Subsea Water Treatment Comes of Age

Subsea Europe
14th – 15th November 2011
Hilton Paris La Defense
Seabox & GDF SUEZ
SWIT technology development

2004 - Technology day

2005 - Funded feasibility study

2006 – 2007 SWIT Phase 2

Lab testing at SINTEF and NIVA

2008 – 2010 SWIT Phase 3

Full scale pilot testing – Oslofjord

GDF SUEZ, TOTAL, Shell,

ConocoPhillips

4,000,000 € Development
How Important is Water Injection?

- The «Age of Easy oil» is over
- Injection of seawater into an oil reservoir is the easiest and most common IOR (Increased Oil Recovery) technique
- Global water injection is currently 240 million BPD i.e. 3 times global oil production
- Global WI projected to 7 times global oil production by 2020
Topsides Water Treatment Restrictions: Problem Recognition

- CAPEX and OPEX
- Non flexible throughput based on pre-production assumptions
- Single quality and pressure water
- Weight and space capacity
- Drainage strategy dependant on no. of wells and locations
- Production vs. Injection well compromise

*Corrosion product - pigged from a HP WI flowline*
Water to be injected into an oil reservoir must be treated to avoid reservoir damage via:-

- Plugging and uncontrolled fracturing of the reservoir - caused by particles, biofilm and scaling
- Microbiological activity turning the reservoir sour

**MAIN CHALLENGES**

- Blocking / plugging of the reservoir injection zones (solids / scaling / microbial growth)
- Microbiological activity needs to be controlled (biofilm and bacterial growth)
- $\text{H}_2\text{S}$ – Souring and MIC
The SWIT Treatment Technology

- **OH⁻ Generation**
- **Disinfection**
- **Long Residence Time**
- **HOCI / NaOCl Generation**
- **Solids Sedimentation**
- **Protection from Exterior**

Treated Seawater

Cable Interface
SWIT Pilot

- Full scale test from July 2009 to October 2010
- Design, Construction, Deployment, Operation, Retrieval
- 15 Months operation control and monitoring on the seabed
- 99.8% uptime – water quality results surpassed expectation………
Results – Biofilm / Bacteria

Control  Non-Biocide Treated  Biocide Treated

Exceptional Results
Results – Solids Reduction

Solids Removal Results

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Mean Particle Size (micron)
Solids Concentration (ppm)
Water Quality: Apples vs. Apples

Seasonal Variations (e.g. algae blooms)

Water quality measured here

Water quality here

~25 m

H.P. Pipelines

Seawater Intake

Water quality here

Water quality here

Water quality here
70% of today’s WI wells are sour:
- Poorer Sweep Efficiency
- Sour crude oil (worth less)
- Dangerous HSE problems
- Reduced operation (e.g. export) options
- Increased topsides maintenance problems

No biofouling all the way into the reservoir:
- Better Sweep Efficiency
- Allows for future tertiary (EOR) techniques e.g.: Low Sal / MEOR / CO₂ injection
Infill Drilling - example how SWIT can be effectively used:

- Long time to increase production (large distances between inj. and prod. wells)
- Difficult to maintain pressure - due to water required balance inj. and prod. rates
- Crossflooding of the pattern can contact new undisplaced oil and significantly add to the ultimate recovery from a field
- Can maintain pressure by balancing prod and injection volumes
- Reservoir heterogeneity and layer discontinuity can be controlled
Technical developments after SWIT pilot:

- Intervention time requirements
- Lifetime issues electrodes

Water intake - design options
Technical developments after SWIT pilot:

Solids rejection system design

Handling of prolonged system shut downs
Technical developments after SWIT pilot:

Online monitoring systems water quality (Turbidity, OPR, Jorin VIPA)

Now qualified for real project application by oil major
Seabed Pumping – Numerous Subsea Applications
Four - Slot Standard module

SWIT gives total flexibility in “Space and Time” for utilisation and implementation.
Injection from Sea Floor

As much high quality water as you want, where you want it and when you want it

The tools are now available:
- Water Treatment System
- Pump System
- Subsea Wells

- Avoid costly flow line
- Solve topside space limitations
- Cable only interface
18-month study prepared for the U.S. Department of Energy on identifying concepts for improving oil recovery in deepwater fields of the Gulf of Mexico

329 pages - 19 IOR processes

Key findings are that:
• ‘Size of the prize’ is enormous
• Water injection (1st) and seafloor injection (2nd) have highest near-term benefits.
Thank You – Questions?

NO! - I don't have time to talk right now;
I’ve got a war to fight