# Establishment of Total Optimization Procedure for WWTP

(Research of FY 2018-2021)

# 1. Purpose

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

- (1) The primary balance of WWTP: Organize wastewater/sludge treatment flows by the treatment method/scale. Create balance sheets of materials, energy, and CO2 emission for each flow.
- ② Systematization of JS' elemental technologies: Systematize elemental technologies that JS owns.
- ③ Establishment of WWTP optimization procedure: 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, the primary balance of WWTP((1)), Systematized JS' elemental technologies((2)), and established optimization procedure for WWTP ((3)) were created.

(1) Study on the primary balance of WWTP

R&D Annual Report 2019, Japan Sewage Works Agency

Table 1 describes wastewater treatment plans. The table allocates the sludge treatment process to the wastewater treatment process based on the wastewater statistics, etc. The plan picked up 14 processes as major sludge treatment processes to study each primary balance.

Maximum daily treatment capacity		Wastewater treatment process	Sludge treatment process	Number of flows
Small-scale	10.000m³/day or less	OD process	Thickening, Thickening-dewatering, Dewatering	3
		CAS process	Thickening-dewatering, Thickening-digestion-dewatering	2
Medium- scale	10.000- 100,000m³/day	CAS process	Thickening-dewatering-incineration, Thickening-digestion-dewatering- drying(yes/no)	4
		Nutrients removal	Thickening-dewatering-incineration, Thickening-digestion-dewatering- drying(yes/no)	3
Large-scale	100,000m <sup>3</sup> /day and over	CAS process	Thickening-dewatering-incineration, Thickening-digestion-dewatering	2
Total				14

#### Table 1. Treatment process setting patterns

(2) Organization of the elemental technologies

Cost functions were created to study their technical summaries, requirements, and adoption effects to classify elemental technologies of nine kinds of wastewater treatment, six thickening/digestion, fifteen dewatering, nine incineration, and two others.

(3) Study on the draft procedure for optimizing the entire wastewater treatment facilities

Table 2 describes the flow of the optimization procedure. A draft of the various input/calculation tool and calculation results were studied to investigate the introduction effects of the elemental technologies.

Table 2. Flowchart of the optimization procedure

# Input

- ① Input sheet: Input WWTP data
  - Facility scale, wastewater/sludge treatment process
- 2 Design requirements sheet: input design requirements
  - Wastewater treatment (HRT, water depth, MLSS, etc.)
  - Sludge treatment (facility scale, unit number, operation times, etc.)
  - Solids balance (inflow quality, solid concentration, recovery rate, etc.)
- ③ Selection sheet of elementary technologies: Selecting technologies for considering introduction effects

## Automatic calculation

- ① Elemental technology sheet: technology summary and function sheets
- ② Balance, energy consumption, CO2 emissions, and cost calculation results of the conventional technologies

#### Output

- Calculation results sheet: Comparison between the conventional and elemental technologies
  - Presenting energy consumption and reduction rates of CO<sup>2</sup> emissions
  - Introduction costs for elemental technologies

## (4) Organization of issues

Drafting the optimization procedure found the input of design requirements was complicated. Accessibility improvement became to be an issue.

# 3. Future Schedule

The total optimization procedure will be established by the accessibility improvement, an issue of this year, and additionally organizing required cost functions of greenhouse gas emission and its costs. The established procedure will encourage the development of the optimization tool which can show and compare the adoption effects of the elemental technologies, including the whole wastewater/sludge treatment.

> Keywords: Total Optimization for WWTP, Energy independence