Optimization of sewage sludge dewatering conditioning using an online charge analyzing system titrator (CAST)

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Introduction

Status and perspectives of sludge management in South Korea

- ✓ Wastewater treatment plants (WWTPs) in South Korea are now facing increased pressure to produce higher quality treated wastewater at a lower cost with reinforced act like waste oceanic dumping ban and total phosphorus discharge limits from 0.5 mg/L (Level 3) to 0.2 mg/L (Level 1) by Ministry of Environment (MOE).
- ✓ Coagulant dosing is traditionally based on jar-tests or operator experience, resulting in either overdosing or insufficient dosing.
- ✓ Sludge arising from wastewater treatment processes is 'difficult' to dewater and require separate treatment termed conditioning, which generally involves the addition of inorganic or organic polymers.
- ✓ Dewatered sludge is the direct result of the chemicals used as coagulants and of course of the pollutants in the effluent water.
- ✓ So, optimum polymer dosage conditioning has been a target of research over years, however, there is no universal criterion for discerning it.
- ✓ Sam Bo Scientific's CAST has been applied in water and wastewater treatment with a diverse range of applications for optimum polymer dosage.

Objectives

We assess the feasibility of an online charge-based automatic polymer dosing control system (CAST), to determine optimal coagulant dosage of digested sludge supernatant from the Cheongju Wastewater Treatment Plant (CWWTP) in Cheongju City, Korea

This was the first attempt to use the CAST(Sam Bo Scientific) as a control system for the optimal polymer dosage in the field of sludge dewatering conditioning. We tested the performance of the online CAST system in maintaining a polymer-reduced and stable quality of dewatered sludge cake in CWWTP

Materials & Methods

CAST Charge-based polymer dose control system

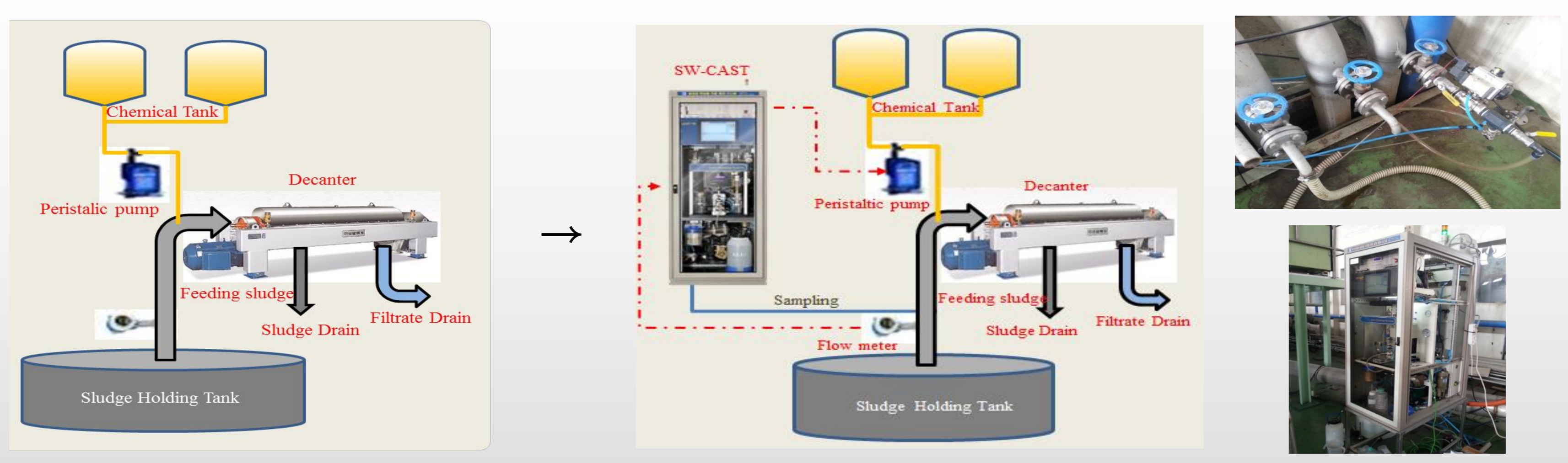

Figure. 1. Schematic diagram of sludge conditioning system (CAST) in CWWTP

Table 1. Operation conditions of Sam Bo Scientific's CAST(Charge Analyzing System with Titrator)

