Dealing with Gas Pains in Offshore Oilfield Developments
A unique alliance for offshore GTL

SBM OFFSHORE

Compact GTL
The modular gas solution

SPP
Sumitomo Corporation
Kawasaki

Johnson Matthey Catalysts

emerging FPSO forum

September 24 - 26, 2013
3 proven and operational GTL processes today

World scale GTL
300MMscf/d ++

CompactGTL
\( \leq 150\text{MMscf/d} \)
Conventional GTL vs. CompactGTL

Shell Pearl Plant - Qatar
140,000 bbl/d GTL products
350 football fields

CompactGTL
Modular Plant
1,000bbl/d plant
1 Football field
Why is this now possible?

Conventional Steam Reforming / ATR

Conventional FT reactor
Fixed bed or slurry phase

10x increase in specific throughput

Compact SMR Reactor
Compact FT Reactor

CompactGTL reactors using brazed plate & fin construction
Mini-channel CompactGTL reactors

- Automated catalyst insertion and removal
- Corrugated metallic catalyst inserts maximise active surface area per channel
- Brazed plate-fin reactor construction minimises metal content and weight
SMR reactor core construction
FT Reactor core construction
Commercial Demonstration Plant

World’s first modular fully integrated GTL facility!

- Gas pre-treatment
- Pre-reforming
- Reforming
- Waste heat recovery
- Process steam generation
- Syngas compression
- Fischer Tropsch synthesis
- FT cooling water system
- Tail gas recycling

Plant commissioned in December 2010. CompactGTL technology now approved by Petrobras for deployment.
Technology scale up completed

Commercial CompactGTL FT Reactors: Constructed by Sumitomo
Comprise proven reactor cores modularised into 40’ containerised packages by Kawasaki Heavy Industries
Wide ranging applications

### Onshore

- 5 - 150 MMscf/d
- 50 – 1,500 MMscm/yr
- ≈ 500 – 15,000 bopd syncrude or diesel

- Monetise stranded & shale gas
- Convert associated gas
- Avoid flaring restrictions & penalties
- Unconventional gas – UCG, CBM

### Offshore

- Up to ≈ 50 MMscf/d
- Up to ≈ 4,000 bopd syncrude
- FPSO production up to ≈ 60 kbopd crude

- Avoid costly gas export or re-injection
- Avoid flaring restrictions & penalties
- Extended Well Test Facilities
- Early Production Systems
- Full Field Development FPSO
What is the market for offshore GTL?

Stranded Oil!
What makes some oil “stranded”?

Remote oilfields with enforced gas flaring legislation

Gas re-injection is:
- Not feasible or..
- Expensive or..
- A risk to the reservoir

No infrastructure

Gas export is:
- Not feasible or..
- Expensive or..
- Has no fair gas buyer

STOP!
Options for associated gas

- Reinjection & Flaring
- FLNG
- CNG
- Pipeline
- Gas to Wire

Distance to market for converted product [km]

Associated Gas MMscf/d

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Completed study for EWT vessel with CompactGTL facility

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>GTL Gas Feed</td>
<td>37 MM scf/d</td>
</tr>
<tr>
<td>Crude production</td>
<td>30,000 bbls/d</td>
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<tr>
<td>Syncrude product</td>
<td>2,200 bbls/d</td>
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<tr>
<td>NGL product</td>
<td>200 bbls/d</td>
</tr>
<tr>
<td>Produced water</td>
<td>10,000 bbls/d</td>
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</tbody>
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The EWTV GTL application

- Strong application for early adopters of CGTL technology
- Enables valuable, long term well testing whilst complying with gas flaring legislation
- ROI derives from the ‘Value of Information’ gathered on reservoir performance characteristics
- Proven robustness to handle a wide range of gas compositions and flow rates

Convert the associated gas into syncrude
Co-mingle and transport with the natural crude
FPSO conceptual study design basis

- Double hull Suezmax conversion
- ~1 MM bl storage capacity
- ~32,000 bl/day oil production rates
- Gas rates based on GOR’s typical of pre-salt
- ~ 25MMscf/d gas rate to GTL
- Dynamic Positioning
  - One or two subsea wells connected via flexible risers and a dis-connectable buoy.
  - Disconnect feature allows risers and buoy to be pre-installed on 2nd field during the production operations on the 1st field, thus minimising downtime between re-locations.
  - Disconnect feature can also be used for extreme weather or DP failure
- Topsides power via GTs fuelled with NG or hydrogen rich fuel gas.
Utility integration opportunities

• Hydrogen permeate/tail gas used to generate topsides power via GT’s. Allowing displacement of more associated gas to the process so increasing yield.

• Steam and heat for start up provided via vessel auxiliary boilers.

• Waste heat from the GTL process used for heating duties associated with crude oil separation, processing and storage

• Alcohols recovered from FT produced water used for hydrate suppression and as a start up fuel.

• FT produced water can be treated and re-used in the process, or discharged to the centralised FPSO produced water treatment system.

• Various water treatment options available depending on local environmental regulations.
Safety

• Special attention has been given to the safety of the GTL process offshore.

• Key areas of process and novel equipment design have been identified, risks assessed and mitigation steps implemented.

• “Approval in principle” notification achieved from an offshore certifying authority in February 2012
Modular plant critical for FPSO application

- High availability – via multiple SMR & FT reactor modules in parallel
- High turn-down & flexibility
- Exchangeable 100 bopd equivalent SMR & FT reactor modules
- No catalyst replacement offshore
- Flameless SMR process with no oxygen supply required
- Wide range of feed gas compositions accommodated
- Offshore certification authority: “Approval in Principal”
A ‘Win-Win’ for IOCs, NOCs and Governments

**IOCs**
- Enhance production
- Unlock new discoveries
- Increase recoverable reserves
- Add gas reserves to balance sheet

**NOCs**
- Increase in PSC profit oil
- Greater tax revenues
- Environmental “Kudos”

**Governments**
- Preserve and utilise National natural resources
- Gain access to World Bank finance
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