Havbunnsproduksjon

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Objectives

The student shall be able to describe, with respect to a subsea production system;

1. Where instruments are found
2. Why instruments are required
3. What is measured
The FMC history
World’s largest supplier of systems and equipment for subsea oil and gas production.
Some of our main customers
FMC Technologies at a glance

An oilfield service and equipment company

- $5.1 billion revenue in 2011
- 16,800 employees worldwide
- 30 production facilities in 16 countries
- FORTUNE® Magazine 2012 World’s Most Admired Oil and Gas Equipment, Services Company
FMC Kongsberg Subsea in Norway

Kristiansund – 76 employees

Bergen – 681 employees

Stavanger – 43 employees

Kongsberg – 2089 employees

Asker – 397 employees

Norway – 3,286 permanent employees, on top of that 656 agency temps
Reservoir

- What is a petroleum reservoir?
  - A subsurface pool of hydrocarbons contained in porous rock formations
  - Sedimentary origin
  - Trapped by overlying impermeable rock formation barriers
Well completion; example of complex well

- 30/36" conductor
- 18 5/8" casing
- 12 1/4" casing
- 9 5/8" casing
X-mas tree

Weight 40 ton
Protection structure for 8 XTs plus manifold

Ormen Lange
Weight: 1100 tons
H: 14.3m
W: 32.1m
L: 44m
Subsea to beach
Tie-back to Subsea Process
Example: Pazflor development

Miocene: 65% of overall reserves
- Heavy oil: 17–22° API
- High viscosity: 40 cP at 55°C
- Reservoir Pressure: 200 bar
- Reservoir Temperature: 65°C

Oligocene: 35% of overall reserves
- Light oil: 35-38° API
- Reservoir Pressure: 350 bar
- Reservoir Temperature: 115°C
Solution - Subsea Processing

Gas / Liquid Separation and Liquid Boosting:
- Gas flows freely to the FPSO
  - Hydrate preventions of flow lines by means of depressurization is possible
  - Reduced cost due to elimination of circular flow line
- Liquid out of separator with relative low gas fraction
  - Efficient pumps with high $\Delta P$ can be used → Increased recovery & less power consumption
- Boosting of liquid
  - Stabilized flow regime in risers reduces slugging
Process Principle
The Ultimate Goal: Subsea to market!
The umbilical

- Hydraulics
- Chemicals
- Power
- Communication

Topside end

Subsea end
Subsea Control Module: Components

SCM

SCM without outer can

Subsea Electronic

Subsea Hydraulics & Mechanics
The subsea system

- Flowlines
- Risers base
- Tree
- Well
- Manifold
The challenges

- Deep waters
  - High ambient pressure
- Far away
  - Power
  - Communication
- Accessibility
  - High reliability requirements
- The process
  - High pressure
  - High temperature
The Early days....(early to mid 1900’s)

Where are the sensors?
Development of water depth

World record water depths achieved by FMC Technologies
Long distance project examples

- Ormen Lange, Hydro/Shell 124km+
- Laggan Tormore, Total 143km+
- Mikkel, Statoil 74km
Why?

- Health, Safety, Environment.....
..... and money

- Monitor and manage the process (avoid problems)
- The reservoir (increase recovery rates)
- XT (reduce/avoid maintenance and repair)
- Manifold (avoid maintenance and repair)
- Processing (reduce/avoid maintenance and repair)
- Equipment status (predict maintenance and repair)
Measure what?

- The process
- The environment
- Internal parameters/the equipment
Process sensors, 1/4

- Pressure and temperature
  - Down hole at the reservoir
    • Optimize production
  - In the XT, upstream and downstream of choke
    • Operate the system in a safe way
    • Optimize production, avoid problems
  - In the XT, annulus side
    • Monitor system integrity
  - In the XT, injection lines
  - At manifolds
    • Optimize production, avoid problems
Process sensors, 2/4

- **Single phase**
  - Injection fluids or gas
    - How much goes where?

- **Multiphase**
  - What is produced
    - (mix of gas, oil and water)
      - Optimize production
      - Optimize chemical injection
      - What is produced where?
Process sensors, 3/4

- Choke position
  - Optimize production
  - Avoid damage to equipment and reservoir
- Level
  - In separation tanks
    - Operate within equipment capacity
Process sensors, 4/4

- Subsea Nucleonic Density Profiler:
  - Nucleonic source array (Cesium 137-50mCi)
  - Two detector arrays with Geiger Müller tubes
  - Topside PLC
- Source and detectors installed in dip pipes
- Retrievable detectors
- Nucleonic source is permanently installed
- Primary function; liquid level
  - Secondary; density distribution
Leakage, 1/2

- Capacitive
  - In the seawater at each XT
- Acoustic
  - Central per manifold, or at each XT
Leakage, 2/2

- Erosion
  - Inside of piping of XT

- Corrosion
  - Inside piping
Internal

- Pressure
- Flow
- Temperature
- Voltage
- Current

Supply pressure
Function line pressure
Supply flow
Why not ”the normal way”?

- Differences compared to topside solutions
  - Lifetime requirements
  - Packaging
  - Process requirements; pressure and temperature
  - Accessibility
    - Calibration / drift
    - Maintenance
  - Conservatism; big money
Summary

- Instrumentation is;
  - the eyes and ears of the operators
  - "everywhere" in the subsea production system
  - of vital importance
  - increasingly sophisticated
  - a key to where we can go in the future
Have we achieved the objectives?

1. Where?
2. Why?
3. What?
Thank you for the attention!