Technologies for Volatile Organic Compounds (VOC) Recovery in Petroleum Industry and JX’s Activities in the Middle East Area

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JX Nippon Oil & Energy Corporation
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1. JX-Group and JX Nippon Oil & Energy Corporation
Introduction of JX-Group

JX Nippon Oil & Energy
- Share in the domestic fuel market: 36% (No.1 in Japan)
- Paraxylene production capacity: 2,620 thousand ton/year (No.1 supplier in Asia)

JX Nippon Oil & Gas Exploration
- Crude oil and natural gas production (a project company basis)
  Approx. 130 thousand BD
- Worldwide business activities ranging from crude oil to LNG and oil sand

JX Nippon Mining & Metals
- Copper Smelting & refining capacity: 1,170 Thousand tons/year
- Equity entitled copper mine production: Approx. 100 Thousand tons/year
- Electronic Materials; Product Lines with World No.1 Market Shares

Listed subsidiaries
- JX Nippon Research Institute
- JX Nippon Oil & Gas Exploration
- JX Nippon Mining & Metals

Common group function companies

Independent companies
**Business Strategy**

**Upstream -> Downstream**

- **Exploring**
- **Importing**
- **Refining**
- **Distributing**
- **Marketing**

- **8 Refineries & 3 Plants**
  - Wakayama Petroleum Refining (Lubricants)
  - Wakayama (345)
- **2 Affiliate Companies**
  - Mizushima (345)
  - Marifu (127)
- **Oita (136)**
- **Osaka (115)**
- **Sendai (145)**
- **Kashima (189)**
- **Negishi (270)**
  - Kawasaki (Chemicals)
  - Yokohama (Lubricants)
  - Chita (Chemicals)
- **Muroran (180)**
- **Taniguchi Petroleum Refining (Lubricants)**
2. VOC Emission from Petroleum Industry and Air Pollution
VOC Emission from Petroleum Industry

(1) Exploration and Transportation

- Associated gas flaring
- Tanker gas emission with VOC
- Hydrocarbon loss
- CO2 Emission
- Hydrocarbon loss
- Odor material dispersion
- To Consumer
VOC Emission from Petroleum Industry

(2) Oil Processing & Consuming

- Vent and tank breather gas emission
- Gas emission with VOC

Valuable products (gasoline and chemicals) loss
Air pollution and firing risk
VOC and Air Pollution

Ultra-violet Rays

Photo-chemical Smog

Photo-chemical Oxidant

VOC

NOx

SOx

O$_3$ (Ozone)

OH

VOC

SPM (Suspended Particle Matter)

Secondary Particle

Throat Disease
3. JX’s Activities on VOC Recovery
VOC Emission from Petroleum Industry

(1) Exploration and Transportation

1. Associated Gas Recovery at the Oil Field
2. Tanker Vapor Recovery at KIIRE Staging Terminal
VOC Emission from Petroleum Industry

(2) Oil Processing & Consuming

Vent and tank breather gas emission

Valuable products (gasoline and chemicals) loss

Gas emission with VOC

Air pollution and firing risk

3. VOC Recovery at the Gas Station
1. Associated Gas Recovery at the Oil Field
- Rang Dong Project
- Yety Project
Rang Dong Project

Location and project scheme

Rang Dong oil field

Project participants of CDM

• Japan Vietnam Petroleum Corporation (JVPC) (Operator)
• ConocoPhillips
• Petrovietnam
• Petrovietnam Exploration & Production Company

Subsidiary of JX Nippon Oil Exploration
Rang Dong Project

Existing infrastructure in 2001

Supplying the associated gas from 2001 (= Rang Dong CDM)

New infrastructure (In process of revision of PDD)

Rang Dong oil field

On-site consumption, Flaring

Production

Oil well

2001 ~

A

Aug 2008 ~

Phuong Dong oil field

Recovered gas

X2

April 2009 ~

Su Tu Vang Oil field

X

B

End of 2011 ~

Dry gas

Transportation

Condensate

LPG

Ca Ngu Vang Oil field

Ca Ngu Vang Oil field

Back Ho Oil field

X'

Phuong Dong oil field

A1

2008 ~
Yety Project

Location

Project participants

• Joint Stock Company Gazprom Neft
• JX Nippon Oil & Energy
• Mitsubishi Corporation

