Co-benefits Project
On Wastewater treatment
For Fish Processing Industry

Nihon Suido Consultants Co., Ltd.
Environmental & Resource Engineering Department

Application of Total Maximum Daily Loads (TMDLs) for Effluent Discharge Permit and Capacity Building for Local Officials to Implement the TMDLs
1. Overview of Co-benefits projects on FPI
2. Wastewater management for FPI in Indonesia
3. Demonstrative experiment using wastewater treatment facility
   3.1 Objective and outline of demonstration
   3.2 Selection of demonstration site
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5. Implementation of capacity building
1. Overview of Co-benefits projects on FPI

(1) Objective of the project

Reduce pollution load to public waters by introducing excellent wastewater treatment technology of Japanese companies in order to promote measures for wastewater treatment in Indonesian fish processing industry (FPI).

At the same time, contribute to the prevention of global warming by reducing the generation of greenhouse gas from wastewater that is drained untreated and by introducing a treatment method which consumes less energy than the usual method. Transmit the technology by conducting capacity-building in the survey process as well.
1. Overview of Co-benefits projects on FPI

(2) Contents of projects

1) 1st stage (FY2011-FY2014)
   • Identify the problems on fish processing industry and survey related legal regulations in Indonesia
   • Select a factory for demonstration, survey on co-benefits type wastewater treatment technologies of Japanese companies and select technology to introduce at site in the factory (aerobic treatment, SW method)
   • Install demonstration facility at the factory, operate it, analyze monitored data and assessment of effect caused by introduction

2) 2nd stage (FY2015-FY2017)
   • To achieve more co-benefits effects, improve the wastewater treatment facility introduced in the 1st phase
   • Install ABR before SW facility and operate demonstration facility, analyze measurement result.
   • Prepare the guideline for fish processing industry using the result of demonstrational experiment.
   ※ Conduct capacity building annually in Indonesia and Japan, workshop, seminar, Japan study tour etc.
2. Wastewater Management for FPI in Indonesia

(1) Condition of environmental management

- Environmental management of fish processing industry is evaluated as the worst level in PROPER System, promoted by Ministry of Environment. Black and red evaluations occupy 90% in FY2012 evaluation result (blue indicates the level that satisfies the effluent standard, and red and black indicate the low management level).
(2) Measures to improve wastewater management

- Necessary to introduce legal systems and measures, such as technical guidance, in order to promote installment of appropriate wastewater treatment facilities and operate it properly.

- Introduction of wastewater treatment facilities by laws and system (PROPER) etc.

- Development, research, education of wastewater treatment technology by universities and research institutes

- Improvement of compliance and technical capacity using the system of qualification such as pollution control manager

- Offer of management support tools through training, guidelines, etc.

- Technical capacity to select a wastewater treatment method according to the wastewater quality and operate properly

- Even if the fish processing factory has wastewater treatment facilities, the treatment is not efficient (not biological but physicochemical treatment)

- Effluent standard is not met

- No wastewater treatment facility

- Necessary to introduce legal systems and measures, such as technical guidance, in order to promote installment of appropriate wastewater treatment facilities and operate it properly.
3. Demonstrative experiment using wastewater treatment facility

3-1. Objective and outline of demonstration

Objective
To promote to spread co-benefit type wastewater treatment technology for fish processing industry in Indonesia using demonstrative experiment.

Outline
1. Select an area which boasts fish processing industry, and select a factory at this area which has problem on wastewater treatment
2. Select appropriate co-benefit type wastewater treatment technology, design and install experimental wastewater treatment facility at the factory site
3. Conduct experiment using the facility and estimate quantitative co-benefit effect

(1) Select factory
- Select an area
- Select factory

(1) Plan Demonstrative Experiment
- Prepare operating plan
- Set up Wastewater Treatment System (WWTS)

(3) Operation and Maintenance
- Operate and maintain WTS
- Monitor water quality, etc
- Collect operating data

Estimate effect
- Analyze operating data (water quality, electric consumption etc.)
- Estimate effect of co-benefit type WWTS
3-2. Selection of demonstration site

(1) Site selected for demonstration

- Conducted on-site survey for 3 sites (as below) proposed by Ministry of Environment in Indonesia
- Selected target area and factory in Jembrana regency

