

# Basic study of water treatment by low discharge in the bubbled water

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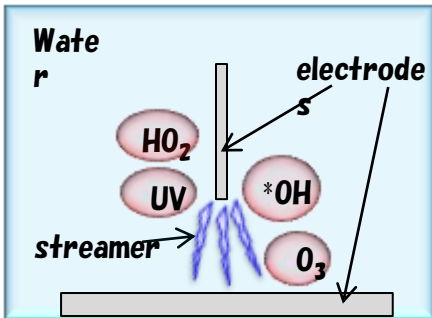


## INTRODUCTION

The current water treatment technology has some problems such as chemical restriction. Therefore, we carried out the discoloration of indigo carmine solution and inactivation of *Escherichia coli* by discharge in water below 10 kV, which is not used chemicals.

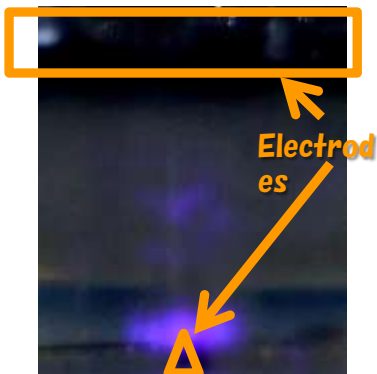
## METHODS

### (1) Discharge in water



Environment load of discharge in water is little since chemicals are not used.

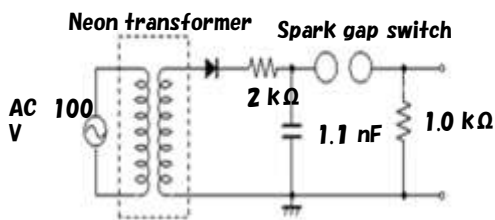
Image of discharge in water



Bubbles with brightly discharges are observed.

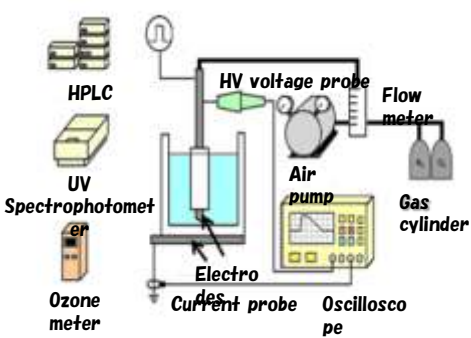
### (2) Experimental setup

#### A pulse voltage supply



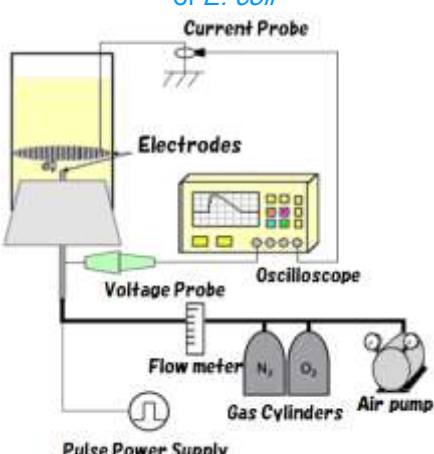
Pulse voltage is used for discharge in water to prevent temperature rise by joule effect and electrolysis.

#### Experimental setup for discoloration of indigo carmine solution



Dry air, nitrogen, and oxygen are supplied by using an air pump and gas cylinders. The concentration of indigo carmine solution is analyzed by HPLC and UV spectrophotometer. Dissolved ozone concentration is measured by ozone monitor.

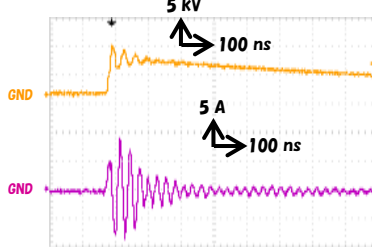
#### Experimental setup for inactivation of *E. coli*



Inactivation effect of discharge in water was inspected by comparing the number of colonies with and without discharge.

