EE&C Best practice in energy and chemical industry
EE&C Best Practice in Japan for Petrochemical Industries in Singapore

15 October 2019, Singapore

EE&C Symposium held by EDB

ECCJ Hidetoshi Suzuki
ECCJ contributes to promotion and dissemination of energy efficiency and conservation domestically and internationally by enhancement of the sensitivity to various needs related to energy conservation.

Japan is one of advanced country of energy savings.
Introduction

Through the Best Practice

EECJ awards outstanding practices. You can utilize these to improve your plants. We’d like to provide you hints of improvement.

Advanced  Effective

Versatile  Sustainable
<table>
<thead>
<tr>
<th>NO.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Energy Saving by Pinch Technology</td>
</tr>
<tr>
<td>2</td>
<td>Energy Saving by utilization of LNG Cold Energy</td>
</tr>
<tr>
<td>3</td>
<td>Reduction of Steam Leakage from 100,000 Steam Traps</td>
</tr>
<tr>
<td>4</td>
<td>Energy Conservation by Additional Boiler Installation to Gas Turbine</td>
</tr>
<tr>
<td>5</td>
<td>Energy Conservation of Hydrogen Plant by Utilization of Petrochemical by-product Hydrogen</td>
</tr>
<tr>
<td>6</td>
<td>Energy Conservations by Surplus Steam Utilization</td>
</tr>
<tr>
<td>7</td>
<td>Energy Conservation for Liner Alkyl-benzene(LAB) Reaction optimization</td>
</tr>
<tr>
<td>8</td>
<td>Aromatic Plant Energy Conservation by Operating Supporting System</td>
</tr>
<tr>
<td>9</td>
<td>Energy Conservation of Hydrogen Plant by Reduction of Reformer Catalyst Deterioration</td>
</tr>
</tbody>
</table>
Categorize

5 Key issues to realize energy conservation

a) Integration (Heat / Material)
b) Asset Integrity
c) Digitalization
d) Reaction
e) Subsidy/Fund (Governmental support)
Analyzing 10 practices

10 practices categorize into 5 keys

a) Integration
b) Asset Integrity
c) Digitalization
d) Reaction
e) Subsidy
a) Integration

Pinch Technology

Pinch technology has been widely utilized from 1980s

It is a way to find an idea of “Integration”

It cannot use only for Heat integration but also Materials one.
a) Integration

Targeting (Principles)

Heat source: Streams to be cooled
Heat sink: Streams to be hot

Ideal state: Vertical exchange
Integration brings

• Effective use of energy
  • Heat Exchanging more
• Effective use of waste
  • Waste value up
• Reduction in environmental load
  • Energy conservation, Minimize losses
a) Integration

Japanese Traditional Integration
The bigger the better in its effectiveness

Japanese Garden “Shakkei” : Borrowed scenery
a) Integration

Integration range and effect
The bigger range challenge brings the bigger fruit.

- i) inside a plant
- ii) Between 2 plants
- iii) Inside facility
- iv) Over fence integration
i) Inside a plant

Heat source temperature arrangement can be realized significant heat exchange.

How to use this big Condense duty?

A: Column temperature up ! = Pressure up

Utilization of Waste Heat of Aromatic Distillation Tower

Air cooler → Kettle HX / Using Xy tower O/H heat

Low temp. Waste Heat recovery of Para-Xylene production apparatus

- Low temp. Waste Heat on OH condensing
- Steam Generator
- Low Press Steam Header
- 150°C
- 120°C
- Adsorb Separation Section
- Solvent Separation Tower
- Xylene Tower
- Mixed Xylene
- Adsorbent
- Para-Xylene
- Boiler
- Reduction of Boiler Fuel
- Installation of Steam Generator

⇒ Low Press (0.2MPa) Steam: About 20ton/h recovery

- 12,300 coe-kl/y savings

Bottom temperature up ⇒ MP steam → Hot oil
The relative volatility goes down
a) Integration

iii) Inside a facility

<Principles>
Right people, Right place
Right purity, Right user

<table>
<thead>
<tr>
<th>Purity %</th>
<th>Plant A</th>
<th>Plant B</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>PSA H2 supplier</td>
<td>H2 supplier</td>
</tr>
<tr>
<td>95</td>
<td>H2 user</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Fuel</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purity %</th>
<th>H2 user</th>
<th>H2 supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quantity

