Full-scale Performance of the Pressurized Screw Press dehydrator (Type III)

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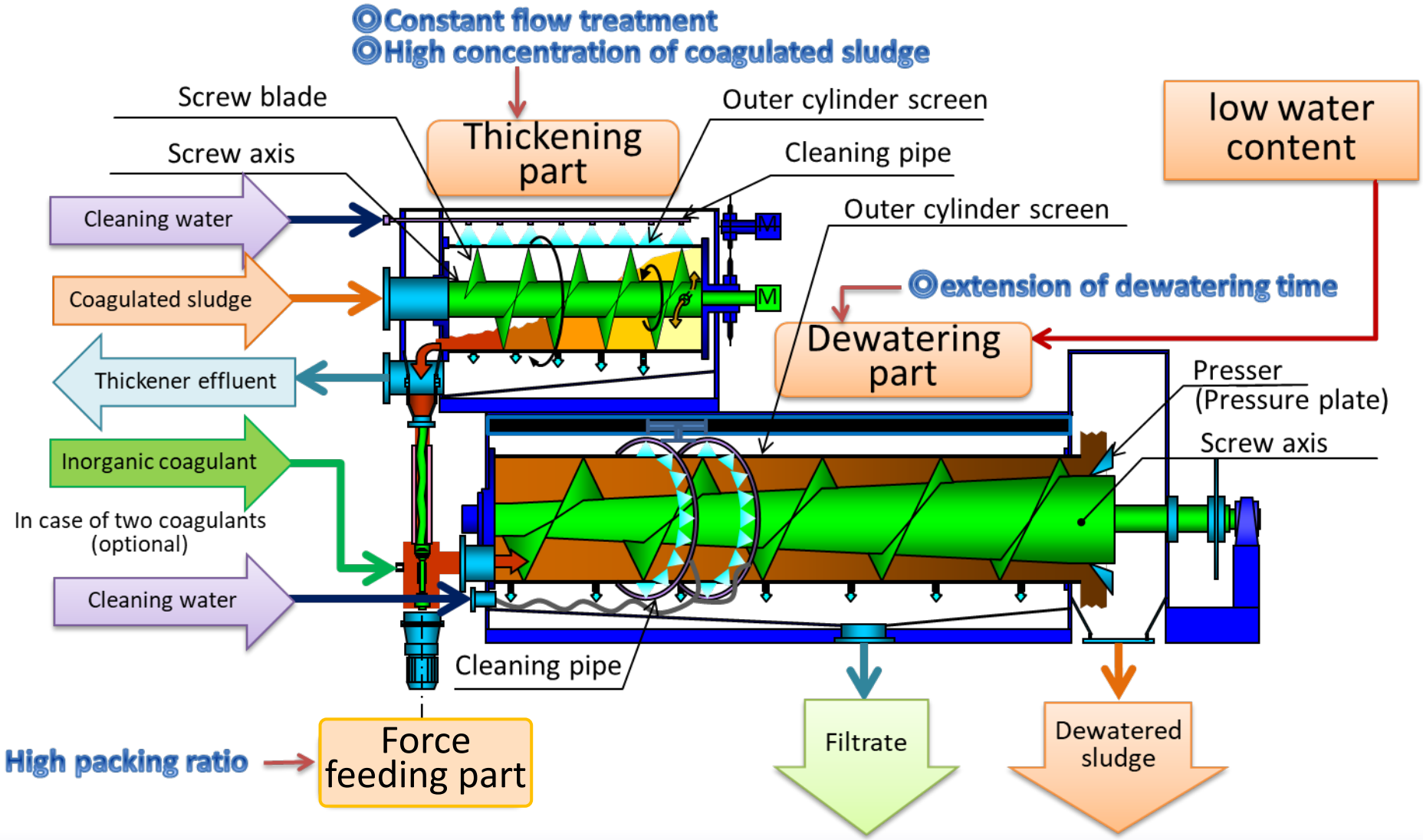
Overview of SP3 (1)



