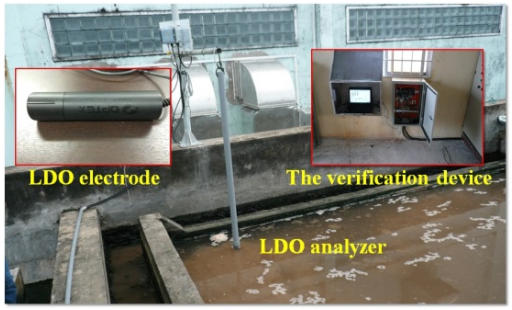
Overview

Technology intended for verification	Electric Reduction and Advanced Treatment using AOSD (Automatic Oxygen Supply Device System)
Environmental technology developer	Foundation for Advancement of International Science, Bio-Eco Technology Development Research Center NPO Bio-ECO Technology Research Center
Demonstration institution	Saitama-ken Environmental Analysis & Research Association
Period of the verification	August, 2018 to March, 2019 (Period of the experiment for existing data July, 2016 to February)
Purpose of this technology	The purpose is to control the blower automatically in order to reduce its excessive operation and to simultaneously reduce power consumption while ensuring advanced water treatment by the blower.

1. Outline of the technology intended for verification

Principle (Flow):
After installing a device (the verification device) that is easily mounted on the blower of a new or existing wastewater treatment facility to calculate the amount of dissolved oxygen required for biological treatment (DO) according to variations in inflow load, operation of the blower is automatically controlled using the calculated results to adjust the aeration time in the biological treatment and activated sludge tanks. This enables the blower operation to be optimized and power consumption to be reduced. Depending on the treatment method, biological nitrification/denitrification and dephosphorization reactions are enhanced, and advanced processing, such as removal of nitrogen and phosphorus in wastewater, can be achieved. The verification device consists of a luminescent dissolved oxygen analyzer (LDO analyzer), a programmable logic controller (PLC), and a computer.



The verification device and LDO analyzer

2. Outline of the verification experiment

2.1 Basic policy of the verification

In the technical meeting for the verification technology, the environmental conservation effects of the verification device were evaluated based on existing experimental data (Business Models for Improving Water Environment in Asia in 2015, 2016, 2017, Ministry of Environment, Japan) submitted by the applicant.

2.2 Outline of the location for performing the verification experiment. (The location for performing the experiment for existing data)

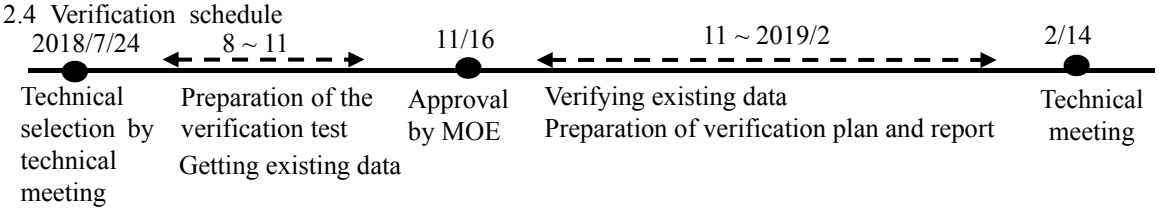
Name	Binh Hung sewage treatment plant (Wastewater treatment plant A for sewage)	Food industrial wastewater treatment plant (Wastewater treatment plant B for food factory)	Becamex industrial wastewater treatment plant (Wastewater treatment plant C for industrial waste)	Thu Dau Mot sewage treatment plant (Wastewater treatment plant D for sewage)
Method	Activated sludge method with shortened retention time*1	Activated sludge method with long retention time*2	Flxed immersion filter bed process	Continuous flow anaerobic/oxic sequencing batch reactor*3
Energy saving equipment	None	None	None	PID control system
Treatment capacity	141,000 m^3/day	200 m^3/ day	4,000 m^3/ day	17,000 m^3/ day
Treated water quality before introduction*4 (central value)	BOD 6.4 mg/L T-N 13.8 mg/L T-P 0.7 mg/L	BOD 7.0 mg/L T-N 5.3 mg/L T-P 6.6 mg/L	BOD 17.1 mg/L T-N 23.6 mg/L T-P 0.6 mg/L	BOD 3.8 mg/L T-N 4.7 mg/L T-P 1.4 mg/L
Address	Vietnam			

*1 The hydraulic retention time in the activated sludge tank is 3 hours.
*2 The hydraulic retention time in the activated sludge tank is 24 hours.
*3 Raw water continuously flows into the batch activated sludge tanks.
*4 The treatment plant B shows the treated water quality just after installing the verification device.