<table>
<thead>
<tr>
<th></th>
<th>Muara Angke</th>
<th>Bitung</th>
<th>Jembrana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Province, area</td>
<td>Muara Angke, Special Capital Province of Jakarta</td>
<td>Bitung, North Sulawesi Province</td>
<td>Jembrana Department, Bali Province</td>
</tr>
<tr>
<td>Fish catch (t)</td>
<td>About 20,000</td>
<td>About 850,000</td>
<td>About 25,000</td>
</tr>
<tr>
<td>Population</td>
<td>10,000</td>
<td>178,000</td>
<td>37,800</td>
</tr>
<tr>
<td>Adoption</td>
<td></td>
<td></td>
<td>Fish meal factory</td>
</tr>
</tbody>
</table>

Map showing locations: Muara Angke, Jakarta Utara and Jembrana, Bali.
3-2. Selection of demonstration site

(2) Production process of selected fish processing factories

- Density of organic substances is very high due to the process of smothering ingredients. Oil is collected by centrifuge, but drained without being removed completely.
(1) Process of wastewater treatment

- Characteristics of wastewater of fish meal factory are (1) variation of flow rate, (2) highly dense organic wastewater (COD: 60,000mg/L) and (3) High SS and oil and grease.
- Wastewater treatment is necessary to be strong to shock load of amount of wastewater, and be able to reduce organic matter, SS and oil and grease.

※Bio-gas include about 60% methane (CH₄) and 40% carbon dioxide (CO₂).
### 3-3. Wastewater treatment technology for experiment

#### (2) Characteristics of ABR

<table>
<thead>
<tr>
<th>Construction</th>
<th>Biomass</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple design</td>
<td>No requirement for biomass with unusual settling properties</td>
<td>Low hydraulic retention times (HRT)</td>
</tr>
<tr>
<td>No moving parts</td>
<td>Low sludge generation</td>
<td>Intermittent operation possible</td>
</tr>
<tr>
<td>No mechanical mixing</td>
<td>High solids retention times (SRT)</td>
<td>Extremely stable to hydraulic shock loads</td>
</tr>
<tr>
<td>Inexpensive to construct</td>
<td>Retention of biomass without fixed media or a solid-settling chamber</td>
<td>Protection from toxic materials in influent</td>
</tr>
<tr>
<td>High void volume</td>
<td>No special gas or sludge separation required</td>
<td>Long operation times without sludge wasting</td>
</tr>
<tr>
<td>Reduced clogging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced sludge bed expansion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low capital and operating costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The best characteristic of ABR is to be able to adjust reactor volume for hydrolysis, acid formation and methane formation according to water quality level.

- For example, in case of high organic substance, volume for hydrolysis can be large. So ABR is flexible toward variation of water quality.

- ABR can control pH in Methane formation phase without no or less alkaline agent by returning treated water, so operation cost tends to decrease.
3-3. Wastewater treatment technology for experiment

(3) Flow chart of Anaerobic process (ABR)

- Oil separation
- Scum removal
- Acid Fermentation
- Methane Fermentation
- Gas Utilization
3-3. Wastewater treatment technology for experiment

(4) Characteristics of Aerobic process (Swim Bed method)

- Swim Bed method can make relatively big microbes stuck on the fringe installed in the tank and stabilize in the reaction tank. It can thus keep SRT (Sludge Retention Time) for a long time and dissolve oil.

- Thanks to Swim bed (fringe) on which microbes stick, there is no problem of clogging nor simultaneous separation unlike the ordinary fixed floor.

Fringe swims up and down using the water flow and microbes continuously separate and stick. It keeps the sludge in the tank in high density, and microbes which are suitable for oil dissolution increase.
3-3. Wastewater treatment technology for experiment

(5) Flow chart of aerobic process (Swim Bed system)

A: Equalization tank
B: Swim Bed tank
C: Clarifier
D: Measuring tank

WATER SUPPLY

AERATION BLOWER

MEASURING TANK

MEASURING TANK

MEASURING TANK

SLUDGE HOLDING TANK

EFFLUENT WATER TANK

OIL TRAP/EQUALIZATION TANK

SWIM BED TANK

CLARIFIER

Treated water
### 3-4. Result of the experiment

#### (1) Monitoring items for evaluation

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>(1) Equalization Tank</th>
<th>(2) Anaerobic Treated Tank</th>
<th>(3) Effluent Tank</th>
<th>Measurement equipment (Simplified measurement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Temperature</td>
<td>☆●☆●</td>
<td>☆●☆●</td>
<td>☆●☆●</td>
<td>Thermometer</td>
</tr>
<tr>
<td>pH</td>
<td>☆●●○</td>
<td>☆●●○</td>
<td>☆●●○</td>
<td>pH meter,</td>
</tr>
<tr>
<td>CODcr</td>
<td>●○○</td>
<td>●○○</td>
<td>●○○</td>
<td>HACH (colorimeter)</td>
</tr>
<tr>
<td>BOD</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>SS, NH₄-N</td>
<td>●○○</td>
<td>●○○</td>
<td>●○○</td>
<td>MLSS meter, Pack test</td>
</tr>
<tr>
<td>T-N, Cl₂, Oil &amp; Grease</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Electricity Consumption</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>Each process (ABR, SW)</td>
</tr>
<tr>
<td>Bio-gas (Methane gas)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of the process flow](image_url)