Overview of SP 3 (2) Prescribed values

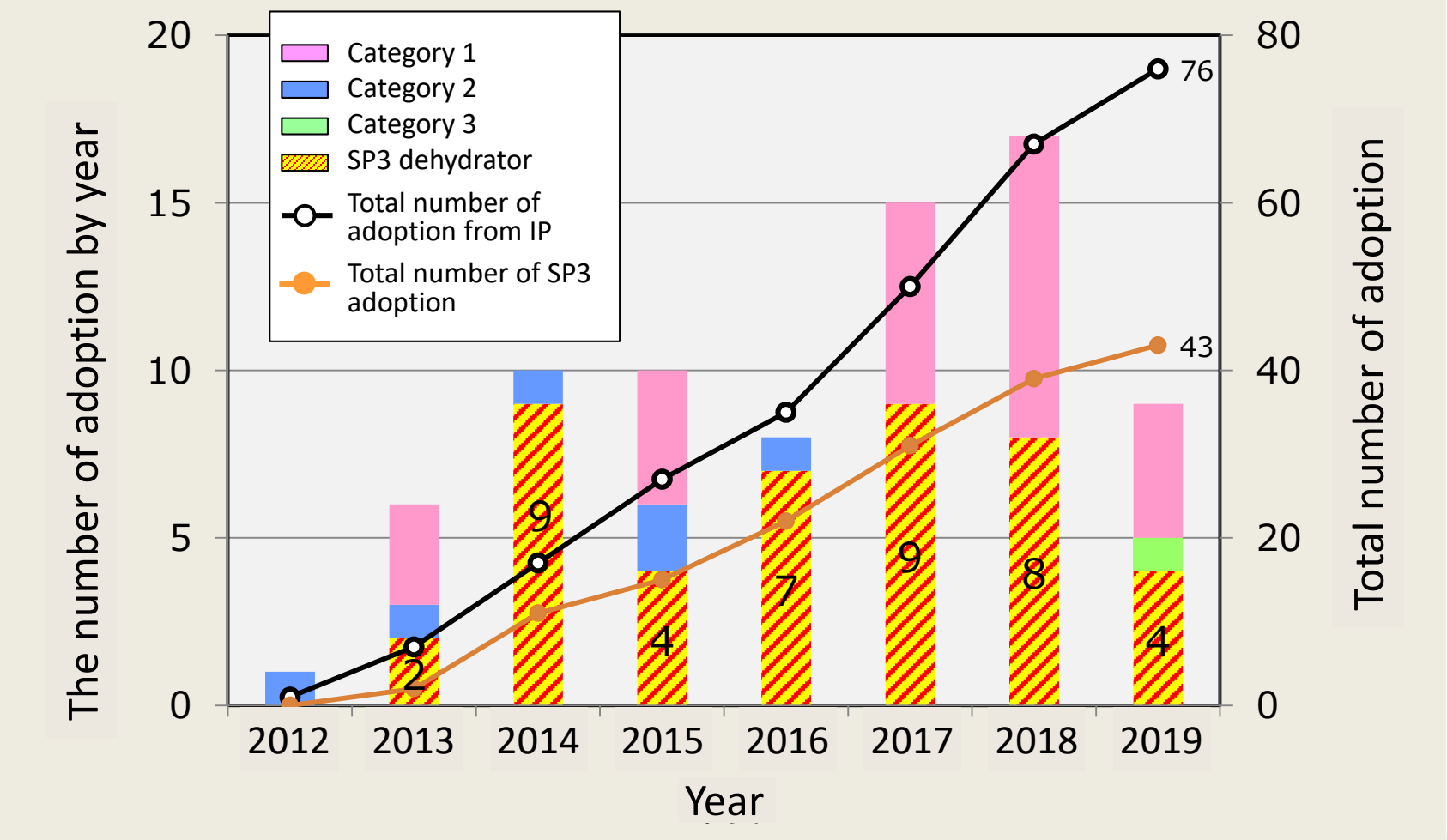
◆ **Treatment capacity, chemical doses, SS recovery rate**

⇒Apply design values of SP2 set at the JS Innovation Program

	Reduction point of cake's water content rate (Against water content rate of cake dewatered by SP2)	
	Polymer coagulant: one liquid conditioning	Polymer/inorganic coagulant : two-liquid conditioning
Mixed raw sludge	-6	-10
Anaerobic digested sludge	-5	-8
Excess sludge	-4	-5

The Number of Adoption

Over 40 WWTPs have adopted SP3.
SP3 occupies 57% of practical application examples of JS Innovation Program.



