Active Flowline Heating Technologies as Alternative Flow Assurance Management Techniques

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Active Flowline Heating Technologies as Alternative Flow Assurance Management Techniques
Flow Assurance Costs + Risks

Cost

Risk

Chemicals
- High CAPEX
- High OPEX
- Medium risk

Thermal
- Medium CAPEX
- Low OPEX
- Low risk

Removal

Hydraulic
- Low CAPEX
- Low OPEX
- Higher risk

Active Flowline Heating Technologies as Alternative Flow Assurance Management Techniques
Flow Assurance
Hydrate Formation Conditions

Active Flowline Heating Technologies as Alternative Flow Assurance Management Techniques
Flow Assurance Limitations

- Insulated Pipeline
  - Depressurisation
  - Chemical Injection
  - Displacement

- One pass Continuous Injection MEG / MeOH Regenerate

- Water Separation

- Heated Pipeline

Active Flowline Heating Technologies as Alternative Flow Assurance Management Techniques
Thermal Flow Assurance

Primary use is prevention or melting of:

- Hydrates
- Wax

Also increases flow of viscous oils
Active Heating Technologies

Electrical Trace Heating

Closed Direct Electrical Heating

Open Direct Electrical Heating

Electrically Heated Bundles

Rigid Pipe Bundles

Active Flowline Heating Technologies as Alternative Flow Assurance Management Techniques
Active Heating Technologies

Open Direct Electrical Heating
+ Single heated pipe wall
+ Piggyback cable
+ Feed + return cables
+ Wet insulation
+ Open electrical system

Typical values:
- $U = 3 \text{ to } 8 \text{ W/m}^2\text{K}$
- Power = 125 to 300 W/m
- Voltage = 7 to 24 kV
Active Heating Technologies

Closed Direct Electrical Heating

+ Pipe-in-pipe
+ Heated pipe walls
+ Feed + return cables
+ Insulation in annulus
+ Closed electrical system

Typical values:

- $U = 0.25 \text{ W/m}^2\text{K}$
- Power = 18 to 65 W/m
- Voltage = 1 to 2 kV
Active Heating Technologies

Electrical Trace Heating

+ Pipe-in-pipe
+ Multiple heating cables
+ Feed cables only
+ Insulation in annulus
+ Typical values:
  - $U = 0.5$ to $1.5 \text{ W/m}^2\text{K}$
  - Power = 4 to 100 W/m
  - Voltage = 1 to 2 kV
Active Heating Technologies

Electrically Heated Bundles

+ Flexible flowline
+ Multiple heating cables
+ Feed + return cables
+ Insulated outer sheath

+ Typical values:
  > $U = 0.25$ to $1 \ \text{W/m}^2\text{K}$
  > Power = 18 to 65 W/m
  > Voltage = 1 to 2 kV

Active Flow line Heating Technologies as Alternative Flow Assurance Management Techniques
Active Heating Technologies

Rigid Pipe Bundles

- Multiple rigid pipes
- Fluid heating in annulus
- Heat from topsides process
- Insulated as appropriate
# Active Flowline Heating Summary

<table>
<thead>
<tr>
<th>Heating Method</th>
<th>Flowline</th>
<th>Type of Heating</th>
<th>Track Record</th>
<th>Operator/Designer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid</td>
<td>Rigid pipe bundle</td>
<td>Fluid in pipes</td>
<td>Britannia 1998 Åsgard, Gullfaks South</td>
<td>ConocoPhillips, Statoil</td>
</tr>
<tr>
<td></td>
<td>Pipe-in-pipe</td>
<td>Fluid in annulus</td>
<td>King 2001</td>
<td>BP</td>
</tr>
<tr>
<td></td>
<td>Flexible</td>
<td>Fluid in multiple steel tubes</td>
<td>Heated risers / bundles</td>
<td>Aker / Technip</td>
</tr>
<tr>
<td>Electrical</td>
<td>Pipe-in-pipe</td>
<td>Trace Heating</td>
<td>1 in operation (1 more planned)</td>
<td>Interpipe (ITP) / Technip</td>
</tr>
<tr>
<td></td>
<td>Single pipe</td>
<td>Open Direct Heating</td>
<td>10 fields in operation 2000 on (more planned)</td>
<td>Statoil/BP/CNR/ SINTEF</td>
</tr>
</tbody>
</table>
Active Flowline Heating Advantages

+ Cost
  ▶ CAPEX
    – Neutral / positive overall
    – Typically tens of millions $ cost for simple installation
  ▶ OPEX
    – Lower (normally only used during shutdown)
    – Lower due to simplicity of operation
    – Lower due to low intervention levels
    – Statoil has saved 1 billion kroner ($175M) on Tyrihans
Active Flowline Heating Advantages

+ Time
  
  ▶ No impact to project design time if identified early in development
  ▶ Reduces topsides construction time (less complexity)
  ▶ Subsea critical path is usually the pipeline design, manufacture and installation
Active Flowline Heating Advantages

Flow Assurance

- Predictable and reliable hydrate management method over a large production flow range
- Not sensitive to water production changes and measurement accuracy (good for late field life)
- Reduces the criticality of understanding aquifer chemistry
- Insulate and blowdown can be used as a backup
- Some technologies can be used as remedial systems
Active Flowline Heating Advantages

- Topsides Facilities
  - Can significantly reduce chemical usage
  - Reduces size of topsides chemical plant
  - Simplicity of operation compared to chemical plant
  - Improves early field life availability
  - Hardware has small topsides footprint and weight
  - Uses existing capacity in power supply on shutdown (intermittent use)
Active Flowline Heating Advantages

+ HSE
  - Reduces waste discharges to environment and the need to treat solid wastes
  - Reduces need to frequently ship large volumes of chemicals (reduced HSE impact / lower OPEX costs)
  - Lower environmental impact
Active Flow line Heating Advantages

Operations/Reliability Availability Maintainability

► Simple to operate and needs low level of intervention
► Reliability / availability – on demand
► Normally switched off when used for shutdowns
► Can be used continually
Active Flowline Heating Disadvantages

+ Technical Risk
  ▶ Perceived as new technology and therefore high risk
  ▶ Has only been used with simple straight flowlines
    (any other architectural features, although feasible,
    will need development, testing & qualification)

+ Commercial Risk
  ▶ Many of the vendors are single or dual source
    (commercialisation not fully matured)
Active Flowline Heating Applications

Minimal onshore processing & storage facility

Export cargo can be LNG or offshore FLNG

Long tiebacks (>200 km) with local subsea processing:
Scattered wells with separation / water injection into wells / compression / pumping to shore / all electric controls
New Technology Standards

- ISO 20815
  - Production assurance and reliability management
- DnV RP-A203
  - Qualification procedures for new technology
- API RP-17N
  - Subsea Production System Reliability and Technical Risk Management & Integrity Management
Conclusion

+ Risk based standards
  ➤ Quantify risks
  ➤ Qualify risks
  ➤ Demonstrate confidence

+ Business Case
  ➤ Demonstrate positive OPEX / CAPEX
  ➤ Technical / Operational benefits

+ Successful qualification can:
  ➤ Enable marginal developments
  ➤ Improve value on existing and new developments
Active Flowline Heating Future?

- Longer
- Deeper
- More complex subsea architectures
- More efficient
- Lower cost
- Becoming a base case technology?
Acknowledgements to:

Images courtesy of:

Statoil
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WÄRTSILÄ