Management of wastewater and approach to excess bio-sludge reduction for refinery
Agenda

Management of wastewater for refinery
  > Wastewater passage
  > Configuration of wastewater treatment facilities
  > Measures of Water Pollution Control

Approach to excess bio-sludge reduction
  > About excess sludge
  > Our approach to excess sludge reduction
  > Application for refinery
Wastewater passage in refinery

Refining units

Oil pit separator

Rain water (refinery facility area)

Oily wastewater

Wastewater treatment facilities

Guard basin

Discharge to sea

Oil tanks

Oil pit separator

Rain water (without oily water)

Non-oily wastewater

API oil separator
General configuration of wastewater treatment facilities

Oily wastewater (Feed water)

Primary clarifier

- Oil separator: API, PPI, CPI
- Dissolved-air flotation (with coagulation)
- Coagulation sedimentation
  ... etc

Biological treatment

- Activated sludge process
- Bio filter process

Secondary clarifier

- Coagulation sedimentation
- Dissolved-air flotation
- Sand filtration
- Activated carbon treatment
  ... etc

Cushion tank (buffer tank)

Treated water to guard basin
Activated sludge process (Biological treatment)

Feed water (including organic matters)

CO₂

multiplication of microorganisms

Activated Sludge Tank

Aeration section

Return line for reused sludge

Settling section

Sedimentation tank

Treated water

Excess Sludge

Dehydrator
Measures of Water Pollution Control

(1) Reduction of waste water volume
   - Complete separation of oily and non-oily water
   - Reuse of treated waste water (TP Desalter injection water etc.)

(2) Reduction of pollution substances at upstream sources
   - Systematic separation and each treatment of polluted water
   - Optimum treatment of special waste solution

(3) Effective operation of water treatment system
   - Daily management
Wastewater management for biological treatment

Maintaining activation and sedimentation property in biological treatment

<Monitoring the daily status of treatment>
- oil content (smell, surface situation)
- pH
- dissolved oxygen concentration (DO), (smell)
- water temperature
- nutritious salt balance
- sedimentation property
Agenda

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Approach to excess bio-sludge reduction
  > About excess sludge
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About excess sludge

Feed water → Activated Sludge Tank → Sedimentation Tank → Treated water

Return Sludge

Excess Sludge to dehydrator

Excess Sludge
(Contained water ratio: 99mass%)

Dehydrator

Dehydrated Sludge
(Containing water ratio: about 85mass%)

CO₂

Incinerator

CO₂

Ash (Waste)

Landfilling, Cement material, …
The simple comparison with general generation of excess sludge related to BOD load of wastewater allowed to estimate that the amount is about half.
Approach of excess sludge reduction (2)

- About our original excess sludge reduction process

Feed water (including organic compounds) → CO₂ → Activated Sludge Tank → Aeration section → Return sludge → Solubilized (liquefied) sludge in Solubilization tank → Alkaline solution → Solubilization tank in Solubilization tank → Treated water
How to solubilize and reduce sludge

Aerobic microorganism

Microorganism cell wall (membrane)

Cell nucleus

Chemical treatment (Chemical addition and stirring)

Physical treatment (Mashing machine)

Dissolution of cell wall

Fragments of cell nucleus

Microorganism can not eat it easily

CO$_2$+H$_2$O

can eat it easily!
Laboratory Tests

Fig. Flow chart of bench scale system for activated sludge process of 40-L scale with alkaline and high speed mixer.

Feed water: 145L/day
COD(Mn): 100mg/L

Activated Sludge Tank (40L)
MLSS: 2000-3000mg/L

Return Sludge: 145L/day

Solubilization tank (5L)
With high speed mixer (batch condition)
Alkaline

Solubilized Broth 2-6L/day (continuously)

Sedimentation Tank (30L)

Treated water

Excess Sludge
Laboratory Tests

Activated Sludge Process Unit

- Activated sludge Tank (40L)
- Sedimentation Tank (30L)

Sludge Solubilization Unit

- Mashing machine
The amount of excess sludge (%)

Results of the circulating sludge volume experiments (each solubilization rate is the same)

Reduction rates of excess sludge
Technology Application

● Excess sludge reduction process that reduces sludge generated during wastewater treatment process

● Field Test: At Sakaide refinery of Cosmo Oil.COO.,LTD (2002) construction completion, January, 2002
  Funded by Petroleum Energy Center, Japan

● Purpose
  1. to establish 50% reduction operation of excess sludge (Laboratory reproducibility)
  2. to find operational conditions for more than 50% excess sludge reduction
Photo of Sludge Solubilization Unit
Field Test Results (Trend of excess sludge amount)

Fig. Trend of excess sludge amount during demonstration testing period
## Reduction amount of excess sludge

### Table Comparison of sludge generation amount before and after introduction of excess sludge reduction system (ESR)

<table>
<thead>
<tr>
<th></th>
<th>1996–2001</th>
<th>2003–2007</th>
<th>Reduced amount of excess sludge</th>
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</thead>
<tbody>
<tr>
<td><strong>Excess sludge volume</strong></td>
<td>7,100</td>
<td>2,780</td>
<td>▲ 4,320</td>
</tr>
<tr>
<td>(KL/year)</td>
<td></td>
<td></td>
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<tr>
<td>(MLSS=10,000mg/L)</td>
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<tr>
<td><strong>Dehydrated sludge</strong></td>
<td>390</td>
<td>153</td>
<td>▲ 237</td>
</tr>
<tr>
<td>(ton/year)</td>
<td></td>
<td></td>
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</tbody>
</table>
Summary

1) We explained the outline of a wastewater treatment unit concerning control of wastewater generated in refineries.
   ➢ Activated sludge method applying biological treatment, the optimization of condition for maintaining performance is especially important.

2) We reported the approach to the reduction of the amount of excess sludge generation.
   ➢ We has developed original excess sludge reduction technology for activated sludge process. We stably achieved Sludge reduction of 50% or more.
Thank you very much for your kind attention.
Wastewater treatment facilities at our Chiba refinery

Oily Water

API

PPI

D.A.F

Aeration Tank

Settler

D.A.F

Treated Water

Physical Treatment Section

Primary clarifier

API : American Petroleum Institute Water-Oil separator
PPI : Parallel Plate Interceptor Separator
D.A.F. : Dissolved Air Floatation

Biological Treatment Section

Activated sludge process

Secondary clarifier
Field Test Results (Trend of solubilization rates)

Fig. Trend of solubilization rate during demonstration testing period
Activated sludge process

- Aeration section
- Settling section