Objectives of Ex-post Evaluation

- Many records of adoption
  - 43 SP3s introduced to JS projects
  - 48 SP3s adopted by municipal WWTPs directly
- To encourage further adoption and follow up after the introduction:
  - **Confirm actual performance**
  - Investigate problems some machines have
  - Ask O&M administrator **requests for improvement**
  - **Make a close analysis of sludge properties** and investigate their impact on the performance of SP3

Approaches

statistics
JS' achievements
Hearing survey to manufacturer: Ishigaki Company, Ltd.

- Figure out sludge properties
- Confirm WWTPs to be surveyed

Survey period	Nov & Dec 2019
Focused group	51 SP3 of 48 municipalities
Mailed questionnaire	34 of 28
Valid answers	23 of 18
Test operation data	26 of 23
Annual/monthly report data	19 of 15

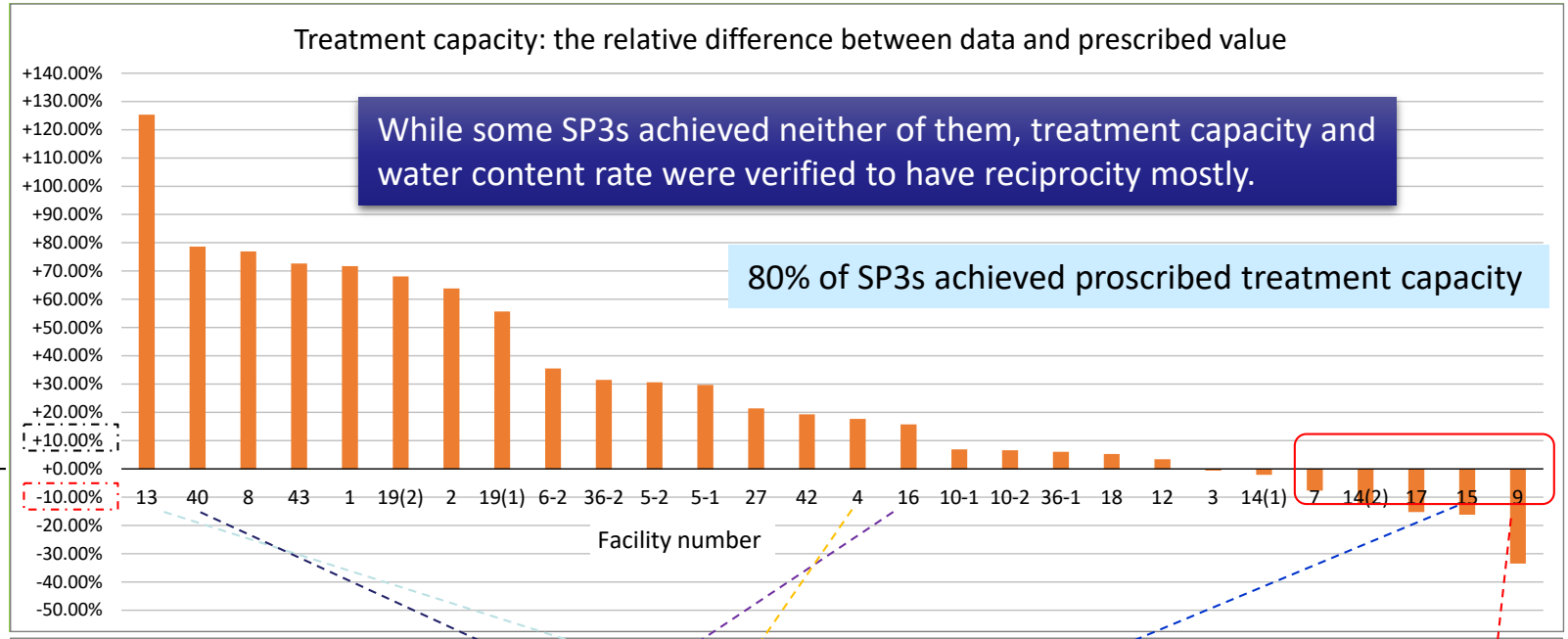
Questionnaire survey

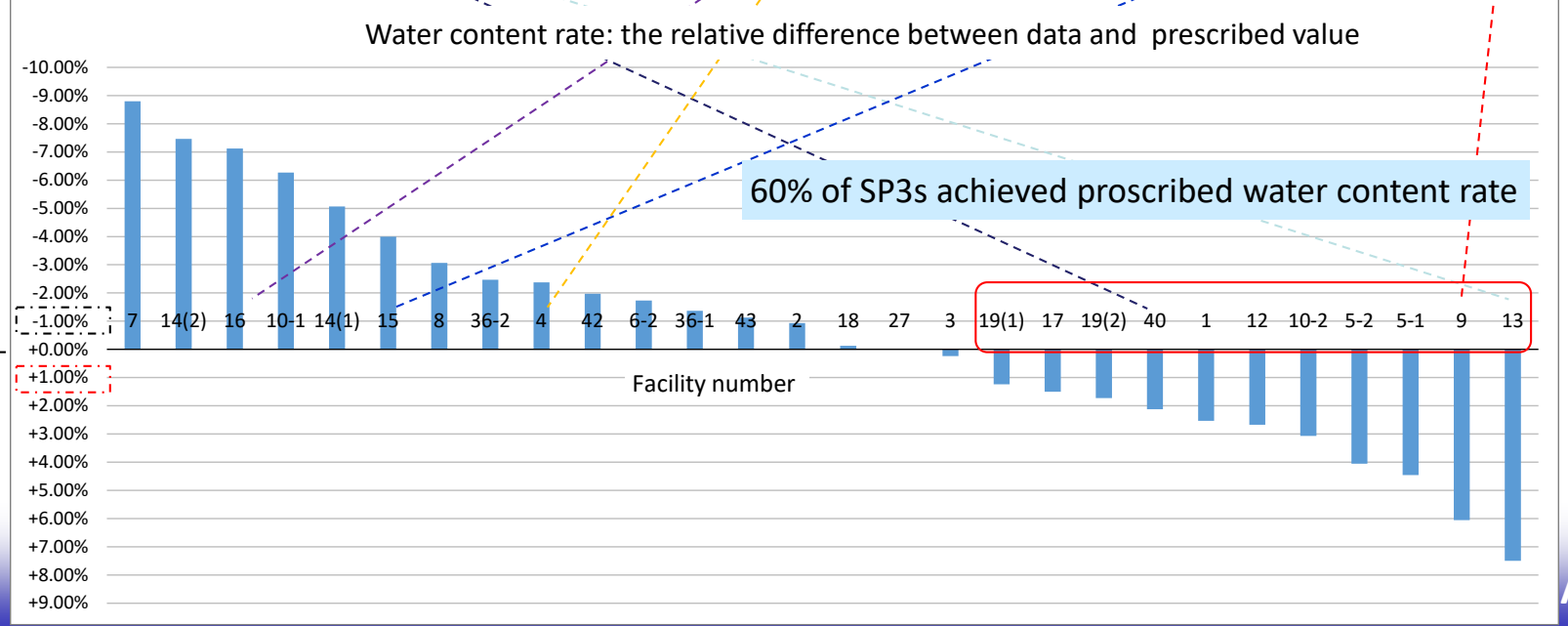
- Verify the dewaterability at test /everyday operations
- Problems, Requests for the improvement

Field survey
Sludge property analysis

- Conduct a field survey at 2 WWTPs
- Close analysis of sludge properties of 6 willing municipal WWTPs

Survey Results: Test Operations





Agency

Survey Results: Dewaterability

・Classify dewaterability by water content rate and treatment capacity
・Categorize dewaterability into A to E by the relative difference between operation data and prescribed values

※Relative difference between data and prescribed value (%)

$$=\left\{\frac{(Data-Prescribed\ value)}{\text{Prescribed value}}\right\}\times 100$$

Ex1: Calculation formula of water content rate
When prescribed value is 76% and data is 79%,
relative difference of water content rate(%)=

$$\left\{\frac{(79-76)}{76}\right\}=3.94$$

⇒Therefore, water content rate is 3.94% higher than (inferior to) the prescribed value

Ex2: Calculation formula of treatment capacity
When prescribed value is 30kgDS and data is 32kgDS,
relative difference of treatment capacity(%)=