Items	System	Conditions	Operation times
Sam Bo Scientific's CAST	Sampling	In-line auto sampling	3min
	Measurement	Negative charges (-mV) Positive charges demand (mL) Quantity of flow (m^3/min)	5min
	Titration	Zero charge with a coagulant	
	Calculation	mL/min = mL/m^3 ×m^3/min	1sec
	Control	Forward control with a quantitative pump	
	Maintenance	Auto cleaning system Sampling line, Cell and Piston	5min
	Diagnosis	Auto	
	DB	Real time & update	
Sum			13min

Results and Discussion

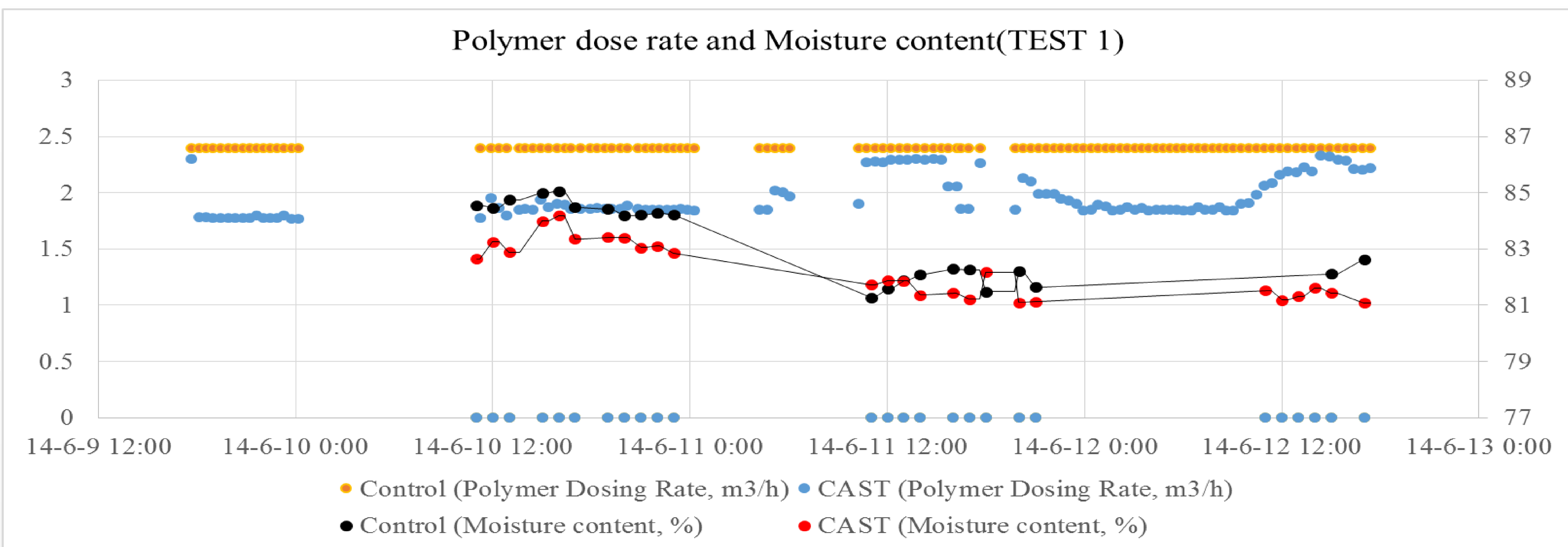

Figure. 2. CAST vs. Control (TEST 1)

