Oil fields developments
Long tie-back concepts

Luc RIVIERE – TOTAL SA

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1. Introduction

2. Review of field architectures

3. Comparison of concepts

4. Conclusion
TOTAL Deep Offshore Oil Developments

- **5 oil fields under production**
  - Angola B17 - Rosa: Plateau 130 kbopd, First oil June 2007
  - Congo - Moho-Bilondo: Plateau 90 kbopd, First oil April 2008
  - Nigeria - Akpo: Plateau 225 kbopd, First oil March 2009

- **3 oil fields developments in progress**
  - Angola B17 - Pazflor: Plateau 220 kbopd, First oil (e) Q3 2011
  - Nigeria - Usan: Plateau 180 kbopd, First oil (e) Q1 2012
  - Angola B17 - CLOV: Plateau 160 kbopd, First oil (e) 2014

- **3 oil fields projects under study**
  - Egina (Nigeria), Bloc 32 (Angola), Moho Nord (Congo)
Pazflor Project: Main achievements

- FPSO start-up – August 2011
- Subsea separator installation (Angola – January 2011)
- Umbilicals (Angola)
- Drilling (Angola)

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Main production line
- 2 production lines
- BRGL + MPP (when necessary)

Preservation
- Live oil displacement with dead oil

Restart
- Warm-up with dead oil
Hybrid Loop

- **Main production line**
  - 1 production line
  - BRGL + MPP (when necessary)

- **Preservation**
  - Live oil displacement with diesel (or dead oil in some cases)

- **Restart**
  - Warm-up with dead oil
- **Main production line**
  - 1 production line
  - BRGL + MPP (when necessary)

- **Preservation**
  - Electrical heating

- **Restart**
  - Electrical heating

- **2 Technologies**
  - Direct Electrical Heating (DEH)
  - Heat tracing with Pipe in Pipe
Single Line with Subsea Gas / Liquids Separation

- **Main production line**
  - 1 Production line
  - Subsea Gas/liquids separator
  - Hybrid pumps for liquids

- **Preservation**
  - Depressurization of the system

- **Restart**
  - Cold restart with injection of hydrate inhibitor

- **3 Technologies**
  - Gravity separator
  - Multipipe
  - Decanter well

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**Concepts comparison: cost, tie-back length, operation**

- **Conventional loop**
  - **Pro’s**
    - Operational flexibility
    - Large experience
  - **Con’s**
    - High cost (2 lines Pipe in Pipe)
    - Tie-back very limited (~20 km)

- **Hybrid loop**
  - **Pro’s**
    - Cost reduction compared to conventional loop
  - **Con’s**
    - Less flexibility than conventional loop
    - Tie-back still limited (~40 km)

- **Single line with G/L separation**
  - **Pro’s**
    - Tie-back limitation about 100 km
    - Cost reduction compared to conventional loop
    - More operational flexibility than hybrid loop
  - **Con’s**
    - Application depending on bathymetry
    - Low pressure operation at early life
    - Restart procedure

- **Single line with electrical heating**
  - **Pro’s**
    - No tie-back limitation
    - Cost reduction compared to conventional loop
  - **Con’s**
    - Robustness of the electrical heating
    - Less operational flexibility than conventional loop
    - High energy for long tie-back
Concepts Comparison: Energy Efficiency (25 km tie-back)

Tie-back = 25km
WD=1500m @ FPSO / +100m @ satellite

Oligocene field
50 kbd liquid

MPP @ Wellhead
+ BRGL = 0.4MMSm³/d

SSU situated @ Riser Base

Heat Tracing
+ U=1W/m²K

Power required on topsides (MW)

<table>
<thead>
<tr>
<th>Power Level</th>
<th>Conventional Loop</th>
<th>Hybrid Loop</th>
<th>Gas Liquid separation</th>
<th>Heated Single Line PiP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 MW</td>
<td>3 MW</td>
<td>2.8 MW</td>
<td>3 MW</td>
</tr>
</tbody>
</table>

Hybrid Pump
MPP
Gas Lift (topside)
Continuous Heating

Concepts Comparison: Energy Efficiency (75 km tie-back)

- Oligocene field: 50 kdpb liquid
- MPP @ Wellhead + BRGL = 0.6MMSm³/d
- SSU @ 25km from RiserBase
- Heat Tracing + U=1W/m²K

Power required on topsides (MW):
- Conventional Loop
- Hybrid Loop
- Gas Liquid separation
- Heated Line Single Pip

Preservation not feasible

- 7.5 MW
- 4.2 MW

Tie-back = 75km
WD=1500m @ FPSO / +300m @ satellite

Conclusion

- More marginal fields with subsea tie-backs to come

- New needs to develop these fields
  - Subsea processing
  - Subsea gas / liquid separation
  - Electrical heating of flowlines
  - All electrical systems
  - Installation vessels

- Thanks to recent innovative projects, the industry is now ready to challenge the new deep offshore developments to come.
Thank you for your attention

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