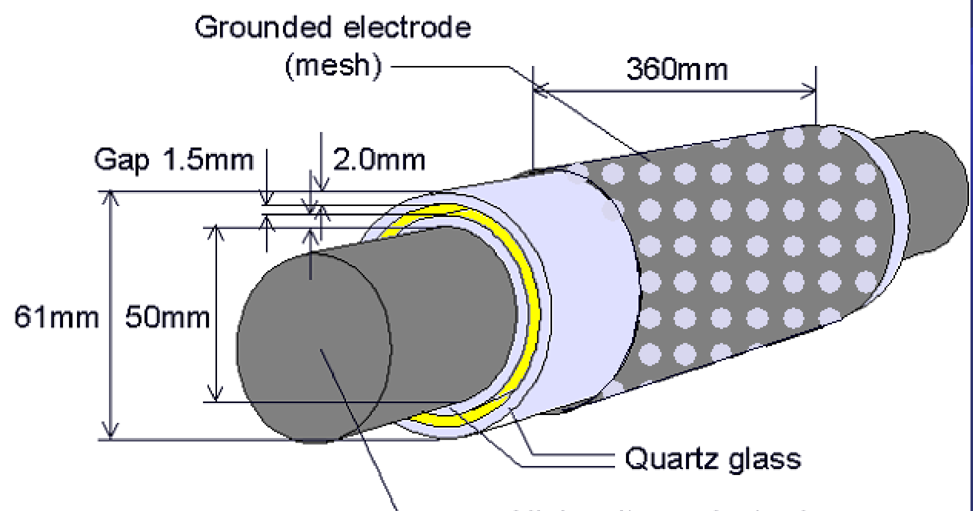
Advantages

- + Simple configuration
- + Strong mixing
- + Little consumption of the water

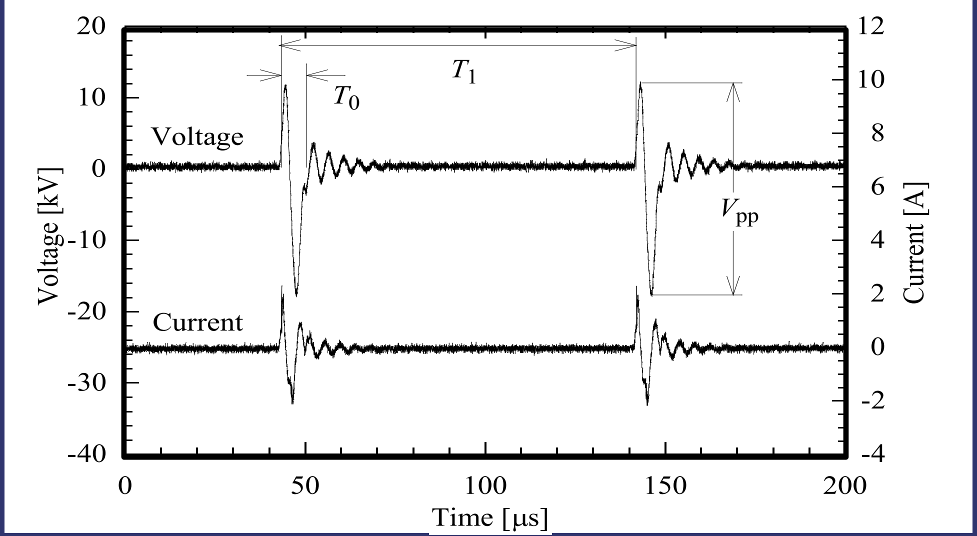
Separator

Water tank

Details of the plasma reactor



coaxial structure



V_{pp} = 7—17 kV

$1/T_1$ = Repetition rate = 10 kHz

Time of one cycle waveform T_0 = 10 μs

Current = 4 A

Fig. 5 Waveform of the discharge voltage and current from an pulsed power source.

Results of Hg removal (Effect of V_{pp})

