Subsea Processing & Boosting
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Subsea Processing

- Largest contributor to Increased Recovery
- Enabler for difficult production regimes:
  - Long distance tie-back’s
  - Low pressure reservoirs
  - Arctic Developments – long distance, under ice
  - Cost efficient handling of increased water production
- Enabler for next generation Subsea Developments (Less Topside – More Subsea)

Subsea Processing = Separation, Boosting, Compression and Power Transmission
FMC is focusing on the IOR Opportunity

IOR Drivers

- Increased demand for oil
- Need for increased production from existing fields
- Extended life-time for existing fields
- OPEX reduction on existing production
- Increased environmental friendliness

Subsea IOR: Great untapped Potential

Increased Oil Recovery defined as the application of technology that can improve recovery beyond what is expected with current plans and methods

IOR Implementation

- Complements continuous production optimization
  - Optimized uptime and production
- Implementation of measures to shift production curve upwards to increase recovery
- Combination of technologies and services

We put you first. And keep you ahead.
Subsea Processing Development

Development continues along established Roadmap

2001
Troll Pilot - Statoil
- First Pilot
- Three-phase Separation
- Bulk water removal with injection

2007
Tordis - Statoil
- First Commercial System
- Four-phase Separation
- Bulk water removal with injection + boosting

2011
Pazflor - Total
- First Deepwater
- Gas/Liquid separation
- Hydrate mitigation & pressure support

2011
Marlim - Petrobras
- First heavy oil deep water
- Four-phase separation
- Water injection for pressure support

2014
Åsgard - Statoil
- First Subsea Gas Compression

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Subsea Processing

Enhancing brownfield oil recovery and enabling greenfield development

• Brownfield challenges:
  − Declining oil & gas production
  − Increasing water production
  − Constrained topside facilities

• Greenfield challenges:
  − Heavy oil
  − Low reservoir pressure
  − Hydrate formation

• Subsea processing solutions:
  − Gas/ oil/ water
  − Gas/ Liquid
  − Sand separation
  − Boosting
  − Gas compression
Why Subsea Processing

• Increased recovery
• Accelerate production
• Reduced Capital Expenditure
• Makes it possible to:
  - connect satellite fields to existing infrastructure
  - exploit fields that are normally inaccessible
  - exploit costly infrastructure fully throughout the systems operational period
  - depressurize system as a hydrate strategy
• Influence on the environment will decrease
• Reduces water disposal to sea
• Enhances flow management
What influence selection of separation technology?

• Drivers for subsea processing station
  - System considerations, not only component considerations
  - Flexibility over the life of field, need to cover changes in conditions and uncertainties
  - Robust and reliable systems

• Fluid properties
  - Density, viscosity, mixed viscosity, inversion point etc at operational conditions, asphaltenes, creation of foam, emulsions etc.

• Production profile
  - Water cut (WC), gas volume fraction (GVF) as function of time
  - Pressure, temperature profile as function of time

• Sand production
  - During “normal” conditions and “worst case” conditions (e.g. screen failure)

• Field layout
  - Field layout of wells/drilling centers/existing infrastructure
  - Sizes of pipelines
  - Location of processing station compared to wells
Some operational issues

• Condition change during the field life
  ➡ Flexible and robust system

• Operate outside the design conditions
  ➡ Fail safe systems and training of personnel

• Failure of equipment due to operational errors
  ➡ Fail safe and protection of equipment, e.g. CPM

• Failure of equipment due to mechanical failure
  ➡ Robust design and testing
Future Solutions

Moving from bulk gravity separation …..
……to slimmer and more compact solutions……
……to inline, ultra-compact solutions

• Proven topside technology
• Ongoing qualification for subsea use
Questions on Subsea Processing

• Do oil companies know what is out there?
• Is the full potential recognized?
• What can we do to increase awareness?
• What will it take to make this a common used technology?
• Economic models demonstrate the benefits, but the risk is considered to high?
• What can we do to reduce risk and increase the confidence?
• Why wait until the added value is less?
The Vision

Thank You!