

Survey on the Operation of Full-scale UV Disinfection in Sewage Treatment Plants in Japan

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We conducted the survey to the UV disinfection facilities.



Grasp the operation and maintenance history of full scale UV disinfection for reevaluation and expand the UV disinfection technology to large-scale WWTPs.

- ◆ Survey method : Questionnaire & Interview
- ◆ Survey period : FY2017(questionnaire) & FY2019(interview)
- ◆ Target : 147 facilities(questionnaire) & 3 large scale facilities(interview)

Chlorine disinfection

- ◆ Widely used in Japanese swage treatment plants.
- ◆ Disadvantage : residual chlorine and by-products, etc.

UV disinfection

- ◆ Applied since the late 1980s for protecting the fishery resources, ecosystems of the discharge water area and ensuring the safety of water use.
- ◆ Disadvantage : the high power consumption.
- ◆ In 1997, Japan Sewage Works Agency (JS) has conducted a “Technical Evaluation of Disinfection Technology” .
 - ⇒UV disinfection was mostly installed at small and medium-scale WWTPs.
 - ⇔UV disinfection facility installation in Japan was 3 in 1995, and has expanded to about 160 facilities including large-scale WWTPs as of 2017.
- ◆ More than 20 years have passed since the last technical evaluation.

We conducted the questionnaire and interview survey to the UV disinfection facilities to grasp the operation and maintenance history of full scale UV disinfection.

Questionnaire survey

- ◆ Survey period : FY2017
- ◆ Target : 147 facilities listed in “Disinfection facilities(UV)” in the 2014 version of “Sewerage Statistics”.
- ◆ Contents of questions : Design parameters of the UV disinfection facility, operation record and maintenance record.
- ◆ Valid answer : 112 facilities (Effective response rate : 75%)

Overview of the target UV disinfection facilities(Interview survey)

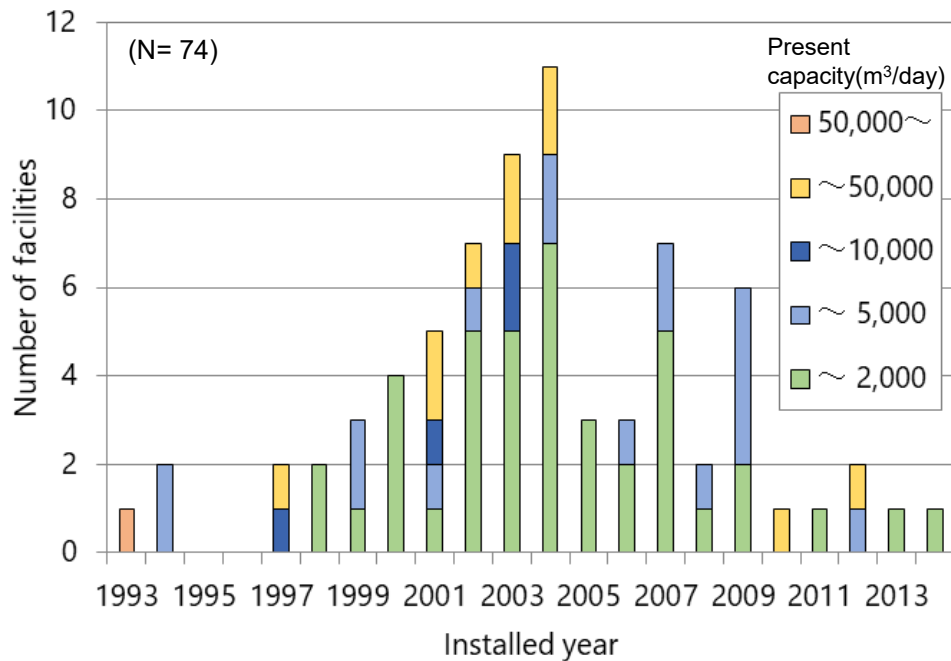
Target facility	Plant A	Plant B	Plant C
UV location	After sand filtration	After sand filtration	After sand filtration
UV channel	Open channel dipping type	Closed channel immersion type	Open channel dipping type
UV lamp installation	Vertical type, Horizontal type	Vertical type	Vertical type, Horizontal type
UV irradiation	Internal lighting	Internal lighting	Internal lighting
Lamp type	Low pressure mercury lamp	Medium pressure mercury lamp	Low pressure mercury lamp
Number of UV disinfection trains	12	3	3
Number of UV disinfection units	96	12	27
Design irradiation dose	300J/m ²	300J/m ²	180J/m ² , 300J/m ²