Plant A

Plant B
NO.5 Energy Conservation of Hydrogen Plant by Utilization of Petrochemical by-product Hydrogen

Diagram:

- **CO2 export**
- **By pro**
- **HY**
- **H2 production**
- **PSA**
- **L user**
- **M user**
- **H user**
- **Fuel Header**
- **By pro**
- **PSA**
- **H user**

**H2 purity**
- Export: 70-86mol%
- 97mol%
- 99mol%
High Operation Rate for H2 Plant

H2 Plant

- H2 from H2 Plant
- By-Product H2
- H2 Consumption

User classification

User classification

Classification

Purity Relaxation

H2 Supply from Hydrogen Plant

<table>
<thead>
<tr>
<th>H2 Generation in H2 Plant KNm3/d</th>
<th>Fuel Consumption in H2 Plant COE-KL/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>720</td>
<td>580</td>
</tr>
<tr>
<td>112.1</td>
<td>91.7</td>
</tr>
<tr>
<td>-140</td>
<td>-20.4</td>
</tr>
</tbody>
</table>

① Before: Average from 1st April to 6th July 2014
② After: Average from 1st December to 6th March 2015

Energy Conservation Effect

- Reduction of Energy, Coe: 6,732 KL Reduction
- Reduction CO2 Emission

Savings

= 791,000 coe-kl/y

Refinery Energy Saving Rate: 0.85%
a) Integration

iv) Over fence
Extra low-level heat can be utilized for specific plants.

<table>
<thead>
<tr>
<th>Deg. C</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Chemical plant A,B,C</td>
</tr>
<tr>
<td>-13~15</td>
<td>-13~15°C</td>
</tr>
<tr>
<td>-100</td>
<td>Naphtha cracker</td>
</tr>
<tr>
<td>-100~20</td>
<td>-100~20°C</td>
</tr>
<tr>
<td>-160</td>
<td>LNG vaporizing</td>
</tr>
</tbody>
</table>

The lower the more Energy!
NO.2 Energy Saving by utilization of LNG Cold Energy

Flexible operation can be realized

Direct use of process stream
NO.2 Energy Saving by utilization of LNG Cold Energy

- 13,000coe-kl/y savings
- Governmental subsidy was required

Enthalpy

Heat sink

H required

Chemical Facility
Gas Facility
Cracker
LNG
LNG Return
For Panel Discussion

More versatile system

Sea water cooling down

- Connecting a Pipeline
- Reduced 40,000KL of crude oil throughput.
  - Increase Recovery Ratio of LPG and Propylene
  - Increase Crackability
  - Energy Conservation

Projects for Stable Supply of Petroleum Products” by RING

RING: Research Association of Refinery Integration for Group-operation

Energy Efficiency Facilitating Hub
THE ENERGY CONSERVATION CENTER, JAPAN

Sea Water → Chita LNG → Power Plant Fuel
LNG → Vaporizer → Power Plant Fuel
Crude Oil → CDU → RFCC → Gasoline, Gas Oil, LPG
Residue Oil → Power Plant Fuel
LPG Recovery → LPG → Propylene
Connecting a Pipeline → To reduce sea water intake.
Connecting a Pipeline → To reduce cold energy discharge.
b) Asset Integrity

Three Major cause of troubles
- Fouling / Plugging
- Mechanical trouble cause of aging (Vibration/Leakage/erosion/corrosion)

Keeping performance
Should be one of the grate energy saving solution
b) Asset Integrity

**CROF (CRude Oil Fouling) PJ *1)**

Pre-heat train fouling is estimated to cost around $1.2 billion per annum in the US alone.

$ 6 billion/y losses in the World ! !

**Cleaning**

brings big energy saving

(=loss recovery)

*1) Imperial College London
b) Asset Integrity

Recognize Specific lifespan

Each equipment have different age and MTBF. Appropriate maintenance brings High performance continuously.