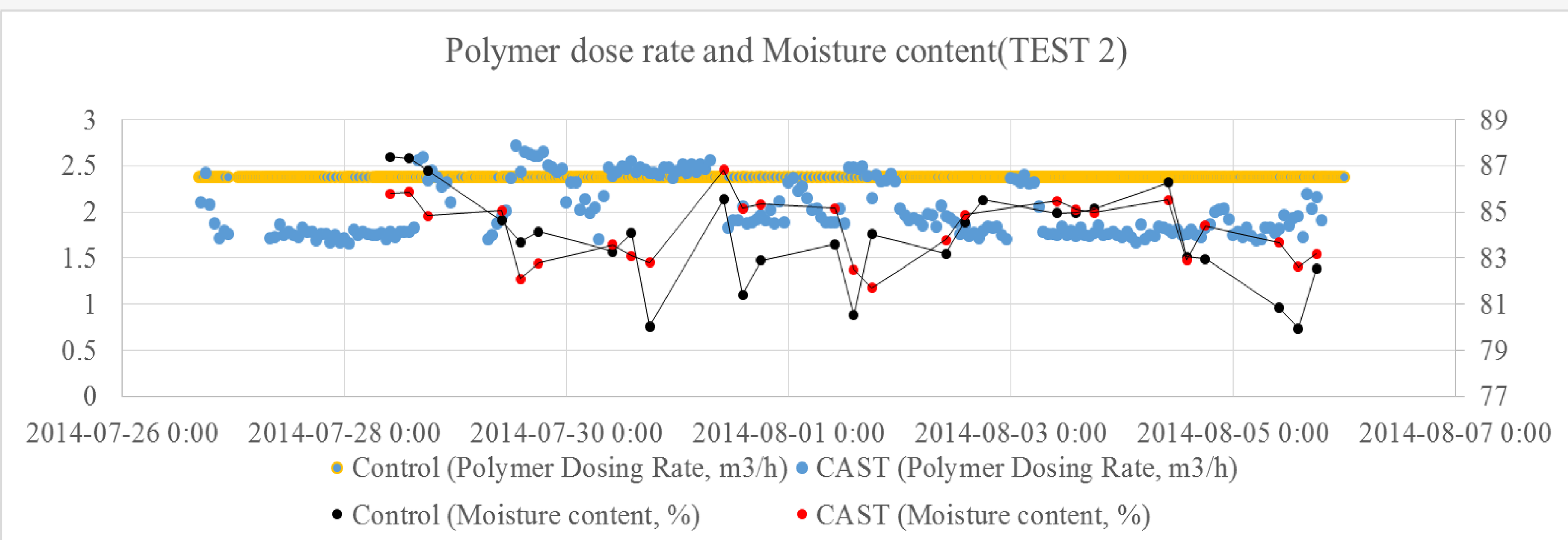

Figure. 3. CAST vs. Control (TEST 2)