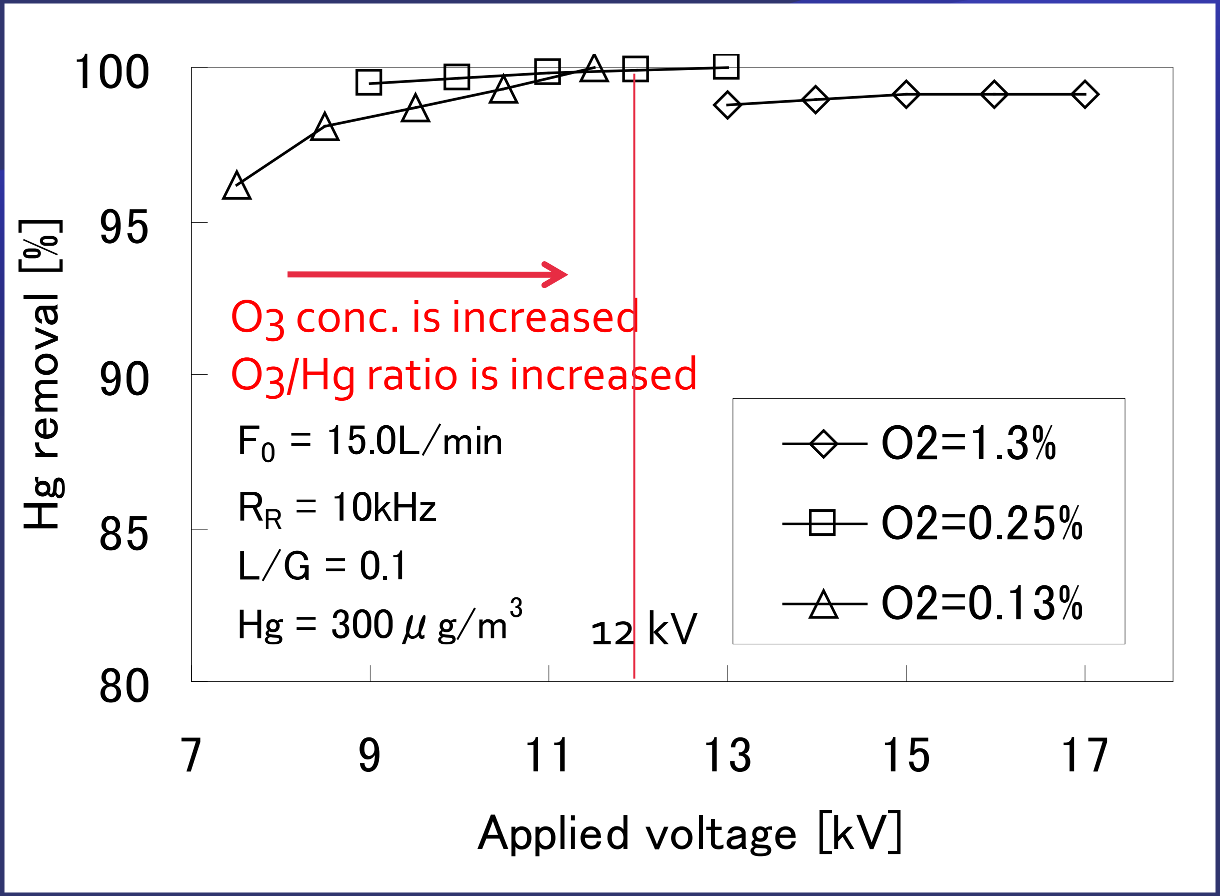


Fig.6 Performance of Hg removal as a function of the applied voltage and oxygen concentration in the plasma reactor.

Complete Hg removal was attained at Vpp = 11.5 kV and O2 = 0.13%.