MTBF : Mean Time Between Failure
NO.3 Reduction of Steam Leakage from 100,000 Steam Traps

- Managed 100,000 traps
- 18,000coe-kl/y savings
- 46,000 t/y CO2 reduction
c) Digitalization

What does Digitalization mean?

- Monitoring
- Computer control / Modeling
- Optimization
  One plant / multi plants / Whole complex
- Big Data, AI

In Japan, Artificial Intelligence has been delayed in practical use.
c) Digitalization

**Monitoring / Visualization**

Improvement should start with awareness. Recognize a gap!

![Diagram showing benchmarking and target with a gap](image)
c) Digitalization

Computer control
The bigger facility control brings the bigger fruit.
Results: Energy Conservation Achievement by Introduction of Operation System and Reduction of Steam Ratio

a) Optimization of Pre-Splitter Operation
b) Reduction of Load for Panel Operator

• 19,600 coe-kl/y savings
Production Plants

Crude Oil

Hydrogen

Steam

Fuel

Products

Electric Power

Weekly Operation Schedule

Develop Cost minimum utility supply plan in real time

Utility control System

Purchase

Purchase

Purchase & Selling

All facilities (Optimization)
NO.3 Reduction of Steam Leakage from 100,000 Steam Traps

Beneficial

Optimization of Energy Balance
- Steam Balance
- Heat And Electricity Balance

Optimization of SA (Steam Application)
- Importance of Quality & Productivity
- Recovery & Reuse of Drain & Waste Heat

Optimization of Steam System

Optimization of Drain Disposal Place
- Reduction of Drain Obstacle
- Reduction of Steam Loss

Fundamental Infrastructure for Steam System Optimization
c) Digitalization

**Big Data / AI**

No best practice is observed.
d) Reaction

Process design procedure
Procedure starts from a reaction.
It dominates the process.
Conversion up brings
Recycle rate decreasing
Reducing distillation duty
### Target of Energy Conservation

<table>
<thead>
<tr>
<th>Item</th>
<th>Target</th>
<th>Coe (t(\text{I}/\text{Y}))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduction of Catalyst Determination</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel gas Consumption</td>
<td>2%Reduction</td>
<td>500</td>
</tr>
<tr>
<td><strong>S/C Reduction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel gas Consumption</td>
<td>2%Reduction</td>
<td>500</td>
</tr>
<tr>
<td>Steam Consumption (Equivalent to Fuel gas)</td>
<td>3%Reduction</td>
<td>750</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7%Reduction</td>
<td>1,750</td>
</tr>
</tbody>
</table>

Target = Ratio to overall H\(2\) plant energy consumption

---

**For Steam Reformer**

- FEED spec. relaxation
- S/C ratio optimization
- High performance catalyst

- 2,170coe-kl\(\text{I}/\text{Y}\) savings are realized

**Diagram:**
- High performance Catalyst
- Change catalysts
- Tube replace
- \(\text{① Expansion of LP Steam Reboiler}\)
e) Subsidy

Support system in Japan

a. Green Investment tax reduction

b. EMS support subsidy

c. EE&C Investment
Conclusion

New approach will be required

Japan has been an advanced energy-saving country so far. The importance of “Best Practices” are never change. However the evolution of digitalization will bring a grate change of energy use.

To accelerate advanced approach, we need a special supports and efforts.

We are now in a same start line.
Thank You Very Much

The Symbol of Energy Conservation
Since 2005 ECCJ has been spreading the symbol mark with the visual image of a flour-leaf clover which is thought to bring happiness named as “SMART CLOVER”, representing everyone’s energy conservation activities.

For More Information;
The Energy Conservation Center, Japan
https://www.eccj.or.jp  <from 1996>

Asia Energy Efficiency and Conservation Collaboration Center
(Established in April 2007)
https://www.asiaeec-col.eccj.or.jp

Japanese Business alliance for Smart Energy-Worldwide
(Established in October 2008)
https://www.jase-w.org/

The Energy Conservation Center, Japan
Since 1978

<Disclaimer>
The views, opinions and information expressed in this presentation were compiled from sources believed to be reliable for information and sharing purposes only. Any other use of this presentation’s content should be subject to ECCJ’s approval.