Interview survey

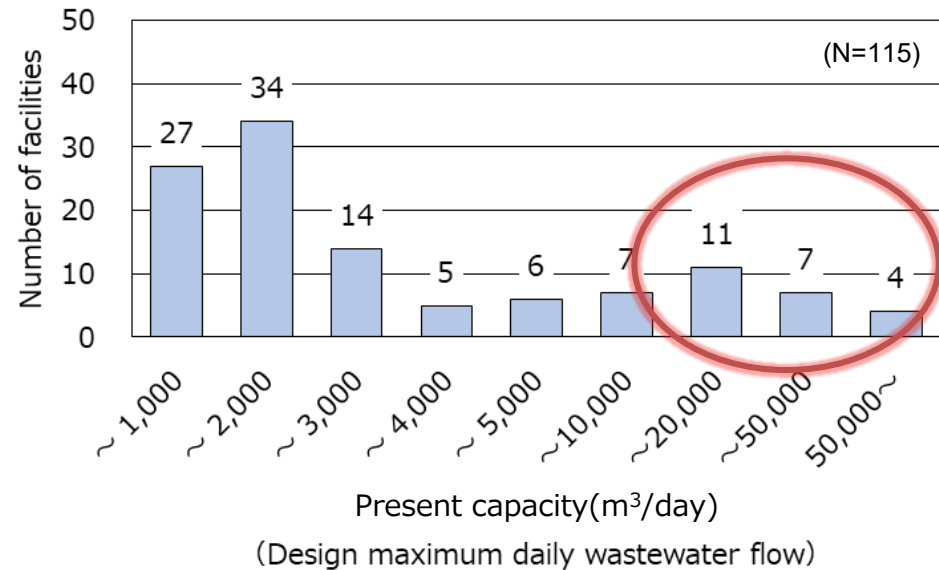
- ◆ Survey period : FY2019
- ◆ Target : 3 large scale facilities (Treatment capacity $\geq 10,000\text{m}^3/\text{day}$)
- ◆ Contents of interview : Control method and operating condition of UV facilities.

Questionnaire survey

- ◆ The late 1990s to the mid-2000s, UV facilities were installed mainly for small-scale WWTPs.
- ◆ Early 2000s, the number of UV facilities for large-scale ($\geq 10,000\text{m}^3/\text{d}$) WWTPs were increased.
- ◆ The number of UV disinfection facilities was 3 in 1995, and increased to 115 including 22 large-scale facilities at the time of the survey.



Installed year and number of UV facilities



Present capacity of UV facilities

Questionnaire survey

- ◆ When the quality (the number of coliform bacteria of outflow) and quantity changed, less than 10% of the facilities were controlled the UV dose or the number of UV units.
- ◆ When the quantity of inflow decreased, 16 facilities were reduced the number of operating train, UV lamps and units.

Control method of UV facilities (Questionnaire survey results)

When the water changes of the quality or quantity (Number of facilities)

No control	UV dose control	Unit number control
101	7	4

When the quantity of outflow decrease (Number of facilities)

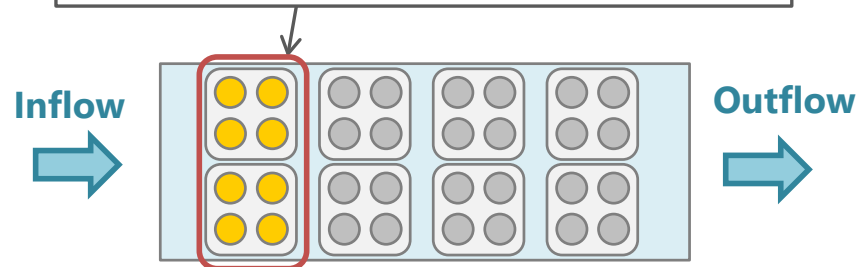
No control	UV dose control	Adjust the number of operating trains, units, lamps	Other
96	7	16	1

※Includes multiple answers

Interview survey

- ◆ In target plants, some UV units were turned off not just as a control the ration of inflow, but it was also to save energy.

