Outline of Sludge Treatment & Disposal at Water Purification Plant in Japan

Masahiro Fujiwara, Dr.Eng.
President, JWRC
What does JWRC do?

Major projects
- Joint R&D projects with businesses, water utilities and academia.
- Hosting international symposium.
Hosting international symposium regularly

The 8th International Symposium on Water Supply Technology
(Kobe, Jun. 10-12, 2009)
Large-scale R&D projects

Ministry of Health, Labour and Welfare

Academia

Water Utilities

Private Companies

Japan Water Research Center
# Major R&D projects to date

## Purification Technology

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Term</th>
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<tbody>
<tr>
<td>MAC21</td>
<td>1991–93</td>
</tr>
<tr>
<td>Advanced-MAC21</td>
<td>1994–96</td>
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<tr>
<td>ACT21</td>
<td>1997–2001</td>
</tr>
<tr>
<td>e-Water</td>
<td>2002–04</td>
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<tr>
<td>e-Water II</td>
<td>2005–07</td>
</tr>
<tr>
<td>Aqua-10</td>
<td>2008–11</td>
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<tr>
<td>(In preparation)</td>
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## Pipeline Technology

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Term</th>
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<tbody>
<tr>
<td>Epoch</td>
<td>2002–04</td>
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<tr>
<td>New Epoch</td>
<td>2005–07</td>
</tr>
<tr>
<td>e-Pipe</td>
<td>2008–10</td>
</tr>
<tr>
<td>Pipe Stars</td>
<td>2011–13</td>
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</table>
Topics

- History of sludge treatment at water purification plant in Japan
- Transition of sludge treatment technology
- Treatment flow of sludge
- Representative sludge treatment plants
- Reuse of treated sludge
- Importance of “non-chemical dose” in sludge disposal
1970  Enactment of “Water Pollution Control Law”
1976  Obligation of installing a sludge treatment facility in water treatment plants
      (for purification capacity of more than 10,000m³/day)
- No discharge of “sludge & effluent” to a river
- 100% effective use of intake source water
- Reuse and recycle of sludge cake is essential
  → Environmental safeguards, resource conservation
Transition of sludge treatment Technology

• -1976: Dilution-discharge or Sun-drying

• 1976-: Vacuum dewatering with lime mixing

• 1980s: Long-period filtration without chemical dosing
  by horizontal dewatering machine
  ⇒ Energy-saving, labor-saving, environmental safeguards

• 1990s-: Improvement of non-chemical-dosing filtration
  ⇒ Various large-scale dewatering machines

New dewatering methods

※ Non-hydraulic filter press
※ Sludge heating treatment
Schematic treatment flow diagram

Conditioning
- Wash-water drainage basin
- Sludge basin

Thickening
- Chemicals-mixing
- Thickener

Dewatering
- (Pre-dewatering treatment)
- Chemical treatment
- Freezing treatment
- Heating treatment

Drying
- Vacuum filtration
- Pressure filtration
- Centrifugation
- Centrifugal dewatering

Disposal
- Drying
- Firing (Kiln)
- Land disposal
- Recycling
Properties and Shapes of Sludge

- **Thickening**: Thickened sludge
  - Dry solid (DS) concentration: 4 percent

- **Dewatering**: Dehydrated sludge cake
  - Moisture content: less than 65%
  - Sludge cake forms 20mm thick plate.

- **Crushing**: Crushed sludge cake
  - After crushing and screening, cake forms 1-5 mm granules.

- **Drying/sterilizing**: Dried cake
  - Moisture content: approx. 35%
  - Heating extinguishes weed-seeds and bacteria.
Facilities for Sludge Treatment

• Wash-water drainage basin
• Sludge basin
• Thickener
• Pre-dewatering treatment facility
• Dehydrator (Filter press)
• Crusher
• Dryer
• Furnace
Dehydrator (Filter Press)

Filter press type
Crusher

Roller type

Impeller type

Crushed cake

Screen

Roller

Dried cake

Crushed cake

Screen

Dried cake

Impeller
Dryer

Indirect heating type

Dewatered cake
Feeder
Air
Flight
Heating pipes
Drum
Exhaust gas
Steam
Dried cake
Motor
Furnace

- Dewatered cake
- Feeder
- Exhaust gas
- Drum
- Fireproof material
- Burner
- Fuel
- Air
- Burnt cake
- Motor
## Pre-dewatering treatment

<table>
<thead>
<tr>
<th>Chemicals used</th>
<th>Acid treatment</th>
<th>Lime mixing</th>
<th>Polymer coagulant treatment</th>
<th>Freeze–thaw treatment</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfate</td>
<td>Hydrated lime</td>
<td>Polymer</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

| Dewater-ability | — | High | — | High | Medium |

<table>
<thead>
<tr>
<th>Dehydrator type</th>
<th>—</th>
<th>Vacuum filter</th>
<th>Filter press</th>
<th>Pressure/compressive filter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vacuum filter</td>
<td>Centrifugation</td>
<td>Centrifugal dewatering</td>
<td>Pressure/compressive filter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature of filtrate</th>
<th>Mostly clear Low pH</th>
<th>Clear High pH</th>
<th>Clear Residuals of coagulant monomer</th>
<th>Moderate</th>
<th>Moderate</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Treatment of filtrate</th>
<th>Use as reclaimed alum, or discharge to river after pH adjustment</th>
<th>Use as alkali agent, or after pH adjustment use as raw water or discharge to river</th>
<th>Return to thickener</th>
<th>Use as raw water, or discharge to river</th>
<th>Use as raw water</th>
</tr>
</thead>
</table>
Asaka Purification Plant, Tokyo Waterworks

Purification capacity
1,700,000m³/Day

Sludge treatment plant

Dehydrator

Dehydrated sludge
Okubo purification plant, Saitama Pref.