## RESULTS

### (1) Electric characteristics

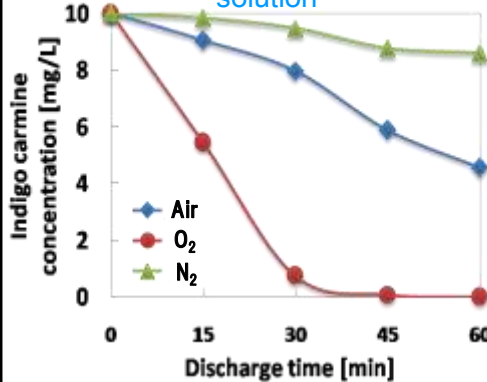


Discharge voltage 7.8 kV

Discharge current 5.8 A

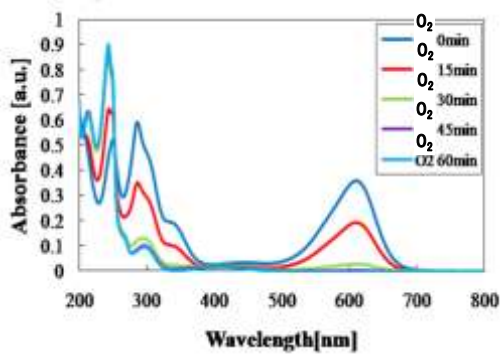
Pulse width 1 μs

### (2) Discoloration of indigo carmine solution



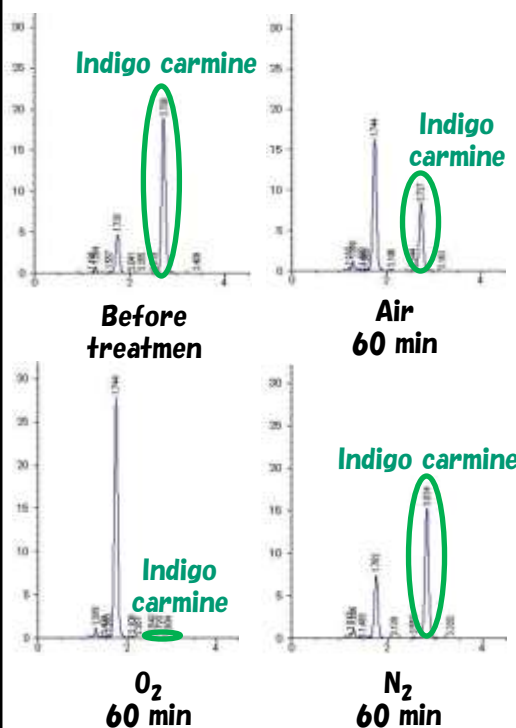
The initial concentration of indigo carmine solution was about 10mg/L. When the discharge voltage was 45 min with O<sub>2</sub>, the concentration dropped to 0 mg/L.

#### Analysis by UV spectrophotometer



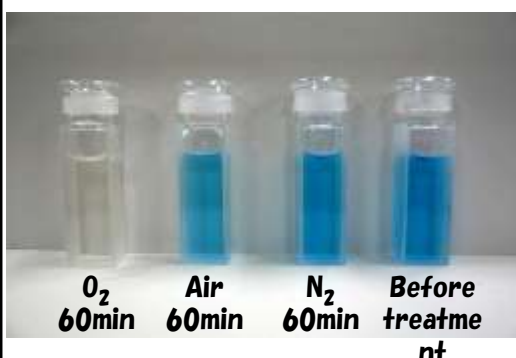
The peak of 611 nm, which is indigo carmine solution decrease with the increase in discharge time.

#### Analysis by HPLC



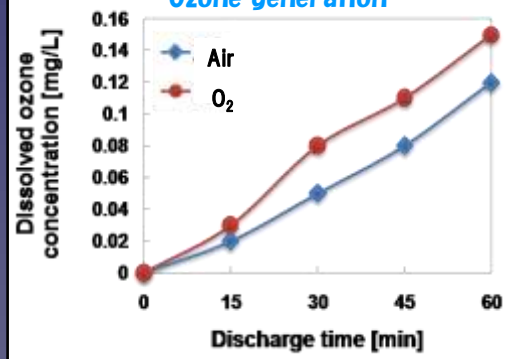
The water treatment performances improve when gas containing O<sub>2</sub> was added to discharge area.

