

# Establishment of the Total Optimization Procedure for Wastewater Treatment Plants

(Research of FY 2018-2021)

## 1. Purpose

This study aims to establish the total optimization procedure for WWTPs, which defines achievable levels for minimizing energy consumption and maximizing resource utilization of the whole WWTP. The working items are as follows;

- ① The primary balance of WWTP: Organize the flows of wastewater/sludge treatment by the treatment method/scale. Create balance sheets of materials, energy, and CO<sub>2</sub> emission for each flow.
- ② Systematization of JS' elemental technologies: Systematize elemental technologies that JS owns.
- ③ Establishment of WWTP optimization method: Establish the selection manner of elemental technologies for WWTP optimization and presentation manner of the balance of the optimized WWTPs.
- ④ Development of the WWTP optimization tool: Develop the optimization tool that enables the presentation of achieving levels against the needs, including energy-saving, energy generation, and cost reduction by the optimization method established at ③.

## 2. Outcomes of this year

This year, typical three treatment processes were set for the above ①, ②, and ③. Issues to implement them were organized.

## (1) Basic balance of WWTP

Based on the sewerage statistics, specifications of wastewater treatment systems are set by facility scale (table 1), and the balance sheet is created for the case existing technologies are applied.

Table 1. Setting of treatment process

Case	Treatment capacity (m <sup>3</sup> /day)	Wastewater treatment	Sludge treatment						
			Thickening	Model 1	Model 2	Digestion	Dehydration	Model	After dehydration
1	250,000	CAS	Separation & thickening	Gravity	Centrifuge	No	Yes	Centrifuge	Incineration
2	25,000	CAS	Separation & thickening	Gravity	Centrifuge	Yes	Yes	Centrifuge	Export
3	1,000	OD	No	-	-	No	Yes	Multi-disc screw press	Export

## (2) Organization and setting of the elemental technologies

Targeted technologies were classified into a research program, including joint research, JS Innovation Program, and B-DASH Program, which JS is involved in. Table 2 shows the applicable elemental technologies by the treatment process.

Table 2. Setting of applied technologies

Case	Target	Applied Technology	Category
1	Incinerator	Power generation system with stepped furnace	New technology
	CAS	Low pressure loss membrane diffuser	Joint research
2	Dehydrator, etc.	Sewage sludge-derived fiber utilization system	New technology
	Dehydrator, etc.	Type 3 screw press dehydrator	New technology
3	OD process	Energy saving wastewater treatment using high efficiency solid-liquid separation and Dual DO control	B-DASH
	Dehydrator, etc.	Type 2 screw press dehydrator with multiple discs	New technology

## (3) Consideration of the optimization of WWTPs

The basic idea for choosing the elemental technologies was organized based on the conditions of WWTP.

The balance sheet for applying the organized elemental technology was created to compare with the balance of conventional technologies. Table 3 presents the comparison of the energy reduction effects.

Table 3. An example of energy saving effects

Subject				Case 1		
				Conventional technology	New technology	
Treatment capacity			m <sup>3</sup> /day	250,000		
Average treatment quantity per day			m <sup>3</sup> /day	200,000		
Power consumption	Wastewater treatment	Blowing facility	kWh/day	14,978	12,672	
		Others		8,200	8,200	
		Sub total		23,176	20,872	
	Sludge treatment	Gravity thickening		173	173	
		Centrifugal thickening		1,175	1,175	
		Centrifugal dehydration		4,436	4,128	
		Incineration		38,382	8,857	
		Sub total		44,166	14,333	
	Total			67,342	35,205	
	Fuel consumption	Sludge treatment		Incineration	MJ/day	230,377
Power generation	Sludge treatment	Incineration	kWh/day	0	22,282	
Power consumption per treated wastewater (including power generation)			kWh/m <sup>3</sup>	0.337	0.065	
Reduction effect of power consumption			%	80.8		

#### (4) Issues

- The consideration of organizing manner of treatment process flow is required to create a material balance.
- When setting elemental technologies, it is favorable to propose multiple technologies with high effectiveness and meeting needs.

- About elemental technologies, the development of functions to treatment capacity, including power consumption and fuel consumption, which are needed for the balance calculation is required.

### 3. Plan

The study will reflect issues from the outcomes of this year to establish the total optimization method for WWTPs.

*Keywords: Total Optimization for WWTP, Energy independence*