Pushing the oil recovery factor (OMC 2011)
How can ultra compact separation solutions help?

March 24th 2011, Ravenna, Italy

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FMC Technologies/CDS Separation Systems
CDS Separation Systems - Technology areas

- Conventional separator vessel internals
- InLine separation (gas/liquid, liquid/liquid & solids)
- InLine Electrostatic Coalescer
- Produced water treatment
- Sand handling (InLine & vessel internals)
- Test facilities & modeling capabilities
- Ultra compact InLine separation systems (incl. subsea)
How can ultra compact separation help?

*Enhancing brownfield oil recovery and enabling greenfield development*

- **Brownfield challenges**
  - Constrained topside facilities
  - Increased water production
  - Declining oil & gas production

- **Green field challenges**
  - Heavy oil
  - Low reservoir pressure
  - Hydrate formation

- **IOR with cyclonic separation**
InLine cyclonic separation technology

- Stokes: \( v_s = \frac{d_s^2 |\rho_c - \rho_d| \ast g}{18 \mu_d} \)

Cyclonic technology
- Swirling flow
  - Increased G-force
  - Decreased residence time
  - Decreased footprint and weight
  - Increased safety, decreased inventory

Swirling flow

Pipe code

We put you first.
And keep you ahead.
## InLine separation technology solutions

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<thead>
<tr>
<th>Case</th>
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Long offset gas transportation pipelines

- Multiphase flow
  - Vibrations
  - Unstable flare & flaring penalties
  - Large $\Delta P$
InLine gas liquid separation equipment
vs. flow composition

InLine DeGasser  InLine PhaseSplitter  InLine DeLiquidiser

0%  60%  20%  95%  90%  100%

Efficiency

100%

Gas from Liquid  Set Point  Liquid from gas

Increasing GVF at inlet
InLine DeGasser – Application – Statoil
Statfjord B, Norway, September 2003

Process: Produced water expansion 60 bar → 6 bar

Challenge:
- Free gas in the system
  - Pipe vibrations
  - Unstable flare control

Solution:
- Install 18” InLine DeGasser
  - Decrease slug flow

Additional benefit:
- Re-use gas instead of flaring
  - 2.3 mln euro in tax savings (CO₂ emission)
InLine PhaseSplitter - Application - Statoil
Veslefrikk, Norway, 2004

Original setup

Prod. header @16 barg

VFA

VFB

10 barg

Inlet separator
InLine PhaseSplitter - Application - Statoil

Veslefrikk, Norway, 2004

- Production header pressure decrease 2 bar
- Corresponding increase in production
InLine Deliquidiser - Application - BP
ETAP, United Kingdom, May 2003

- Location: Upstream HP gas cooler discharge drum
- Flow rates: 554 MMSCFD & 56.9 m³/h (water + HC) (62barg)

Before installation
- Condensate carry-over

After installation
- System availability 97% (from 26%)
- Water dew point export gas -52°C (from -20°C)

LxWxH = 4.1x0.5x4.3m
Weight = 4208kg
### InLine separation technology solutions

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Debottlenecking/subsea processing
Application areas for ultra compact separation technology

- **Perdido**
  - Greenfield
  - Gas/Liquid Separation
  - Boosting

- **Marlim**
  - Greenfield
  - Gas/Oil/Water/Sand Separation

- **BC-10**
  - Greenfield
  - Gas/Liquid Separation
  - Boosting

- **Pazflor**
  - Greenfield
  - Gas/Liquid Separation
  - Boosting

- **Tordis**
  - Brownfield
  - Gas/Oil/Water/Sand Separation
  - Boosting

- **Arctic**

- **Floating LNG**

- **Debottlenecking**

- **Ultradeep water**

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**InLine separation – Subsea processing**

- Subsea separation progression
  - shallow water
  - ultra depths (>1500m)

Marlim, 2011

InLine separation & water re-injection ➔
Pilot application, intermediate step to ultra depths

Tordis, 2007

cyclonic inlet device, gas by-pass & water re-injection ➔ decrease vessel volume by 53%

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Subsea Inline separation skid – Marlim
Brazil, start up expected 2011

• Sand is recombined with oil & gas and produced to surface
• Water is re-injected
• Separation components
  – Inlet Inline DeSander
  – Gas harp
  – PipeSeparator
  – Outlet section
  – InLine water DeSander
  – InLine HydroCyclone

Installed @ 900 m
API ~ 21 - 25°
Tekna case study - Debottlenecking

- Early life
  - Oil: 66,000 bbl/d
  - Water: 9,450 bbl/d
  - Gas: 35.3 Mscf/d

- Late life
  - Oil: 12,600 bbl/d
  - Water: 62,900 bbl/d
  - Gas: 35.3 Mscf/d

- Water cut: 12.5%

- Water cut: 83.3%
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  - Water cut: 83.3%

MPM

InLine DeGasser
2 x 6”

InLine PhaseSplitter
2 x 10”

InLine ElectroCoalescer
8” & 6”

InLine DeWaterer
21 & 10 liners
# Tekna case study comparison

Original design vs. Ultra compact design

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<tr>
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<th>Conventional</th>
<th>InLine skid</th>
</tr>
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<tr>
<td>Dimensions [m]</td>
<td>13 x 3.5 (1st stage sep.)</td>
<td>14 x 3 x 6</td>
</tr>
<tr>
<td></td>
<td>3 x 8; 3 x 12</td>
<td></td>
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<td>Total operational weight [T]</td>
<td>212</td>
<td>10.7</td>
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![Diagram of Tekna case study comparison](image)
Pushing the oil recovery factor
How can ultra compact separation solutions help?

Market trends
- Increase production
- Extend field life time
- Reduce OPEX

Ultra compact solutions
- Debottleneck separation capacity
- Decrease pressure drop
- Reduce costs
  - Maintenance
  - Inspection
  - Boosting
  - Heating
- Reduce inventory

HSE