

Re-evaluation of Disinfection Technology

(Research of FY 2017-2021)

1. Purpose

Ultraviolet (UV) disinfection has no residual effects like chlorination, and this feature has enhanced WWTPs, including large-scale facilities, to adopt UV disinfection for downstream water utilization and ecosystem preservation. On the other hand, the UV system has high power consumption and O&M costs for replacing UV lamps.

Since the "Evaluation Report of the Latest Disinfection Technology" reported by JS technology evaluation committee in 1996, UV disinfection has been recognized as technology for small to medium-scale facilities. This study aims to promote adopting UV disinfection in Medium to large WWTPs by investigating its technology trend and facility management procedures.

2. Outcomes of This Year

As followed last year, UV disinfection facilities of the Medium to large-scale WWTPs were investigated for their operational conditions for years.

A hearing survey targeted five WWTPs with a treatment capacity of 10,000m³ per day. The survey collected their transitions in operational conditions and O&M costs, operation control procedures and O&M issues, and interviews with O&M administrators. Table 1 shows the survey results.

Table 1. Survey results

	WWTPD	WWTPE	WWTPF	WWTPG	WWTPH
Disinfection facility overview					
UV system's installed site	After final settling tank	After final settling tank	After final settling tank	After final settling tank	After final settling tank
Water conduction	Immersion open channel	Closed channel	Immersion open channel	Immersion open channel	Immersion open channel
Lamp installation	Vertical	Vertical	Horizontal	Horizontal	Horizontal
Exposure	Internal illumination	Internal illumination	Internal illumination	Internal illumination	Internal illumination
Kind of mercury lamp	Low pressure	High pressure (Medium pressure)	Low pressure	Low pressure	Low pressure
Number of water channels	2 (1 reserve)	3 (1 reserve)	4 (no reserve)	2 (1 reserve)	1 (no reserve)
Number of lamps per a channel	12	16	40	80	104
Flow direction	Parallel flow	Counter flow	Parallel flow	Parallel flow	Parallel flow
Lamp output (kw/lamp)	1	2.5	0.16	0.25	0.25
Operation and management status					
Inflow ratio against planned maximum inflow per hour	90%	36%	86%	150%	28%
Exposed number of lamp unit's	All units	All units	All units	All units	All units
Lamp output	100% fixed	100% fixed	100% fixed	50% fixed in 2019, 30% fixed in 2020	60-100% automatic
Timing of lamp replacement	Lamp dead	Every 2 years	Every 2 years	Every 1.5 years	lamp dead or number of coliform increased
Year average power consumption per unit inflow (kwh/m3)	0.034-0.114* for 2001-2019	0.049-0.091* for 2002-2019	0.027-0.030* for 2011-2019	0.003-0.007* for 2012-2020	0.025-0.027* for 2012-2019
	0.040 in 2019	0.055 in 2019	0.030 in 2019	0.003 in 2020	0.027 in 2019
UV system's power consumption rate against the entire WWTP	2.5% in 2019	9.4% in 2019	5.4% in 2019	0.6% in 2020	-

*lamp output × unit × running time (Since WTP H has no data of automatic control status, it is assumed 100%)

- Operation control:

One WWTP has automatically controlled UV illumination strength; another has a fixed value below 100%, and three WWTPs have set at 100% all the time. There was no WWTP adjusting illumination strength by the number of lamp units adopted by all three WWTPs last year.

- Power consumption:

While treatment plant E has recognized only UV facilities' power consumption, other treatment plants do not. So, researchers calculated UV facilities' power consumption by lamp outputs, number of lamps, and running times, and power consumption changed little except for increasing facility expansion.

- UV lamp replacement frequency:

While UV lamp manufacturers recommend replacement in 12 to 18 months, surveyed WWTP have yet to do less except WWTP G.

3. Future Schedule

The past surveys have inspired some solutions for the power consumption of the UV disinfection system. While creative operation control, including running numbers of units and illumination intensity, may reduce power consumption, effects on disinfection performance should be verified. The water quality will be investigated to study the impact of disinfection capability by the UV facilities' operation control next year.

We sincerely appreciate WWTPs for their cooperation with the survey.

Keywords: **Ultraviolet disinfection, Illumination intensity, Power consumption**