$$\left\{\frac{(32-30)}{30}\right\}\times 100=6.66$$

⇒Therefore, treatment capacity is 6.66% higher(better) than the prescribed value

Treatment capacity satisfies prescribed value ← → Below prescribed value

Water content rate satisfies prescribed value ↑ / Below prescribed value ↓

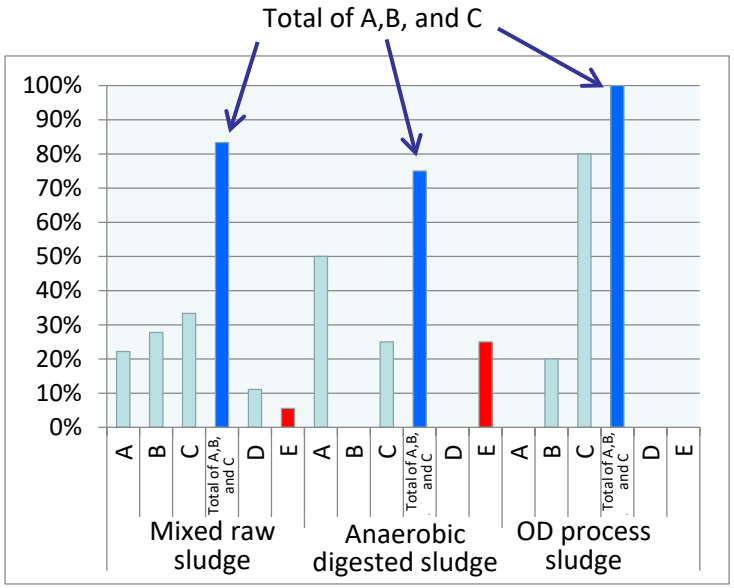
Water content rate \ Treatment capacity	10% or more than the prescribed value	Less than ±10% difference with the prescribed value	10% or less than the prescribed value
1.0% or less than the prescribed value	Category A: much better performance than the prescribed value 4 ,6-2,8,16,36-2,42,43	Category B: better performance than the prescribed value 7,10-1,14(1),36-1	Category C: Equivalent performance to the prescribed value 14(2),15
Less than ±1.0% difference with the prescribed value	Category B: better performance than the prescribed value 2,27	Category C: Equivalent performance to the prescribed value 3,18	Category D: less performance than the prescribed value
1.0% or more than the prescribed value	Category C: Equivalent performance to the prescribed value 1,3,5-1,5-2,13,14-2,15,18, 19(1),19(2),40,	Category D: less performance than the prescribed value 10-2,12	Category E: much less performance than the prescribed value 9,17

Survey Results: Test Operations

Categorizing by dewaterability using test operation data

Facility No.	Sludge property	water content rate achievement(%)	Grade	treatment capacity achievement(%)	Grade	category
16	Mixed raw sludge	92.9	Very good	115.8	Very good	A
8	Mixed raw sludge	96.9	Very good	176.9	Very good	A
36-2	Mixed raw sludge	97.5	Very good	131.5	Very good	A
4	Anaerobic digestion	97.6	Very good	117.6	Very good	A
42	Excess sludge	98.0	Very good	119.3	Very good	A
6-2	Mixed raw sludge	98.3	Very good	135.5	Very good	A
43	Anaerobic digestion	98.9	Very good	172.7	Very good	A
7	Mixed raw sludge	91.2	Very good	92.3	Average	B
10-1	Mixed raw sludge	93.7	Very good	106.9	Average	B
14(1)	Mixed raw sludge	94.9	Very good	97.9	Average	B
36-1	Mixed raw sludge	98.6	Very good	106.1	Average	B
2	Mixed raw sludge	99.1	Average	163.8	Very good	B
27	OD sludge	100.0	Average	121.4	Very good	B
14(2)	Mixed raw sludge	92.5	Very good	87.9	Poor	C
15	Mixed raw sludge	96.0	Very good	83.8	Poor	C
18	OD sludge	99.9	Average	105.2	Average	C
3	OD sludge	100.2	Average	99.4	Average	C
19(1)	OD sludge	101.2	Poor	155.7	Very good	C
19(2)	OD sludge	101.7	Poor	168.1	Very good	C
40	Anaerobic digestion	102.1	Poor	178.7	Very good	C
1	Mixed raw sludge	102.5	Poor	171.7	Very good	C
5-2	Mixed raw sludge	104.1	Poor	130.6	Very good	C
5-1	Mixed raw sludge	104.5	Poor	129.7	Very good	C
13	Mixed raw sludge	107.5	Poor	225.3	Very good	C
12	Mixed raw sludge	102.7	Poor	103.4	Average	D
10-2	Mixed raw sludge	103.1	Poor	106.6	Average	D
17	Anaerobic digestion	101.5	Poor	84.7	Poor	E
9	Mixed raw sludge	106.1	Poor	66.5	Poor	E

While some cases of mixed raw sludge and anaerobic digested sludge did not achieve their goals, most SP3 satisfied prescribed values in the test operation.



