INNOVATION IN GASIFICATION

Gasification Technologies
Conference 2011

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PEARL – WORLD’S LARGEST GTL PROJECT
SHELL HAS 30+ YEARS OF GTL DEVELOPMENT

1973
LABORATORY AMSTERDAM
grams/d

1983
PILOT PLANT AMSTERDAM
3bbl/d

1993
BINTULU SMDS MALAYSIA
Current capacity 14,700 bbl/d

2011
PEARL GTL QATAR
Start-up 140,000 bbl/d

CONTINUED TECHNOLOGY DEVELOPMENT
PEARL GTL: INTEGRATED GAS-TO-LIQUIDS PROJECT

• 1.6 Bcf/d of Wet Gas
• 120 kbbl/d NGLs/Ethane
• 140 kbbl/d GTL products
• Major construction completed Q4 2010
• 2011 ramp-up ~12 months, full production mid 2012
• ~$18-$19 billion development cost
• Project 100% funded by Shell
• No gas feedstock cost – operating costs of $6/boe upstream production
• Shell receives cost recovery of investment and shares profit with state of Qatar

Full integration from offshore to refined products
# PEARL GTL: A MAJOR ENGINEERING FEAT

## MATERIAL STATISTICS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>CONCRETE</th>
<th>STEEL</th>
<th>REACTOR TUBES</th>
<th>CABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Offloading Facility: Imported &gt;2 mln freight tonnes</td>
<td>750,000 m³ ~8 Wembley Stadiums or 2 Burj Khalifas</td>
<td>Erected 2.5 Eiffel Towers/month in pipe &amp; structural steel at peak</td>
<td>GTL synthesis reactor tubes end to end would stretch from Doha to Tokyo</td>
<td>~13,000 km of cables: Doha to Houston</td>
</tr>
</tbody>
</table>

## PROCESS STATISTICS

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>WATER FOR STEAM &amp; COOLING</th>
<th>STEAM FOR POWERGEN</th>
<th>OXYGEN FOR GTL</th>
<th>CATALYSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 GW of rotating equipment</td>
<td>~45,000 m³/day cleaned Town of 140,000 people</td>
<td>Steam 8,000 tonnes/hr 3 Olympic size swimming pools/hr</td>
<td>28,000 tonnes/day produced</td>
<td>Surface area equivalent to 18x surface area of Qatar</td>
</tr>
</tbody>
</table>
**Shell Gasification Process (SGP)**
- based on Partial Oxidation (POX)
- 9 SGPs per train
- Reaction temperature ~1300 °C
- Refractory clad reactor

**Heavy Paraffin Synthesis (HPS)**
- 12 reactors of 1,200 tons per train
- Tens of thousands of tubes containing 200 tons of Cobalt-based FT catalyst per reactor

**Heavy Paraffin Conversion (HPC)**
- Largest hydrocracker in Shell
- Platinum-based catalyst dedicated to GTL
- Maximizing yield of gasoil and BO
SHELL GASIFICATION PROCESS

Concept:
- Partial oxidation
- Refractory clad pressure vessel

Challenges:
- Severe conditions (reducing, \(\sim 1350^\circ C\))
- Materials of construction
- Burner design and control
- High pressure

Advantages:
- No catalyst, no steam, favouring efficiency
- High conversion efficiency
- >40 years experiences (>100 units)

Performance:
- Good burner reliability (> 2 years)
- Excellent overall availability (>99%)
PEARL GTL HSSE PERFORMANCE

LARGE WORKFORCE, COMPLEX PROJECT

- Pearl GTL workforce - at peak circa 53,000
- Pearl Village community established
- In 2010 LTIF< 0.04/mln hrs
- Shell Record – Onshore - 77 mln hrs LTI free
- 270mln km driven without serious accident

PM congratulates CCC Safety Manager on achieving 75 million hrs without LTI

10 TIMES LOWER LTI THAN INDUSTRY AVERAGE
2.0
NEXT GENERATION GASIFICATION
Shell & Wison jointly agreed in February 2011 to develop and market next generation low cost hybrid gasifier.

About Wison
- Chinese EPC firm
- Operated ~ 50 million man hours without LTI (all in China and related to EPC projects in China)

Objectives of cooperation
- Aiming for ~35% capital costs reduction
- De-risking technology
- Demo plant will be in located in Wison’s Chemical site in Nanjing, China
- Learn from a low-cost dynamic Chinese company

Timing
- Demonstration plant by ~ 2013
- Anticipated commercial availability by ~ 2014
**Advantages:**
- High thermal efficiency, dry ash removal, simple water treatment
- Suitable for even wider range coal, mature membrane/burner, simple configuration, capex reduction
- Capex reduction, mature membrane/burner and simple configuration

**Applications:**
- IGCC, chemicals, ammonia & poly-generation
- IGCC, chemicals, ammonia & poly-generation
- Smaller size applications, fouling coals