#### Photograph of the indigo carmine solution



The color of indigo carmine solution was brighter, especially when O<sub>2</sub> or Air was supplied while discharge.

### Ozone generation

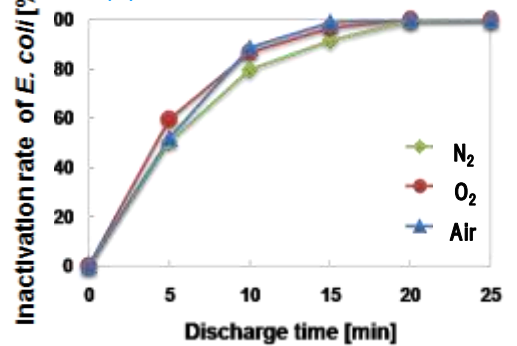


O<sub>2</sub> + e → O(3P) + O(3P) + e

O(3P) + O<sub>2</sub> + M → O<sub>3</sub> + M

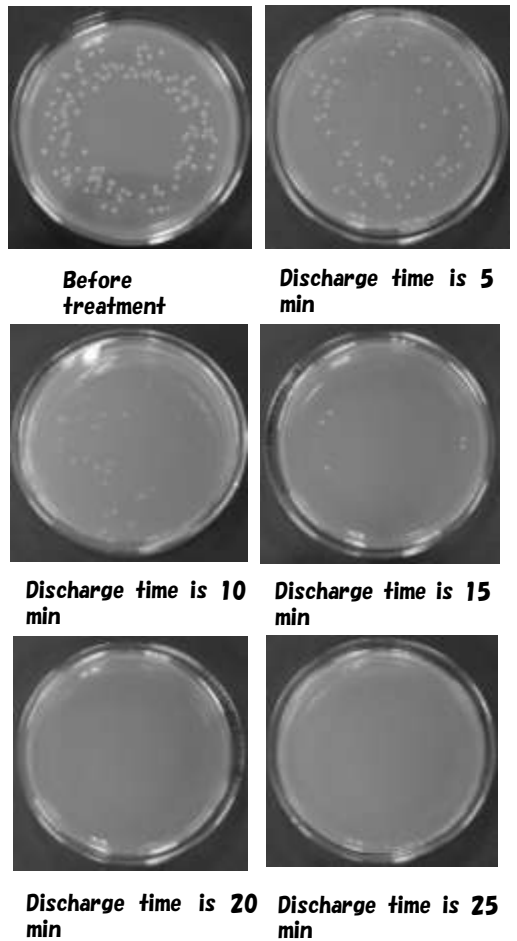
When O<sub>2</sub> is supplied to the solution, dissolved ozone concentration was 25 % higher compared with air. At a discharge time of 60 min, the dissolved ozone concentration of 0.15 mg/L with O<sub>2</sub>, 0.12 mg/L with air was obtained.

### (3) Inactivation of *E. coli*



A shorter period of time was necessary for the complete inactivation of *E. coli* when Air or O<sub>2</sub> was used to bubbled in water.

#### Image of *E. coli* treated samples



O<sub>2</sub> supply  
100 % inactivation after 20 min

## CONCLUSIONS

The following conclusions were obtained by the series of experiment by using discharge in bubbled water.

- Indigo carmine was degraded by low voltage discharge below 10 kV in bubbled water.  
10 mg/L → 0 mg/L  
discharge time was 45 min with O<sub>2</sub>
- E. coli* was 100% inactivated by low voltage discharge below 10 kV in bubbled water.  
discharge time was 20 min with Air and O<sub>2</sub>
- The water treatment performances improve when gas containing O<sub>2</sub> is added to discharge area. This result could be the effect of the generation of active radical species and ozone.