Purification capacity
1,300,000m³/Day

Dehydrator

Sludge treatment plant
(Continued: Okubo plant)

Dehydrated cake

Dried cake

Sludge dryer
Representative Sludge Treatment Facility (1)

Source: Ishigaki Company, Ltd.
Representative Sludge Treatment Facility (2)

Murano Purification Plant, Osaka pref.
Filtration area: $1000\text{m}^2/\text{unit} \times 16\text{ units}$

Higashi-Murayama Purification Plant, Tokyo
Filtration area: $300\text{m}^2/\text{unit} \times 4\text{ units}$
$420\text{m}^2/\text{unit} \times 5\text{ units}$

Source: Tsukishima Kikai CO., Ltd.
### Examples of Sludge Treatment Facilities in Large-scale Water Treatment Plants in Japan

<table>
<thead>
<tr>
<th>Plants</th>
<th>Sludge treatment capacity (approx.) (ton/year DS)</th>
<th>Average water content of cake (%)</th>
<th>Annual amount of raw water (m³)</th>
<th>Annual average raw water turbidity (TU)</th>
<th>Maximum raw water turbidity (TU)</th>
<th>Purification capacity (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murano</td>
<td>8,600</td>
<td>55.0</td>
<td>451,521,600</td>
<td>6</td>
<td>61</td>
<td>1,797,000</td>
</tr>
<tr>
<td>Asaka</td>
<td>14,900</td>
<td>52.8</td>
<td>349,354,100</td>
<td>15</td>
<td>190</td>
<td>1,700,000</td>
</tr>
<tr>
<td>Kanamachi</td>
<td>13,900</td>
<td>50.5</td>
<td>296,315,000</td>
<td>18</td>
<td>460</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Okubo</td>
<td>14,500</td>
<td>47.0</td>
<td>330,876,000</td>
<td>16</td>
<td>39</td>
<td>1,300,000</td>
</tr>
<tr>
<td>Higashi-murayama</td>
<td>5,800</td>
<td>56.0</td>
<td>264,422,300</td>
<td>8</td>
<td>92</td>
<td>1,265,000</td>
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<tr>
<td>Kunijima</td>
<td>4,100</td>
<td>64.6</td>
<td>233,831,250</td>
<td>5</td>
<td>37</td>
<td>1,180,000</td>
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<tr>
<td>Nishinagasawa</td>
<td>4,700</td>
<td>63.4</td>
<td>229,658,900</td>
<td>7</td>
<td>110</td>
<td>1,137,700</td>
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<tr>
<td>Misato</td>
<td>13,600</td>
<td>50.8</td>
<td>321,358,400</td>
<td>15</td>
<td>480</td>
<td>1,100,000</td>
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<tr>
<td>Inagawa</td>
<td>4,300</td>
<td>60.4</td>
<td>228,489,390</td>
<td>6</td>
<td>33</td>
<td>916,900</td>
</tr>
</tbody>
</table>
Sludge Generation in Japan

- Total sludge generation from water purification $\approx 290,000$ t-DS/year
- Recycling $\approx 158,000$ t-DS/year (55%)
- Land fill $\approx 62,000$ t-DS/year (21%)
- Others $\approx 70,000$ t-DS/year (24%)
Effective Use of Sludge (Recycling)

- Farming and gardening soil
- Ceramic products
- Civil works materials (backfill materials)
- Cement raw material
- Ground soil
## Examples of sludge disposal in large-scale water treatment plants

<table>
<thead>
<tr>
<th>Plants</th>
<th>Reclamation (%)</th>
<th>Discharge to Sewer (%)</th>
<th>Effective use (%)</th>
<th>Examples of Recycling</th>
<th>Others (%)</th>
<th>Details of Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murano</td>
<td>97.4</td>
<td></td>
<td>2.6</td>
<td>Horticulture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asaka</td>
<td>65.0</td>
<td>0.0</td>
<td>35.0</td>
<td>Agriculture, Horticulture, and others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kanamachi</td>
<td>4.0</td>
<td>0.0</td>
<td>96.0</td>
<td>Agriculture, Horticulture, Potting compost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Okubo</td>
<td>0.0</td>
<td>33.3</td>
<td></td>
<td>Ground soil, Horticulture</td>
<td>66.7</td>
<td>Cement</td>
</tr>
<tr>
<td>Higashi-murayama</td>
<td>0.0</td>
<td>0.0</td>
<td>58.6</td>
<td>Agriculture, Horticulture, and others</td>
<td>41.4</td>
<td>Particulate improved soil</td>
</tr>
<tr>
<td>Kunijima</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nishinagasawa</td>
<td>100.0</td>
<td></td>
<td></td>
<td>Horticulture, Backfill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misato</td>
<td>10.5</td>
<td>0.0</td>
<td>16.0</td>
<td>Agriculture, Horticulture, Potting compost</td>
<td>73.5</td>
<td>Particulate improved soil</td>
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<tr>
<td>Kosuzume</td>
<td>100.0</td>
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<tr>
<td>Inagawa</td>
<td>100.0</td>
<td></td>
<td></td>
<td>Ground soil, Cement</td>
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</tbody>
</table>
Importance of non-chemical dose in sludge disposal

Closed System
- Refrain from using chemicals because generated water from sludge disposal goes back to receiving wells.
  → Natural thickening
  → Dewatering by using filter press dehydrator
  (debut of full-automatic, high-efficient dehydrator with non-chemical dosing)

For Recycling
- To reuse treated sludge, chemical residual is not desirable.

Non-chemical dosing system

Non-Chemical Treatment
Thank you for your attention