Results of NO removal

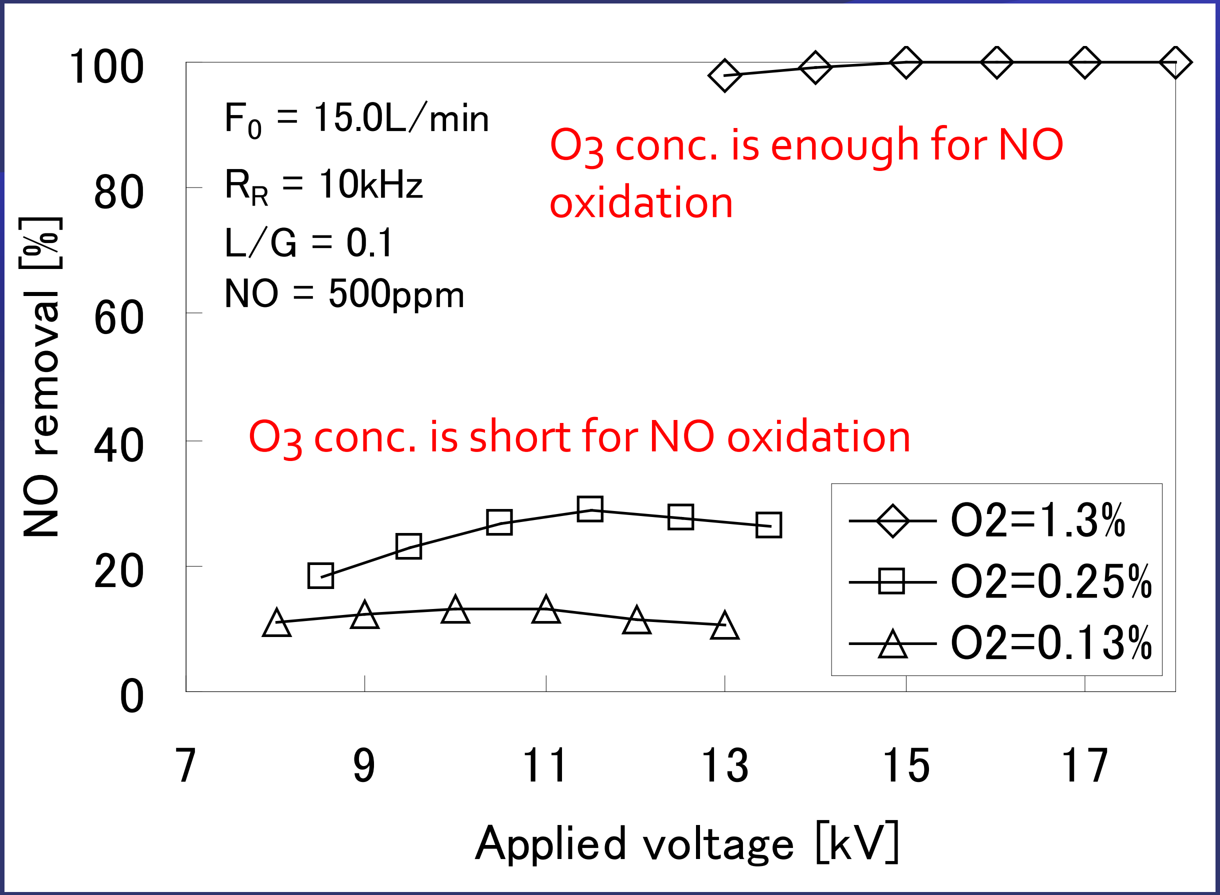
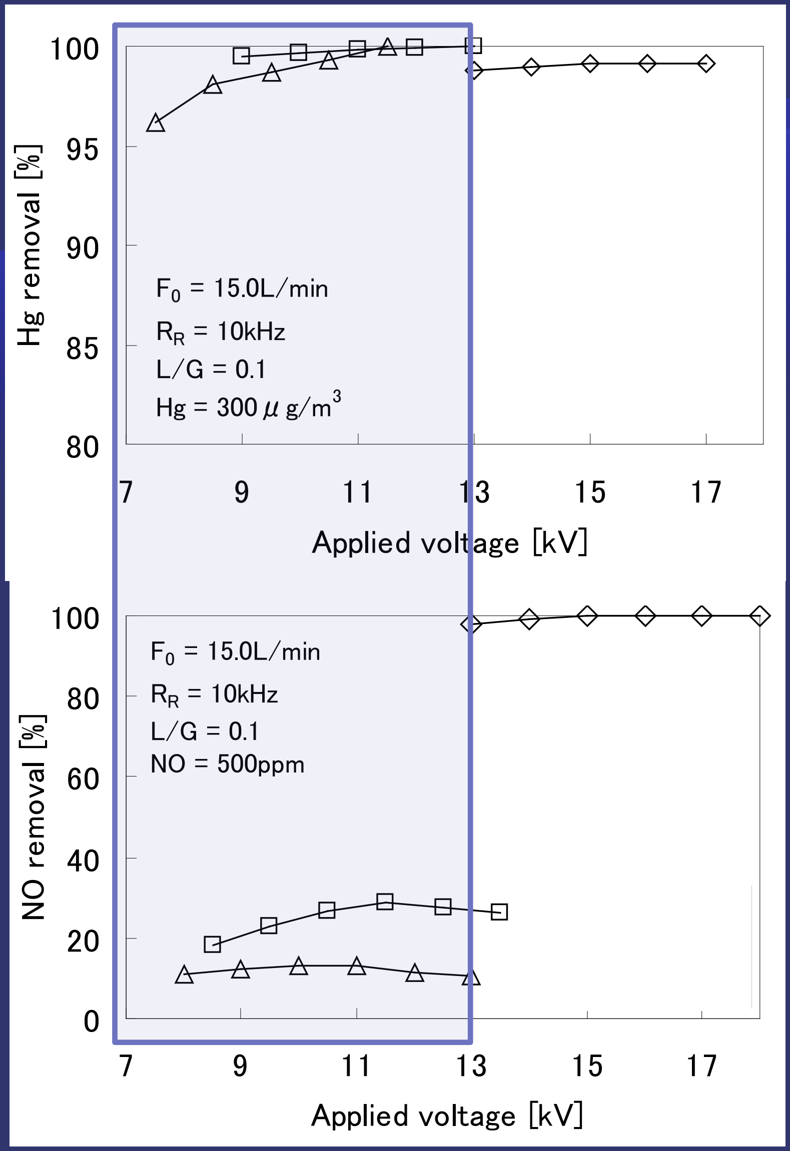


Fig.7 Performance of NO removal as a function of the applied voltage and oxygen concentration in the plasma reactor.

