Conventional Subsea production system

Advanced Subsea

- Backpressure on reservoirs: \( \Delta P/L = 50-70 \text{mbar/m} \)
- Limitations in pumping technology - Multiphase
- Flow assurance issues – slugging flow, hydrates etc.
- Topsides bottlenecks: increased water production, sand etc.
- Overall effects – Reduced production rates and recoverable reserves

Subsea separation systems
Major Subsea Processing Projects

Gullfaks
- Brownfield
- Wet Gas Compression
- To be installed 2015

Åsgard
- Brownfield
- Gas Compression
- To be installed 2015

Perdido
- Greenfield
- Gas/Liquid Separation
- Boosting to topside
- Installed 2010

Marimba VASPS
- Brownfield
- Gas/Liquid Separation
- Boosting to topside
- Installed 2001

Tordis
- Brownfield
- Gas/Oil/Water/Sand Separation
- Boosting/Water Injection
- Installed 2007

Troll Pilot
- Brownfield
- Gas/Oil/Water/Sand Separation
- Water Injection
- Installed 2001

Pazflor
- Greenfield
- Gas/Liquid Separation
- Boosting to topside
- Installed 2011

Marlim
- Brownfield
- Gas/Oil/Water/Sand Separation
- Water Injection
- Installed 2012

BC-10 Ph 1 & 2
- Greenfield
- Gas/Liquid Separation
- Boosting to topside
- Installed 2009

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Greenfield
Brownfield
Quick overview – Subsea separation systems

FMC Technologies subsea systems:

- Gas/liquid separation and boosting
- Liquid-Liquid separation
- Bulk water separation & Re-injection
- How is sand managed in subsea separation systems?
- What to do with the sand?
Sand Handling Experience in Subsea Processing Applications

Adekunle Opawale, Tarig Abdalla, and Remko Westra
FMC Technologies (Separation Innovation & Research Centre), Europe

Presentation outline

- Subsea sand management technologies - Overview
- Technology developments & Qualifications
- Recent advancements in desanding technologies for subsea applications
- Conclusions & Questions
• Brown field – Operated by Statoil
• Challenges - Increased water production (70-80%) & sand production (500kg/day)
• SSBI – Gas / Liquid, Liquid/Liquid and sand handling, installed 2007

• Utilizes a dual Sand handling concept – Vessel based & Gravity desander
Tordis SSBI - Process Flow Diagram
Tordis: Sand management concept – Separator based

- Sand jet technology fluidizes accumulated sand.
- Mepro Tore technology - only Pressure suction
- Nozzles header installed from the vessel repose angle – 34 deg
- Laterally spaced – 50% overlapping
Tordis: Sand management concept – Desander Vessel

- Idea is to protect WIP from such large particles (100 microns)
- Pump dynamic pressure is used as a motive fluid for slurry suction
- Produced water and sand injected back into reservoir.
• Brown field – Operated by Petrobras
• Challenges - Heavy oil production, declining reservoir pressure, increasing water & sand production
• SSS achieves G/L, L/L and 3 stages of sand separation, installed 2009
Marlim - Process flow Diagram
Sand handling in Petrobras Marlim subsea system

Multiphase desander

*Protects entire subsea equipments from sand damage - >60%*

Liquid desander

*Protect injection wells from sand >50microns*

Optimized sand jet technology

*Prevents sand from accumulating in the bottom of separator*
Sand handling in Petrobras Marlim subsea system - 2

Inline desander – Technical background

- Fluid enters the desander axially
- Pressure energy + swirl element initiates circular motion – Centrifugal force.

\[ F_c = (\rho_p - \rho_f) \cdot V_p \cdot a_c \]

- Developed G-force separates sand particles from process stream.
- Clean underflow reverses to outlet through the internal low pressure core.
- Sand slurry; through the desander reject
Total’s Pazflor subsea Gas-liquid subsea Sep. & Boosting

- Heavy & Viscous fluid produced
- High GVF, and low temperature – Potentials of Hydrate
- Relatively low reservoir energy
- Gas-liquid separation. Liquid boosting & gas flows freely to topsides
- Low produced sand; <100ppm
Pazflor Sand management strategy – TQP 2008

- Risk of sand accumulation in inlet pipe investigated during TQP, and avoided in real design.

- Proprietary sand flushing arrangement installed as a back-up.
- Removes any sand build-up during operation.
Advanced sand removal system for future subsea applications

Dual Vessel Desanding system – Integrated sand jet and pressure suction

- Better efficiency
- Less vessel disturbance
- Less water consumption
- Minimal risk of clogging

Ref: IPTC 17643
Conclusion

- Sand handling technologies featured in the subsea processing systems are unique, high-tech & innovative
  - Marlim – Compact inline desander + optimized Sand jet
  - Tordis – Dual (&Independent) sand handling systems
  - Pazflor - Proprietary sand flushing system

- Advanced sand handling systems for future subsea Applications.
  - Dual Vessel Desanding system – Integrated sand Jetting + pressure suction
Our dream....all processing subsea!

Thank you.