Project site
Yety Project

Project scheme

Before the project

After the project
2. VOC Recovery at the Crude Oil Shipping Terminal in Japan

KIIRE Terminal
Tanker Vapor Recovery Project
Kiire Crude Oil Terminal
(JX Nippon Oil & Energy Group)

Jetties; 5
Tanks; 57
Capacity; 7 Million KL
Domestic Tanker (100,000DWT Class) 
Now on loading crude oil
Actual Vapor Emission from Tanker

- 31 million m³
- Vapor Emission
- Ocean Tanker
- Domestic Tanker
- Crude Loading 31 million KL/year
- Crude Oil Tanks
Residential zone

Vapor [Bad Smell]
## Main Technology of VOC Treatment

<table>
<thead>
<tr>
<th>System</th>
<th>Burning</th>
<th>Recovery</th>
<th>Recovery</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Direct Burning</td>
<td>Absorption</td>
<td>Adsorption</td>
<td>Separation</td>
</tr>
<tr>
<td>Equipment</td>
<td>Flare Incinerator</td>
<td>Kerosene etc.</td>
<td>Activated Carbon or Silica Gel</td>
<td>Membrane</td>
</tr>
<tr>
<td>Large amount of VOC</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>VOC Recovery</td>
<td>X</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>VOC &gt;= 5%</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>VOC &lt; 5%</td>
<td>O</td>
<td>X</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Removal of VOC</td>
<td>O</td>
<td>50 ~ 95%</td>
<td>90 ~ 99%</td>
<td>70 ~ 90%</td>
</tr>
<tr>
<td>Investment Cost</td>
<td>Relatively cheap</td>
<td>Medium</td>
<td>Medium</td>
<td>Relatively expensive</td>
</tr>
<tr>
<td>Others</td>
<td>Auxiliary fuel needed</td>
<td>Depend on absorbent</td>
<td>Regeneration needed</td>
<td></td>
</tr>
</tbody>
</table>
Basic design concept

Absorb with Crude

Kiire terminal storage large amount of crude and wide variety
(Instead of kerosene or other solvent)
Some crude have good absorbability

Flare Combustion

Combustion unabsorbed Vapor
Complete decomposition odor and VOC
Absorber Condition
Press. ; 0.3 ~ 0.5 Mpa
Temp. ; 3 ~ 7 °C

TANKER VAPOR RECOVERY PROJECT
PROCESS OVERVIEW

COMPRESSOR
10,000Nm³/h×2

KNOCKOUT
DRUM

TANKER
VAPOR

Tanker

KNOCKOUT
DRUM

10,000KL

Crude Oil Tank

Off Gas

SEAL
DRUM

800 °C

Ground Flare

NH₃

70% Recovery

ABSORBER

JX Nippon Oil & Energy
TVR (Tanker Vapor Recovery) Plant

May 2007 Operation Start
### Performance of TVR (2007 FY)

<table>
<thead>
<tr>
<th>Items</th>
<th>Amount</th>
<th>Unit</th>
<th>Utilization Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Total Crude Oil of Shipment</td>
<td>32,080,000</td>
<td>KL</td>
<td></td>
</tr>
<tr>
<td>(B) Crude Oil Connected with TVR</td>
<td>28,594,000</td>
<td>KL</td>
<td>(B) / (A) = 89.1%</td>
</tr>
<tr>
<td>(C) Nos. of Ship Total</td>
<td>293</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(D) Nos. of Ship connected with TVR</td>
<td>264</td>
<td></td>
<td>(D) / (C) = 90.1%</td>
</tr>
<tr>
<td>(E) VOC Recovery Volume as Crude Oil</td>
<td>11,093</td>
<td>KL</td>
<td></td>
</tr>
<tr>
<td>(F) VOC Recovery Rate</td>
<td>70.8</td>
<td>%</td>
<td>(E) / Feed Total-Hydrocarbon</td>
</tr>
<tr>
<td>(G) Average VOC Concentration of Tanker Vapor</td>
<td>13.1</td>
<td>%</td>
<td></td>
</tr>
</tbody>
</table>
3. VOC Recovery Demonstration at a Gas Station by Vapor Recovery Unit in the Middle East
VOC Recovery at a Gas Station