High NO removal was attained at Vpp = 15 kV and O_2 = 1.3%.

Behavior at lower ranges of V_{pp}



At lower applied voltage and O2 conc.

$$Hg + O_3 \rightarrow HgO + O_2$$

is high conversion, because O_3/Hg ratio is high.

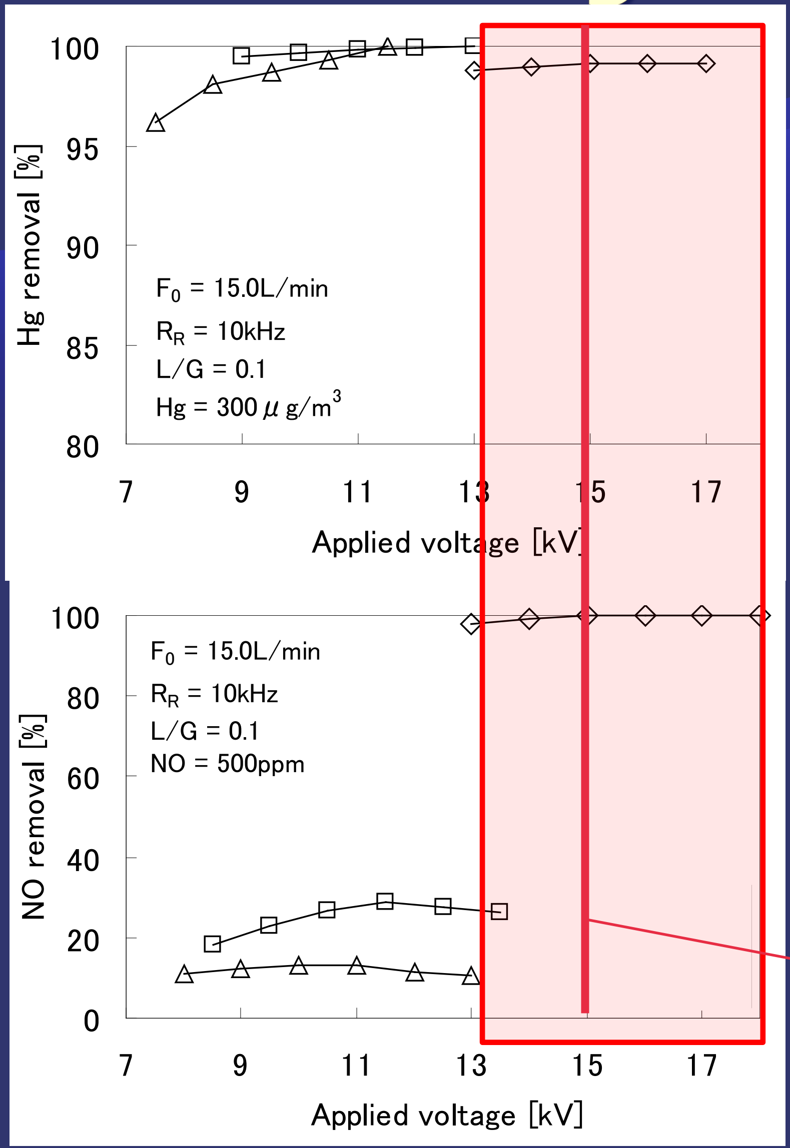
But reaction in NO oxidation

$$NO + O_3 \rightarrow NO_2 + O_2$$

is low conversion, because O_3/NO ratio is low.

Fig.8a Comparison between Hg removal and NO removal at lower ranges of the applied voltages.

Behavior at higher ranges of V_{pp}



At higher applied voltage and higher O2 conc.,
NO oxidation may occur selective reaction

$$NO + O_3 \rightarrow NO_2 + O_2$$

In Hg oxidation,

$$Hg + O_3 \rightarrow HgO + O_2$$

is high conversion, however O_3/Hg ratio is slightly decreased by selective NO oxidation.

Optimum conditions

Fig.8b Comparison between Hg removal and NO removal at lower ranges of the applied voltages.

Summary

- Hg removal and NO removal was examined by using the oxidation process and the absorption process.
- Hg and NO were oxidized by ozone generated by atmospheric plasma.
- Hg and NO removal were depended on O2 concentration in plasma reactor and V_{pp}.
- 100% NO removal and 98% Hg removal was attained at V_{pp}=15kV and O2=1.3%.

Future plans

Development of Hg/NOx removal system for medical waste incinerators.

Fig. A typical incinerator for medical waste incinerators.

Incinerator (10t/D) → Bag filter → Ozone injector → Mu scrubber