- **(1) Equalization Tank**
  - Measurement Items: pH, Water Temp. (everyday), CODcr, SS, NH₄-N (3 times a week)
  - Biogas Flow rate
  - Bio-gas

- **(2) Anaerobic Treated Tank**
  - Measurement Items: pH, Water Temp. (everyday), CODcr, SS, NH₄-N (3 times a week)
  - Scum Removal Tank
  - Activated Sludge Tank
  - Methane Fermentation Tank

- **(3) Effluent Tank**
  - Measurement Items: pH, Water Temp. (everyday), CODcr, SS, NH₄-N (3 times a week)
  - Sedimentation Tank
  - Effluent Water Tank
3-4. Result of the experiment

(3) Removal ratio of water quality

**ABR (Anaerobic treatment)**
- Removal ratio of COD is more than 90%.
- Removal ratio of NH₄ is about 70%, Oil&Grease is about 50%.

**SW method (Aerobic treatment)**
- Removal ratio of COD is more than 99%.
- Removal ratio of NH₄ is more than 90%, Oil&Grease is about 70%.
3-4. Result of the experiment

(4) Electricity consumption of each water treatment process

- The electricity consumption per removed COD of SW method was about 1 (kWh/kg-COD load) and 1/3 of the average of activated sludge treatment method in Indonesia.
- The electricity consumption of ABR was about 0.3 (kWh/kg-COD load) and 1/3 of SW method.
- Pressure of biogas in gas holder was more than 5kPa.
- Methane concentration of bio gas was from 65% to 70%.

![Graph showing electricity consumption per removal COD load for different processes and facilities.](attachment:image.png)
### 3-4. Result of the experiment

#### (6) Reduction of electricity consumption in factory

<table>
<thead>
<tr>
<th>Traditional treatment (Activated sludge)</th>
<th>Co-benefit type treatment (ABR+SW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow rate 15m³/d</td>
<td>Flow rate 15m³/d</td>
</tr>
<tr>
<td>Activated sludge (first stage)</td>
<td>Bio gas 450m³/d</td>
</tr>
<tr>
<td>Activated sludge (second stage)</td>
<td>Generator</td>
</tr>
<tr>
<td>Wastewater COD 60,000mg/L</td>
<td>Treated water COD 3,000mg/L</td>
</tr>
<tr>
<td>Treated water COD 3,000mg/L</td>
<td>Treated water COD 60,000mg/L</td>
</tr>
<tr>
<td>〈COD removal ratio95%〉</td>
<td>〈COD removal ratio95%〉</td>
</tr>
<tr>
<td>Treated water COD 150mg/L</td>
<td>〈COD removal ratio85%〉</td>
</tr>
<tr>
<td>〈COD removal ratio98%〉</td>
<td>〈COD removal ratio98%〉</td>
</tr>
</tbody>
</table>

**【Calculation of electricity consumption】**
- first stage of activated sludge
  \[ 15 \times (60,000-3,000) \times \frac{2.7}{1,000} = 2,309 \text{kWh/d} \]
- second stage activated sludge
  \[ 15 \times (3,000-150) \times \frac{2.7}{1,000} = 115 \text{kWh/d} \]
- Total electricity consumption
  \[ 2,309 + 115 = 2,424 \text{kWh/d} \]

**Difference between traditional treatment and co-benefit type treatment:** 2,975kWh/d

- Generated electricity (bio-gas765kg-COD × 0.35/0.6)
  \[ 450 \times 0.6 \times 35.8 \times 0.35/3.6 = 940 \text{kWh/d} \]
- Surplus of electricity: **551 (=940-389) kWH**
4. Preparing the guideline for wastewater treatment

4.1 Preparing formation of the guideline

Chairman of Committee (ITB)
Expert of wastewater treatment
Working team for preparing guideline

Guideline preparing committee

Ministry of environment and forestry (KLHK)
Ministry of environment of Japan (MOEJ)
Japanese consultants (NSC)

Expert regarding fish processing industry
Manager and operator of fish processing factory
Local government person in charge of wastewater management

Stakeholder and participants of workshop/seminar

Spread and utilize guideline
4. Preparing the guideline for wastewater treatment

4.2 Contents of the guideline

Management flow on wastewater treatment at fish processing factory

1. Recognize wastewater quality and regulation like as wastewater standard
2. Plan and introduce wastewater treatment facility at the factory
3. Operate & maintain the wastewater treatment facility (meet water standard)
4. Submit Environmental report and dispose environmental information

Wastewater standard: Guideline chapter 1.2.1 (GL, Ch.1.2.1)
Example of water quality of wastewater GL, Ch.2.1, 2.2.