4 UV lamps / Unit
8 units / Train
→ Lights only 2/8 units
Lighting one side in the flow direction



Example of reduce the number of operating units

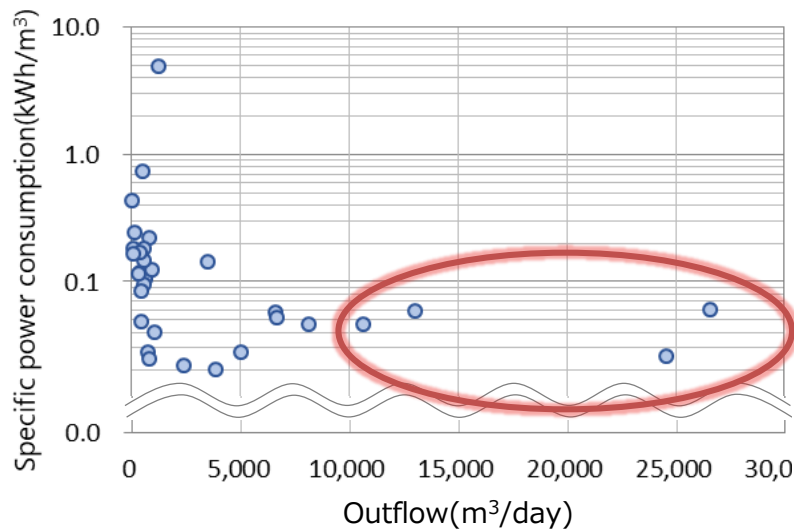
Results – Power consumption

Questionnaire survey

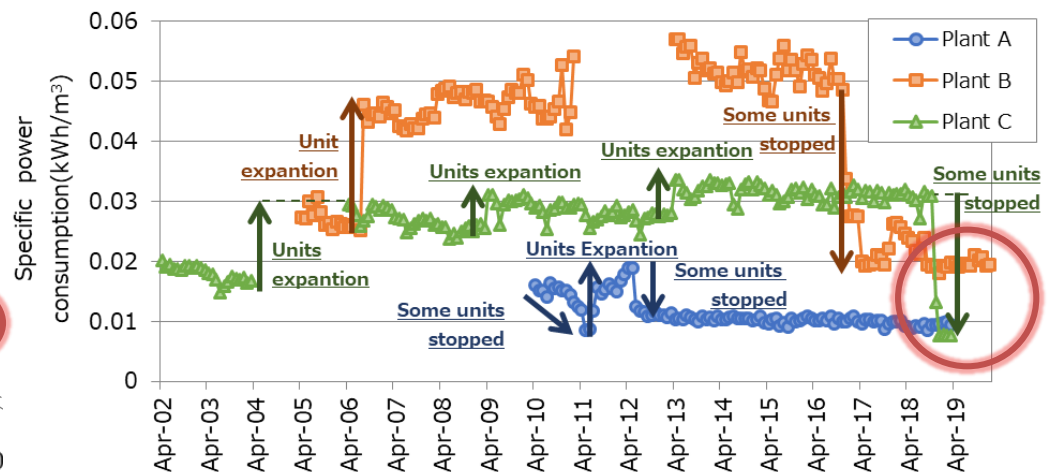
- ◆ The specific power consumption of UV facilities (SPC) tended to decrease as the amount of outflow increased, and was less than 0.06 kWh/m^3 at over $10,000 \text{ m}^3/\text{day}$ facilities.

Interview survey

- ◆ The most recent SPC of UV facilities is 0.01 to 0.02 kWh/m^3 , which is less than half the SPC compared to before carry out the energy saving measures.
- ◆ Although the prescribed standard is sufficiently satisfied, it is necessary to examine the effect of usage such as turning off some units on the disinfection effect.



The distribution of specific power consumption (Questionnaire survey results)



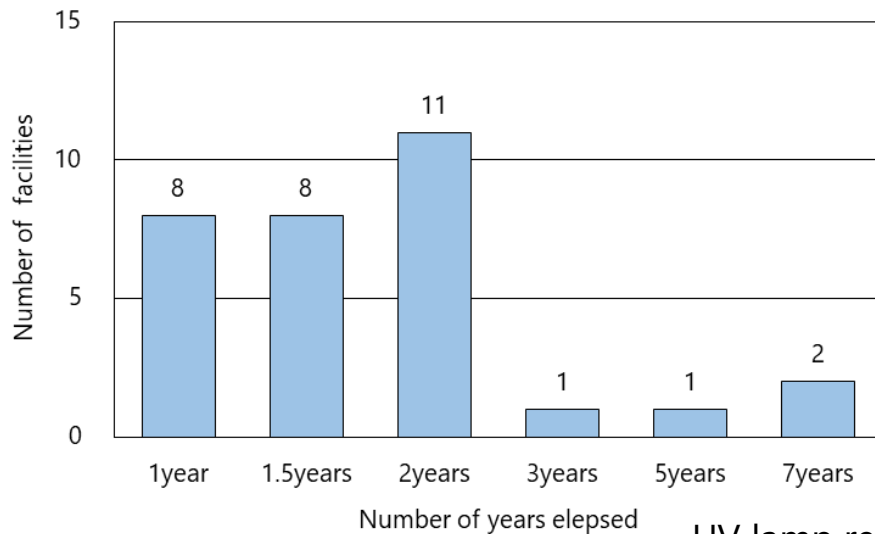
The change of power consumption and operating units (Interview survey results)

