Natural Gas as Feedstock for Town Gas Production

HKIE/IGEM Joint Gas Seminar

24 April 2013

Ir. Chris Man
GM - Gas Production
H.K. & China Gas Co. Ltd.
HKCG (Towngas) Profile

1862 - Established in England
- £35,000 capital
- HK’s oldest public utilities

1864 - Gas produced at West Point Work
- Supply ~ 500 gas lamps in Central (today) area
- 24 km low pressure network

Core Business (Hong Kong)
- Gas supply & supporting services
- > 1.75 million customers
- > 3,500 km HP & LP network
- Listed company, Market Cap ~ HK$200B

Diversified Business (Hong Kong)
- Telecommunication
- LPG Filling Station
- Landfill Gas etc.

Mainland China Business (Over 150 JV’s)
- City Gas
- Water Business
- New Energy Business
Gas Production Milestone

- HKCG founded
- Feedstock change to heavy oil
- Tai Po Gas Plant commence operation
- Introduction of NG to Tai Po Plant


- Commence supplying town gas with coal as feedstock
- Feedstock change to Naphtha
- First LFG utilization project in Shuen Wan
- NENT SNG Plant
- Twin 34 km
- Diameter: 450 mm
- Working Pressure: 90 Bar Max
## Tai Po Plant – Key Dates

<table>
<thead>
<tr>
<th>Phase</th>
<th>Project Started</th>
<th>Commenced Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>March 1985</td>
<td>December 1986</td>
</tr>
<tr>
<td>Phase II</td>
<td>January 1990</td>
<td>December 1992</td>
</tr>
<tr>
<td>115% &amp; NG Modifications</td>
<td>March 2003</td>
<td>September 2006</td>
</tr>
</tbody>
</table>
Tai Po Plant Layout

- Phase I
- Phase II
- Naphtha Storage Tanks
- Natural Gas Receiving Station
- Air Compressors Station
### Tai Po Gas Production Plant

| **Plant Capacity** | Phase I = 4 x 700,000 Sm³/day (NG)  
4 x 805,000 Sm³/day (Naphtha only)  
Phase II = 4 x 1,400,000 Sm³/day (NG)  
4 x 1,610,000 Sm³/day (Naphtha only) |
| **Feedstock**     | Naphtha (Sulphur <100 ppm) & Natural Gas |
| **Product Gas**   | 17.27 MJ / Sm³ |
| **Process Route** | Catalytic Rich Gas (CRG) Process |
| **Delivery Pressure** | 3,500 kPag |
CRG Process
Town Gas from Naphtha and NG

NG Feed

Naphtha Feed

De-sulphurisation

CRG Reactor

Reformer

Steam

CO Converter

Heat Recovery

CO₂ Absorber

Air Odour

Town Gas

Recycle Gas
## Tai Po Gas Characteristics

<table>
<thead>
<tr>
<th>Chemical Composition</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>16.3 - 19.9</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>1.0 - 3.1</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>28.2 –30.7</td>
</tr>
<tr>
<td>Hydrogen (H₂)</td>
<td>46.3 - 51.8</td>
</tr>
<tr>
<td>Nitrogen &amp; Oxygen (N₂ &amp; O₂)</td>
<td>0 - 3.3</td>
</tr>
</tbody>
</table>

### Physical Properties

- Calorific Value (MJ/m³) 17.27
- Specific Gravity 0.52
- Wobbe Index 24.00
- Weaver Flame Speed 35.00
Natural Gas as Feedstock (I)

Advantage (1) - More Reliable

- Dual feedstock – improve supply security
- Revert back to 100% naphtha when required
- Natural Gas currently 55 – 60% of input
Natural Gas as Feedstock (II)

Advantage (2) - More Economical

- 25 year contract ➔ cheaper & more stable price than naphtha
- Benefits pass back to customers
  ~ 10% price reduction since Q4 2006
- HK$ 9.5 billion accumulated saving to customers up to Dec 2012
Natural Gas as Feedstock (III)

**Advantage (3) - More Environmental**

- Natural Gas is cleaner#
  - CO$_2$: ~ 21% reduction
  - NOx: ~ 50% reduction
  - SOx: ~ 30% reduction

- Accumulated CO$_2$ reduced up to Dec 2012
  ~ 533,000 MT $\Rightarrow$ ~ 23 million Trees.

# 2012 Data
Why not Direct NG Supply?

• Security
  - Single Source of NG from Dapeng LNG Terminal

• Cost
  - Huge investment involved for converting 1.7 million+ customers, HK$ Billions

• Inconvenience
  - Need to open up large portion of existing underground pipeline network for sectorization over a 10 years period
Further NG Utilisation

- HKCG founded
- Feedstock change to heavy oil
- Tai Po Gas Plant commence operation
- Introduction of NG to Tai Po Plant
- MTK NG Conversion

- Commence supplying town gas with coal as feedstock
- Feedstock change to Naphtha
- First LFG utilization project in Shuen Wan
- NENT SNG Plant
MTK NG Conversion

Existing pipeline
• Tai Po Plant to Shatin
  (make use one of the existing 750mm dia. submarine pipeline)

New U/G pipeline to be constructed
• Shatin Section ~ 6.7 km
• Kowloon Section ~ 5.8 km

New pipeline to be constructed in Tunnel
• Beacon Hill Tunnel Section ~ 2.2 km

• Commence modification at 2009
• Target commissioning at 2013

Legend

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
</tr>
</tbody>
</table>

Legend

- - - - - - - - - - U/G Pipeline
- - - - - - - - - - Tunnel Section
Greener Energy Targeted

- HKCG founded
- Feedstock change to heavy oil
- Tai Po Gas Plant commence operation
- Introduction of NG to Tai Po Plant
- MTK NG Conversion

- 1862
- 1864
- 1967
- 1973
- 1986
- 1999
- 2006
- 2007
- 2013

- Commence supplying town gas with coal as feedstock
- Feedstock change to Naphtha
- First LFG utilization project in Shuen Wan
- NENT SNG Plant

>65% NG
<25% Naphtha
~10% Renewable
Thank You

Question are welcome
Naphtha Vapouriser

Convert S to $\text{H}_2\text{S}$

$2 \text{R-S} + 3 \text{H}_2 \rightarrow 2 \text{H}_2\text{S} + 2 \text{R-H}$
Naphtha + Steam $\rightarrow$ $\text{CH}_4 + \text{H}_2 + \text{CO}$
Tubular Reformer

\[ \text{CH}_4 + \text{H}_2\text{O} \rightleftharpoons 3 \text{H}_2 + \text{CO} \]
CO Converter

CO + H₂O → CO₂ + H₂
$\text{H}_2\text{O} + \text{K}_2\text{CO}_3 + \text{CO}_2 \Leftrightarrow 2 \text{KHCO}_3$
Drying System
Phase II
Naphtha Storage Tanks
Natural Gas Receiving Station