Basic scheme of wastewater treatment:
GL, Ch.1.3.
Water treatment technology GL, Ch.3.1.
Planning process of water treatment facility:
GL, Ch.3.2.

Management organization of wastewater treatment GL, Ch.4.1.
Operation & maintenance of treatment facility GL, Ch.4.2.
Emergency procedures GL, Ch.4.2.

Water quality analysis method:
GL, Ch.5.1.
Environmental report:
GL, Ch.5.2.
4. Preparing the guideline for wastewater treatment

4-3. Spread and Utilize Guideline at the factory

- Survey on producing process and water quality of effluent and condition of wastewater treatment
- No facility

- Identify the problem of waste water treatment and give technical assistance to improve operation more effectively.

- Plan to introduce the co-benefit type wastewater treatment facility to meet wastewater quality standard of this factory

- Compile the information for improving guideline which was obtained through technical assistance
## 5. Implementation of capacity building

### Outline of capacity building

<table>
<thead>
<tr>
<th>No.</th>
<th>Event &amp; Location</th>
<th>Presenter</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Workshop in Jembrana regency in Bali (experiment site)</td>
<td>Ministry of Environment of Japan (MOEJ)</td>
<td>Promotion of co-benefit approach by MOEJ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Japanese consultants (Nihon Suido Consultants)</td>
<td>Outline of demonstrative equipment in Jembrana</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manager of FPI (Indonesian)</td>
<td>Installation and operation of demonstrative equipment</td>
</tr>
<tr>
<td>(2)</td>
<td>Japan study tour (Tokyo and nearby prefecture in Japan)</td>
<td>Person in charge of wastewater regulation (prefectural government)</td>
<td>Wastewater regulation for fish processing industry at Ibaragi prefecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Professor of University</td>
<td>Wastewater treatment technology</td>
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<tr>
<td></td>
<td></td>
<td>Expert of Japanese wastewater engineering company</td>
<td>Site visit at research center of Japanese wastewater engineering company</td>
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<tr>
<td></td>
<td></td>
<td>Manager of fish processing factory complex</td>
<td>Site visit at fish processing factory complex (common wastewater treatment facility)</td>
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<tr>
<td></td>
<td></td>
<td>Manager of factory of fish or food processing company</td>
<td>Site visit at the factory of food processing industry (anaerobic wastewater treatment facility)</td>
</tr>
<tr>
<td>(3)</td>
<td>Workshop in Jakarta</td>
<td>Ministry of Environmental pollution control MOEF, KLHK</td>
<td>Introduction of policy of environmental management of KLHK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ministry of Environmental pollution control MOEF, KLHK</td>
<td>Introduction of pollution control from fish processing industry in Indonesia</td>
</tr>
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<td></td>
<td></td>
<td>Ministry of Environment of Japan (MOEJ)</td>
<td>Promotion of co-benefit approach by MOEJ</td>
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<tr>
<td></td>
<td></td>
<td>Japanese consultants (Nihon Suido Consultants)</td>
<td>Operation of demo plant and evaluation of co-benefit effect</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Estimation of co-benefit effect in Indonesia</td>
</tr>
</tbody>
</table>
5. Implementation of capacity building

Workshop in Indonesia (No.1 at previous table)

Site visit of experimental site and factory in Japan (No.1, No2)
5. Implementation of capacity building

Lecture by Japanese expert in Japan study tour (No2, No3)

- Lecture regarding wastewater regulation and wastewater treatment technology

Lecture regarding wastewater regulation from expert of prefecture

Lecture regarding wastewater treatment technology from academic expert
Acknowledgement

Co-benefit project have been conducted with KLHK generous cooperation, especially Ms. NOOR RACHMANIAH, Deputy Director of Sub Directorate Water Pollution and Domestic Waste Control, Directorate of Water Pollution Control, Directorate General for Pollution and Environmental Degradation Control, Ministry of Environment and Forestry.

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TERIMA KASIH BANYAK

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