2.3 Specification and goal of the device used for verification.
(The sizes in the following table are the specifications of the site where the verification test was conducted.)

Category	Item	Specification and goal
Outline of the facility	Size (mm)	LDO electrode W 30 × D 30 × H 150 LDO control panel W 400 × D 200 × H 1,000
	Weight (kg)	LDO electrode 0.5 LDO control panel 50
	Supplementary facility	A stirring device may be required for preventing settling of the sludge.
Performance conditions	Goal	To perform a treatment that is equivalent to advanced treatment by comparing its water quality and to reduce the power consumption.

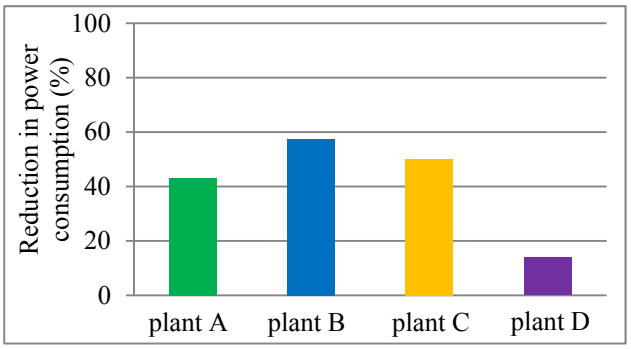
2.4 Verification schedule



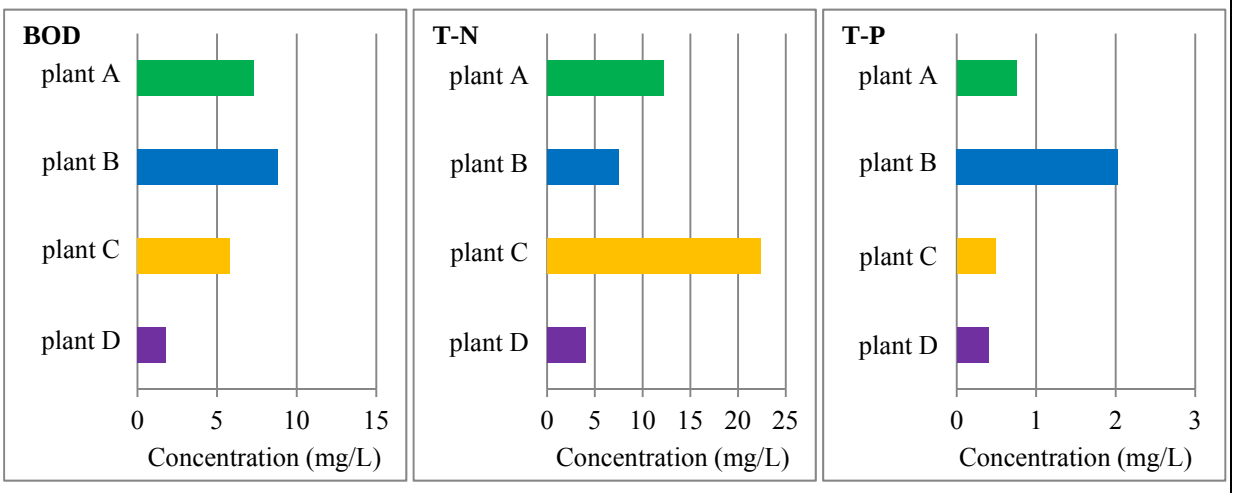
3.Results of the verification experiment

3.1 Verification experiment (4.3 on page 17 of the original version)

We verified whether the verification device can perform a treatment that is equivalent to advanced treatment by comparing its water quality (BOD, total nitrogen, total phosphorus) and reduce the power consumption (reduction in power consumption) of the aeration tank. Water quality after installing the verification device is as below. BOD was low in all of the wastewater treatment plants. The total nitrogen level was low at two of the treatment plants (wastewater treatment plants B for food factory and D for sewage water). The total phosphorus level was low at three of the treatment plants (wastewater treatment plants A and D for sewage water, and C for industrial waste). The reduction in power consumption was between 13.9% and 57.5%.