Questionnaire survey

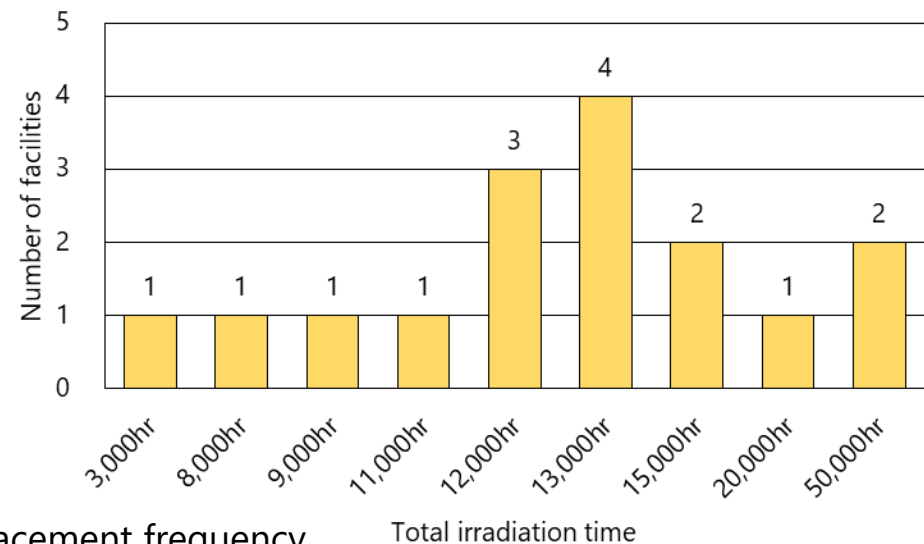
- ◆ 44% of the facilities regularly replace UV lamps.
- ◆ The most replacement frequency was in 2 years, followed by 1 year and 1.5 years.
- ◆ Based on total irradiation time, the most replacement frequency was in 13,000hr (\approx 1.5years).

Interview survey

- ◆ UV lamp were replaced when the lamps burned out at Plant A and B, after 2years of use at Plant C.



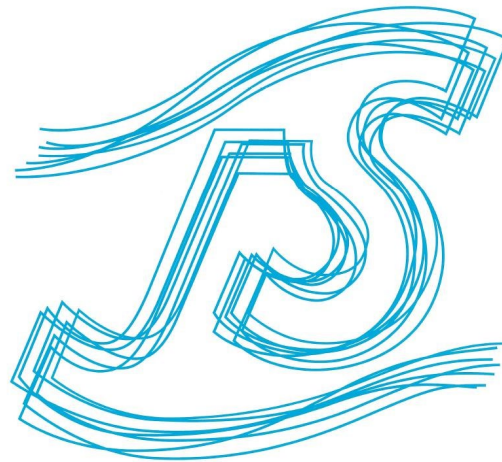
UV lamp replacement frequency
(Questionnaire survey results)



Total irradiation time

- ◆ When the water quantity and quality changed, UV dose or the number of UV units were controlled in some UV facilities.
 - ◆ When the inflow is less than the facility capacity, some UV units in target plants were turned off depending on the quality of inflow and outflow of the facility, as an energy-saving measure.
 - ◆ The SPC of UV facilities tended to decrease as the quantity of outflow increased, and was less than 0.06kWh/m^3 at over $10,000\text{m}^3/\text{day}$ facilities.
- It is necessary to verify the impact to the disinfection effect by adjusting (turning off) the UV facilities.

**Thank you for
your kind attention.**



***We would like to express our gratitude
to all concerned with the WWTPs for
their cooperation of this survey.***