1. Need for Tanker Vapor Recovery
VOC Emitted from Tankers

Volatile Organic Compounds (VOC) remained in cargo tanks are emitted when crude oil is loaded.

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Tanker Vapor Exhaust Vent

Vapor Release Points

- VOC
- Propane, Butane, H₂S
- Boiler Flue Gas
- N₂, CO₂, O₂ (less than 8%)
Necessity of TVR (1/2)

1. **EPA Requirements** (40 CFR, Part 63, Subpart Y)
   Terminals with crude oil throughput of 200 M b/y or more to reduce VOC emissions by
   - 95 wt% when using vapor recovery techniques
   - 98 wt% when using vapor combustion techniques

2. **USCG Requirements**
   - 33 CFR, Part 154, Subpart E
     Safety regulations for onshore vapor processing units
   - 46 CFR, Part 39
     Safety regulations for tank vessels in US waters

Necessity of TVR (2/2)

1. **International Regulation** (MARPOL Annex VI Regulation 15)
   - requires ports/terminals to have VECS*
   - requires tanker owners to provide VECS* on tankers
     *Vapor Emission Control System

2. **Prevention of Wasting Energy**
   VOC can be recovered as crude oil by TVR.

3. **Protection of Environment and Ourselves**
   Reduction of Greenhouse Effect
2. TVR Processes

Chilled Absorption Process (CAP)
Integrated Membrane Process (IMP)

**Chilled Absorption Process (CAP)**

- Absorption Process with Chilled Arabian Light -

- Arabian Light as Absorbent.
- Absorbent is chilled at 10 °C.
- 70% of HC is recovered at the Absorber Column.
- The remaining HC is combusted at the Ground Flare to remove all odor contents.
- The 1st commercial plant at JX Kiire Terminal. In operation since 2007 without trouble.
- The patent owned by JX Nippon Oil and Energy.
THE 1ST COMMERCIAL TVR PLANT

Owner: JX Nippon Oil and Energy Staging Terminal Corporation
Location: Kiire Terminal, Kagoshima, Japan
Process: Chilled Absorption Process
Capacity: 20,000Nm³/h
Completion: 2007

High Recovery Rate: 95%
Compact & Simple Plant Configuration
Wide Selection of Absorbent AL, AXL, AM & AH
Pre-Absorption Process: VOC is absorbed to Absorbent.
Membrane Separation Process: Enrich VOC content of recycle gas.
The process was developed in 1980s by JFE.
A lot of track records for gasoline vapor.
JFE, together with JX, started modification of IMP for tanker vapor application in 2011.
A pilot plant in Kiire Terminal proved the stable performance with high recovery rate.
The technology materialized by the cross license between JFE & BORSIG.
### IMP PILOT PLANT in KIIRE TERMINAL

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>80 Nm³/h</td>
</tr>
<tr>
<td>Process</td>
<td>Integrated Membrane Process</td>
</tr>
<tr>
<td>Performance</td>
<td>NMVOC Recovery Rate 95%</td>
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</tbody>
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4. Integrated Membrane Process for Offshore Application
Typical Offshore Crude Loading Terminal

IMP Plant can be installed offshore.

Custom Built Vessel (CBV)

- CBV for a 14 kNm³/h Plant
  80m x 33m x 4,300 DWT
- Vessel Orientation
  External Turret – CBV – Tanker
- CALM or SALM buoy will be replaced to External Turret.
- CBV is kept moored to Turret.
- Crude loading operation will be similar to the current practice.
IMP’s compact design for Tanker Vapor Recovery at offshore crude oil terminals.

Preliminary vessel design was performed by Japan Marine United Corporation.

Please contact us for further inquiries.

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THANK YOU FOR YOUR ATTENTION.