Reduction in power consumption result of each plant



Water quality result of each plant

Result of water quality and reduction in power consumption

Method and name		Water quality (mg/L)		Reduction in power consumption (%)
		Result (central value)	Reference values*1	Result
Activated sludge method with shortened retention time	Wastewater treatment plant A for sewage	BOD 7.3 T-N 12.2 T-P 0.75	BOD below 10 mg/L T-N below 10 mg/L T-P below 1 mg/L	43.3
Activated sludge method with long retention time	Wastewater treatment plant B for food factory	BOD 8.8 T-N 7.5 T-P 2.03		57.5
Flxed immersion filter bed process	Wastewater treatment plant C for industrial waste	BOD 5.8 T-N 22.4 T-P 0.49		50.0
Continuous flow anaerobic/oxic sequencing batch reactor	Wastewater treatment plant D for sewage	BOD 1.8 T-N 4 T-P 0.40		13.9

*1 Concentration values of water quality that are generally obtained by advanced treatment.

3.2 Operation and maintenance item

(1) Environmental impact item

Item	Verification result
Amount of wastes	Additional wastes do not occur while the verification device is being used.
Noise	The verification device controls the blower operation, and therefore no noise is detected from the device.
Odor	Not applicable as the verification device is a control system.

(2) Used resources index

Item	Verification result
Amount of chemical used for wastewater treatment	Not used in this verification test.

(3) Operation and maintenance performance item

Maintenance item	Maintenance time per operation and maintenance frequency	Number of people and skill required for maintenance
Maintenance of the LDO analyzer	Cleaning maintenance of the tip of the LDO analyzer 10 minutes/time	One person with general knowledge of operation and maintenance

(4) Qualitative remark

Item	Remark
Remark	According to the transparency and turbidity tests at each treatment facility, treated water with less turbidity was obtained.
Reliability of the device intended for verification	No trouble has occurred with the verification device during the period in which the data were obtained.
How to solve the problems	If a trouble occurs, contact the manufacturer (applicant for verification).
Evaluation of the instruction manual of operation and maintenance	The instruction manual for operation and maintenance was easy to understand.
Summary	Aimed at wastewater treatment plants with different treatment targets and methods, the ability of the device to treat the wastewater to the water quality obtained by advanced treatment and to reduce power consumption was demonstrated. As a result, although some plants showed that the treated water quality was above the reference value, the values were generally the same or less. Also, power consumption was reduced by 13.9% - 57.5%. Therefore, although the reduction in power consumption can vary depending on the treatment method, the verification device can reduce the power consumption in comparison with operation without the device.
Important notice	These results are from wastewater treatment plants without DO control, except wastewater treatment plant D. In plants that already have installed DO control for operation management, the power consumption is expected to be reduced when the verification device is installed, but the reduction in power consumption may be less than that shown by this verification.

4. Reference information

The information shown on this page is provided by the applicant for verification at its responsibility for publication of the technical data and not the subject of the verification experiment. The Ministry of the Environment and the organization conducting the verification experiment are not responsible for the information on this page.