Survey Results: Everyday Operations

Categorizing by dewaterability using everyday operation data

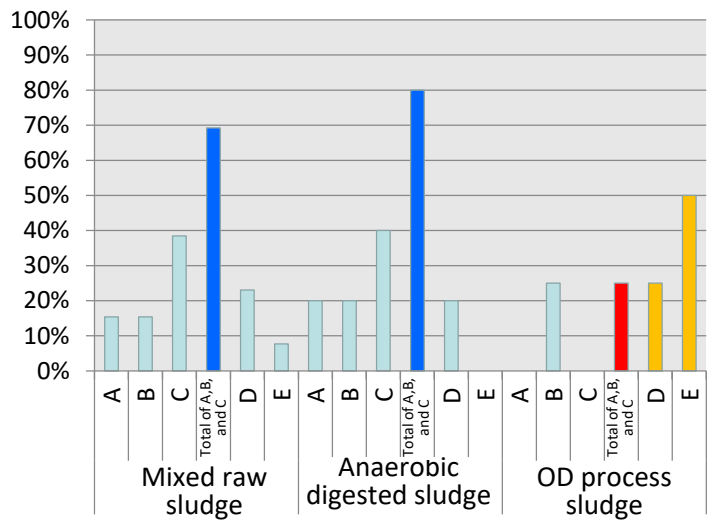
Facility No.	Sludge property	water content rate achievement(%)	Grade	treatment capacity achievement(%)	Grade	category
6-1	Mixed raw sludge	97.60	Very good	121.91	Very good	A
11	Mixed raw sludge	98.67	Very good	162.41	Very good	A
35-1	Anaerobic digestion	98.91	Very good	114.48	Very good	A
6-2	Mixed raw sludge	99.07	Average	121.91	Very good	B
41	OD sludge	100.39	Average	133.02	Very good	B
35-2	Anaerobic digestion	98.96	Very good	102.60	Average	B
1	Mixed raw sludge	96.40	Very good	79.66	Poor	C
12	Mixed raw sludge	99.01	Average	100.00	Average	C
10-2	Mixed raw sludge	99.27	Average	108.10	Average	C
10-1	Mixed raw sludge	99.41	Average	103.68	Average	C
13	Mixed raw sludge	102.00	Poor	141.85	Very good	C
43	Anaerobic digestion	102.00	Poor	143.33	Very good	C
40	Anaerobic digestion	102.15	Poor	160.78	Very good	C
30	Anaerobic digestion	100.38	Average	70.28	Poor	D
27	OD sludge	100.79	Average	86.67	Poor	D
5-1	Mixed raw sludge	101.76	Poor	93.64	Average	D
5-2	Mixed raw sludge	101.76	Poor	93.64	Average	D
3	OD sludge	101.20	Poor	71.52	Poor	E
39	OD sludge	102.35	Poor	71.43	Poor	E
9	Mixed raw sludge	106.97	Poor	55.68	Poor	E

At everyday operations,

- 70% of mixed raw sludge
- 80% of anaerobic digested sludge
- Only 20% of OD sludge

Satisfied prescribed values.

So, OD sludge requires the performance improvement.



No reduction of sludge water content rates was verified when sludge treatment volumes were declined at everyday operations.

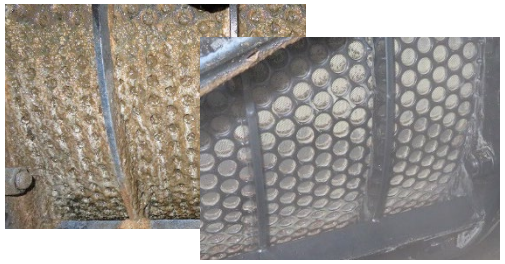
Failures, Request for Improvement

Category	Reported answers	No. of answers
Problem	Leakage and corrosion of inspection access, inspection window, and outer cylinder cover	6
	The clog of washing nozzle	5
	Problems of measuring instruments	5
	The clog of sludge/chemical pipes	4
	Leakage from thickening parts	3
Trouble	Caused by low water content rate	4
Requests	The improvement of outer cylinder cover, inspection access, and inspection window	8
	Simplification of dewatering conditions adjustment	6
	The improvement of washing water pipe strainer	3
	Simplification of washing nozzle cleaning	3