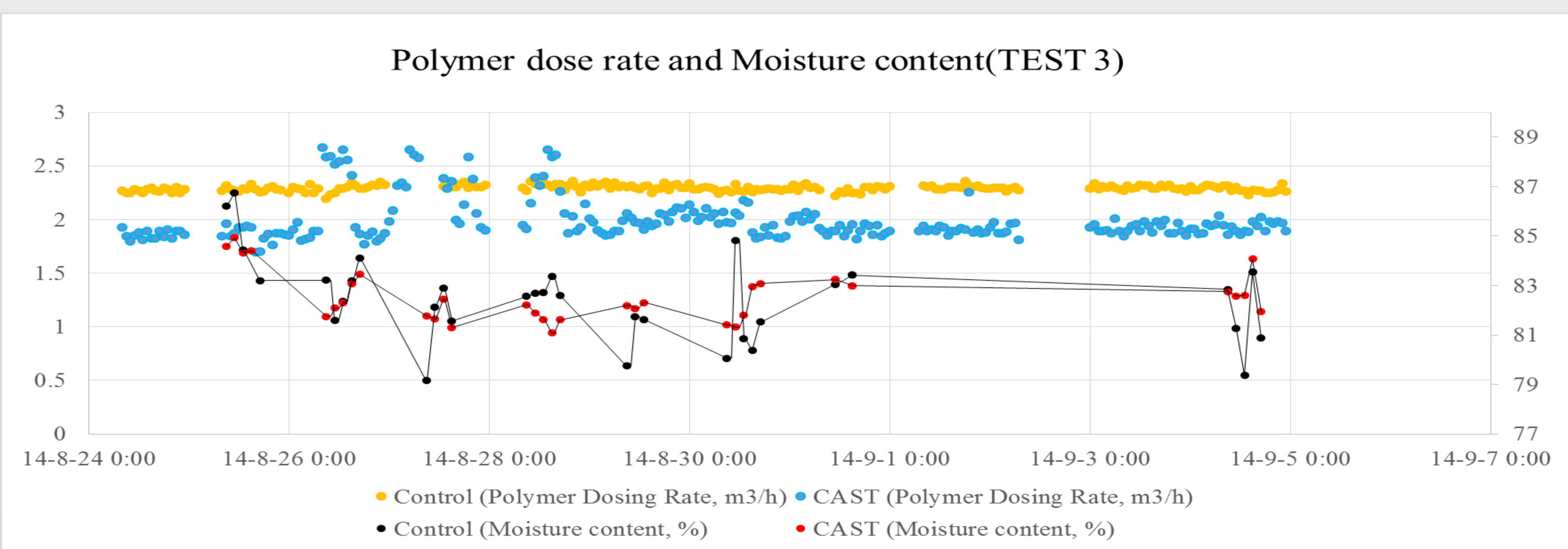

Figure. 4. CAST vs. Control (TEST 3)

Table. 2. Comparison of Polymer Saving & Moisture Content between CAST and Control(TEST 1)

Item	Control	CAST	Difference
Ave. Moisture Content (%)	83.23	82.23	1% (↓)
Flow(m^3/hr)	35.96	38.93	2.97
Polymer Dosing Rate (m^3/h)	2.488	2.043	0.445 (24.2% ↓)

Table. 3. Comparison Polymer Saving & Moisture Content of between CAST and Control(TEST 2)

Item	Control	CAST	Difference
Ave. Moisture Content (%)	83.83	84.19	0.36 (0.4% ↑)
Flow(m^3/hr)	38.13	38.67	0.54
Polymer Dosing Rate (m^3/h)	2.377	1.981	0.396 (18% ↓)

Table. 4. Comparison Polymer Saving & Moisture Content of between CAST and Control(TEST 3)

Item	Control	CAST	Difference
Ave. Moisture Content (%)	82.55	82.45	0.1 (0.1% ↓)
Flow(m^3/hr)	38.58	37.10	1.48
Polymer Dosing Rate (m^3/h)	2.353	1.989	0.363 (19% ↓)

Table. 5. Calculation of Polymer cost reduction using CAST

Test	CAST	Control	Efficiency improvement (%)	Cost reduction (US$ /year)
TEST 1	2.043 m^3/h	2.488 m^3/h	24.2% ↑	413,001.73
TEST 2	1.981 m^3/h	2.377 m^3/h	18.0% ↑	307,191.37
TEST 3	1.989 m^3/h	2.353 m^3/h	19.0% ↑	324,257.55
If we assuming efficiency improvement → Average 20.4%				US$348,150.22

[Calculation]
- Capacity: 30 m^3/h, - Polymeric Flocculant : 2.66 US$/ kg
- Polymer usage per year : 642,011kg
- Assuming 20% reduction from total capacity, ex) Cost reduction = 642,011 * 20% = 128,402 kg/year
  128,402kg * 2.66 US$/kg = 341,323.74 US$ /year

- ➢ **We tested the performance of the online CAST system in maintaining a polymer-reduced(at least 20%) and stable quality of dewatered sludge cake with highly fluctuating wastewater quality during 3 test periods**
- ➢ **On the other hand, current polymer dosing system like Control ignores variations in influent water concentrations, which may lead to chemical under-dosing or over-dosing.**
- ➢ **Also, CAST charge-based optimal polymer dose control system could contribute to reduce not only polymer cost, but also waste sludge volume.**

Acknowledgment

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