Each Station

Shipping Point

Loading at Terminal

Unloading at Gas Station

Vapor return

Underground Gasoline Tank

Loading at Terminal

Tank Truck

Unloading at Gas Station

Vapor return

Underground Gasoline Tank

Loading at Terminal

Tank Truck

Shipping Point

Loading at Terminal

Tank Truck

Each Station
# Comparison of VOC Recovery Technologies

<table>
<thead>
<tr>
<th>Type</th>
<th>Adsorption</th>
<th>Membrane</th>
<th>Condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Silicagel</td>
<td>Activated carbon</td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>◎</td>
<td>◎</td>
<td>◎</td>
</tr>
<tr>
<td>Recovery rate</td>
<td>◎</td>
<td>◎</td>
<td>○</td>
</tr>
<tr>
<td>Initial Cost</td>
<td>◎</td>
<td>○</td>
<td>▲</td>
</tr>
<tr>
<td>Running Cost</td>
<td>◎</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Area</td>
<td>◎</td>
<td>○</td>
<td>▲</td>
</tr>
<tr>
<td>Safety</td>
<td>◎</td>
<td>▲</td>
<td>○</td>
</tr>
<tr>
<td>Disadvantage</td>
<td></td>
<td>Flammable adsorbent</td>
<td>High Initial Cost</td>
</tr>
</tbody>
</table>

◎: Best
○: Better
▲: Poor
VRU Process Flow of Adsorption Process

- **Underground Tanker**
- **Vapor** to **Heat Exchanger**
- **Liquid**
- **Chiller**
- **Measurement Tank**
- **Adsorbent (Silica gel)**
- **Clean gas to Atmosphere**

Chiller unit is not necessarily required.
VRU Process Flow of Desorption Process

- **Tanker**
- **Underground Gasoline Tank**
- **Gasoline Vapor**
- **Liquid**
- **Measurement tank**
- **Heat exchanger**
- **Chiller**
- **Vacuum pump**
- **Adsorbent (Silica gel)**

Chiller unit is not necessarily required.
### Unloading Conditions, Adsorption / Desorption Conditions and Expected Performance of VRU

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Unloading Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>1.1. Unloading Volume from 1 Tanker</td>
<td>36KL</td>
</tr>
<tr>
<td>1.2. Concentration of Hydrocarbon</td>
<td>45%</td>
</tr>
<tr>
<td>1.3. Unloading Velocity</td>
<td>80m3/hour</td>
</tr>
<tr>
<td>1.4. Unloading Period per 1 Tanker</td>
<td>60min</td>
</tr>
<tr>
<td>1.5. Interval of Unloading</td>
<td>5 – 6 hours</td>
</tr>
<tr>
<td><strong>2. Adsorption Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>2.1. Adsorption Temperature</td>
<td>Ambient</td>
</tr>
<tr>
<td>2.2. Adsorption Pressure</td>
<td>Slightly Positive (Almost less than 2KPa)</td>
</tr>
<tr>
<td><strong>3. Desorption Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>3.1. Desorption Pressure</td>
<td>Slightly Positive (Almost less than 2KPa)</td>
</tr>
<tr>
<td>3.2. Approximate Desorption Period</td>
<td>4-5 hours</td>
</tr>
<tr>
<td><strong>4. Expected Performance</strong></td>
<td></td>
</tr>
<tr>
<td>4.1. Recovery Rate of Hydrocarbon</td>
<td>More than 98%</td>
</tr>
<tr>
<td>4.2. Recovery Amount</td>
<td>More than 0.2%</td>
</tr>
</tbody>
</table>
### Summary of Trial Results

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Trial run results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trial Run Period</td>
<td>September - October, 2012</td>
</tr>
<tr>
<td>2. Total unloaded Volume</td>
<td>1,692KL (1,184Ton)</td>
</tr>
<tr>
<td>3. Recovery Amount of Hydrocarbon</td>
<td>2,122KG</td>
</tr>
<tr>
<td>4. Recovery Rate of Hydrocarbon</td>
<td>99.5% of Hydrocarbon Content (HC)</td>
</tr>
<tr>
<td></td>
<td>(Calculated by measured result of HC concentration at VRU inlet and outlet)</td>
</tr>
<tr>
<td>5. Recovery Amount of Gasoline</td>
<td>0.2% of the unloaded volume</td>
</tr>
</tbody>
</table>
Future Activities on VOC Recovery

JX-Group tries to continue activities on VOC Recovery in the Middle East.

Acknowledgements

The demonstration of VOC recovery at a gas station was conducted, based on the Joint Technical Cooperation Program with JCCP. JX appreciates the cooperation of JCCP.
Thank you for your attention.