Solutions for improvement requests

Outer cylinder cover
→ Redesign shape and structure
→ Workability improvement of inspection access

Washing nozzle, strainer
→Review specifications
→Add checking items for supply water quality



Troubles from low water content rates
→Add checking items for facilities planning

Sludge Property Analysis Results

WWTP		1	2	3	4	5	6
Sludge kind		Mixed raw sludge	Anaerobic digestion	Anaerobic digestion	Anaerobic digestion	OD process	OD process
Category by dewaterability		C	A,B	C	D	B	E
Thickening process		Gravity	Gravity Mechanical	Mechanical	Gravity Mechanical	Gravity	Mechanical
Analysis items / Supplied sludge							
TS	%	1.8	1.3	2.5	1.9	1.8	3.6
VTS	%	86.0	73.3	73.8	76.4	90.5	85.9
Fibrous material (mesh-100th)	%	1.3	3.8	8.7	5.8	3.6	6.5
Fibrous material (mesh-200th)	%	2.0	5.1	9.7	8.7	4.4	4.9
Crude protein	mg/L	7,400	4,800	8,100	6,500	7,700	13,000
Anion	meq/g-TS	0.27	0.68	0.65	0.69	0.23	0.31
M alkalinity	mg-Cac O_3/L	320	3,400	6,800	4,100	180	780
Organic acid(total)	mg/L	1,100	<5	<5	<5	540	1,600
Carbohydrate	mg/L	<800	<800	<800	<800	<800	<800
Acid-soluble materials	mg/L	7,500	3,600	7,800	4,600	3,900	6,400
Alkali-soluble materials	mg/L	9,300	4,300	8,100	9,000	8,100	10,000
pH		6.0	7.6	7.6	7.5	5.7	6.0
SVI 3000	mg/L	4.0	17	23	18	16	16
Carbon (C)	%:dry sludge	42	37	39	41	43	44
Hydrogen (H)	%:dry sludge	6.3	5.8	6.4	6.4	6.5	7.1
Nitrogen (N)	%:dry sludge	8.0	6.5	6.3	6.7	9.2	7.2
Sulfur (S)	%:dry sludge	<1	<1	<1	<1	<1	<1
Oxygen (O)	%:dry sludge	29	30	19	29	29	18
Electric conductivity	ms/m	190	690	1,200	820	99	230
Colloidal equivalent	Meq/g-TS	-0.54	-1.3	-1.3	-1.3	-0.46	-0.63
Ammonia nitrogen (NH_4-N)	mg/L	37	440	2,300	1,100	29	18
Nitrite nitrogen (NO_2-N)	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrate nitrogen (NO_3-N)	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total phosphorus	mg/L	200	410	1,000	800	310	990
N-hexane extract	mg/L	110	100	<20	230	60	120
Biodegradability COD	mg/L	52	280	270	140	81	220
Refractory COD	mg/L	31	430	580	400	25	130
Solubility COD	mg/L	83	720	850	550	100	350
Calcium	mg/L	160	190	600	260	100	400
Magnesium	mg/L	20	73	250	110	48	110
Analysis item / Dewatered sludge							
Water content rate	%	82.2	80.8	83	78.8	81.5	83.8

The analysis showed that many sludge properties other than TS/VTS/fibrous materials influence dewaterability.

For example,

- Crude protein,
- M alkalinity,
- Organic acid,
- Electric conductivity

have an impact on only the OD process sludge.

On the other hand,

- N hexane

affects both anaerobic digestion sludge and OD process sludge.

The study will continue using more samples.

Conclusions

◆ From test/everyday operation data

→ While having a necessary performance as a dehydrator, SP3 shows no good achievement for OD sludge at the everyday operations.

→→ Performance improvement for OD sludge

◆ From failures and request for improvement

→ Maintainability of large-sized outer cylinder covers, clogged washing nozzles and strainers, hard adjustment of dewatering parameters

→→ Improve the shape of an outer cylinder cover, verify the quality of supplied wastewater

◆ From sludge property analysis data

→ Factors having impacts on dewaterability: Crude protein for anaerobic and OD sludge, Organic acid for OD sludge

→→ Continuous research is scheduled this year for a centrifugal dehydrator with inside two-agents conditioning and SP2 dehydrator

We sincerely appreciate municipalities for their cooperation.

Thank you for your attention.