4.1 Product date

Items		Column to be filled in by the applicant for verification
Name / type		Electric Reduction and Advanced Treatment using AOSD (Automatic Oxygen Supply Device System) / AOSD―YRINAS2018
Manufacturer (distributor)		Foundation for Advancement of International Science Bio-Eco Technology Development Research Center, NPO Bio-ECO Technology Research Center, **Cooperation** ALS Co.Ltd, SAKURA ECO TECH Co. Ltd, Rtec Co.Ltd and so on.
Contact address	Address	24-16, Kasuga, Tsukuba-shi, Ibaraki, 305-0821, Japan #301 Kyaratto21 1-8-4 Hanabatake, Tsukuba-shi, Ibaraki-ken 300-3261, Japan
	Web address	http://www.fais.or.jp
	E-mail	y_inamori@fais.or.jp inamori514@gmail.com
	TEL / FAX	090-3203-4853 / 029-860-3336
Size (mm)		LDO electrode W30 × D30 × H150 Control panel W400 × D200 × H1,000
Weight (kg)		LDO electrode 0.5 Control panel 50
Supplementary facility		The AOSD system requires electrodes, such as LDO analyzer. Under anaerobic conditions, a stirring device to protect sludge from settling and to promote effective microorganism reaction is required. Depending on the blower conditions, the stirring device may not be required as stirring occurs by slight aeration.
Life of the device		The verification device has a life span of around 10 years. The sensor cap for the luminescent dissolved oxygen analyzer (LDO analyzer) needs to be replaced according to the state of deterioration.

Approximate cost (yen)

*In the case of the following conditions

Design wastewater flow Around 10,000 m^3/day

Expense item	Unit price	Quantity	Total
Initial cost*1			20,000,000
Equipment and construction fees (system software, control panel)	18,000,000	1 set	18,000,000
Supplementary facility cost (LDO analyzer)	2,000,000	1 set	2,000,000
Running cost (monthly)			97,200
Chemical cost*2	6,000	1 set	6,000
Sensor cap for the LDO analyzer	2,400	1 time/year	2,400
Amount of electric energy used			85,000
Cost for treating wastewater : 0.38 yen/m^3 Note: Wastewater volume 10,000 m^3/day (As operated for 30 days)			

*1 The initial costs vary depending on the condition of the treatment facility.
*2 Usage of flocculant is assumed.

4.2 Other information from the manufacturer

The AOSD system has been developed based on the result of the long-running development of basic and applied technology. Accordingly, the Business Models for Improving the Water Environment in Asia, which is the basis of this report, was performed based on the following outstanding characteristics, and the aim was accomplished under normal conditions.

●Before this verification test was attempted, more than 10 years of basic and applied research had been conducted on developing technology for AOSD systems. Using the same water temperature and raw water concentration (BOD: 200 mg/L, total nitrogen: 45 mg/L, total phosphorus: 5 mg/L) as the evaluated performance of Jokaso in the Building Center of Japan, the optimum conditions for the treated water quality (BOD: below 10 mg/L, total nitrogen: below 10 mg/L, total phosphorus: below 1 mg/L) and reduction in power consumption were obtained in the Bio-Eco Engineering Research Laboratory in the National Institute for Environmental Studies, Japan. Also, based on the experimental results, it was decided to locate the LDO electrodes at the final tank if multiple tanks are present, and relatively good performance was obtained with the fixed bed intermittent aeration treatment. It was also shown that in the AOSD and membrane separation systems, by utilizing the air quantity for effective membrane cleaning, advanced treatment and approximately 70% reduction in power consumption were possible. In other words, this is a multi-purpose technique for sewage water, industrial wastewater, and Jokaso.

●An important property of the AOSD system is that the thermal behavior is reflected by the PLC program. Tests were performed at the Bio-Eco Engineering Research Laboratory in the National Institute for Environmental Studies using the same raw water as used for evaluating the performance under the seasonal changes. As a result, the optimum control system works similarly at water temperatures in frigid zones at 10°C and tropical zones above 30°C, and the power used for wastewater treatment was reduced. This can therefore be applied internationally.

●This technique reduces the power consumption in addition to securely maintaining the target water quality, within the normal range of nitrification inhibitor addition, balance of C/N, and concentration of nitrogen and phosphorus in raw water, using the optimum blower control.

●This innovative technique not only protects the environment by purifying the effluent quality to BOD less than 10 mg/L, total nitrogen less than 10 mg/L, total phosphorus less than 1 mg/L and neutralizing its pH for restoring the environment and conserving natural water areas, but can also secure precious water resources for the water cycle and improve the removal of nutrient salts in an energy-efficient way using less power.

●This can help resolve pending issues such as power consumption in the activated sludge method that involves food chain ecosystems of bacteria, protozoa, and micrometazoa and the removal of nitrogen and phosphorus at lower cost.