First World Wide Subsea Raw Seawater Injection System in Operation on CNR’s Columba E Field

Nils J. Vågen
Framo Engineering
Columba E – First Raw Seawater Injection System

- PROTECTIVE STRUCTURE & FRAMO DUAL PUMP STATION INSTALLED MAY 2006
- PUMPS DELIVERED JUNE 2007
- START-UP JULY 2007
A cost effective alternative to conventional topside water injection system
CONVENTIONAL PLATFORM MOUNTED WATER INJECTION SYSTEM

- expensive Topside Water Injection System including pump with filter, de-aerator, piping, valves, etc. will generate
  - extra Interface Engineering
  - expensive Platform modifications/extensions
  - expensive Platform installation, hook-up and commissioning work
  - extra space & Weight requirement

- expensive high pressure water injection pipeline
Water Injection Objectives

- Provide WI support to E-2 and E-5 producers
- Add reserves and accelerate production
Subsea Water Injection System

Topside – Ninian S. Platform
- Power & Control module on the host platform
- New chemical injection package
- Fibre optics based automation and control system

Subsea
- 8km Power and Control umbilical
- Subsea Framo Dual pump station
  - 2 x W.I. pumps
  - 2 x 100% filter unties
  - 1 x subsea control module
  - 2 x 6” flexible flowlines to XT’s
  - 4 x controls jumpers
  - 2 x 10k subsea XT’s
80 microns Filter A

Filter backwash

Inlet strainer

Filter B

Wi pump 1

Wi Pump 2

Duty flowrate 35,000 bbl/day (331m³/hr) & 320bar

Max flowrate 63,000 bbl/day at 222 barg
Min flowrate 18,000 bbl/day at 390 barg
Protection structure:  $L \times W \times H = 23m \times 10 \times 6.5$

Weight = 110 T

Pump Module:  $L \times W \times H = 8m \times 7 \times 5.5$

Weight = 100 T
FDS In Protection Structure
FDS Components

WI Pumps
By-pass Valve Insert
Filter Units
Control Pod

8 x 6 x 7m
Circa 110te.
2 x 100% Filters

Filter A

Filter backwash

Filter B

Inlet strainer

Wi pump 1

Wi Pump 2

Duty flowrate 35,000 bbl/day (331m3/hr) & 320bar
Subsea Water Injection System

- Subsea
- Subsea Framo Dual pump station
  - 2 x W.I. pumps
  - 2 x 100% filter units
  - 1 x subsea control module
Duty flowrate 35,000 bbl/day (331m³/hr) & 320bar
Framo Engineering have generated more than 800,000 hrs of operating experience for subsea pumps.
Subsea Retrievable Water Injection Pump

- Motor rating 2.3 MW
- Design Speed 3600 rpm
- Design Capacity 360m3/h @ 3600 rpm
- Rated dP typical 160 bar
- Design pressure 400 bar
- Height 5 m
- Weight 20 T
- Oil submerged electric motor
- Centrifugal pump design
- No dynamic seals to environment
- Retrivable from light intervention vessel
Subsea Water Injection System

- **Subsea**
- **Subsea Framo Dual pump station**
  - 2 x W.I. pumps
  - 2 x 100% filter units
  - 1 x subsea control module
Subsea Pump Control System SEM Configuration

SEM Configuration
- Up to 36 process sensors
- Up to 30 solenoid valves
- Up to 12 Serial interfaces
- 600 Watt for external power supply
- Configuration is flexible due to open architecture

Key Specifications
- Bandwidth Fiber Optic: 100 Mb / 10 Mb
- Redundant communication paths
- Electromagnetic noise immunity
- Power consumption: 100 Watt
- Temperature 0 to 50 °C (-20 to 50 °C storage)
- Water depth down to 3000 meters

Designed and built to:
- ISO 13628 Part 6
Umbilical

8km Power and Controls umbilical
8km Power & Control Umbilical
Umbilical Installation

Umbilical loaded out - Rosyth

Platform termination pulled in – Ninian South

Subsea Termination Unit deployment
Topside Power & Control Module

Topside – Ninian S. Platform
• New 90 tonne power & control module on the host platform
• New chemical injection package
• Fibre optics based automation and control system
Topside Power & Control module installed on Ninian South

split in 3 parts
PCM Installed topside on Ninian S
System Integration Testing

Topside – Ninian S. Platform
- New 90 tonne power & control module on the host platform
- New chemical injection package
- Fibre optics based automation and control system

Subsea
- 8km Power and Controls umbilical
- Subsea Framo Dual pump station
  - 2 x W.I. pumps
  - 2 x 100% filter unties
  - 1 x subsea control module
  - 2 x 6” flexible flowlines to XT’s
  - 4 x controls jumpers
  - 2 x 10k subsea XT’s
Columba E – First Raw Seawater Injection System

- PROTECTIVE STRUCTURE & FRAMO DUAL PUMP STATION INSTALLED MAY 2006
- PUMPS DELIVERED JUNE 2007
- START-UP JULY 2007
Project Qualification & System Testing

- Subsea Test Dock
- Corresponding tunnel
- Deep Water Quay
System Integration (SIT) – Dry Dock
System Integration (SIT) – Wet Dock
Structures Installation

Structure Loadout Barge - Norway

Pump station Deployment

Protection Structure Deployment
Project Schedule – Sanction to Start-up

- Sanction: Feb ’05
- Pump station & umbilical installed: May ‘06
- Topsides PCM Installed: Oct ‘06
- Drilling commencement: Nov ‘06
- Topsides System Pre-commissioning Complete: Mar ‘07
- Drill & Complete WI Wells: May ‘07
- Subsea Hook-up end May ’07
- Subsea & Full System Commissioning: Jun ‘07
- Water Injection start-up: Jul ‘07
Online connection between Framo Control Room and Customer Site
Condition monitoring through Real-time streaming of Quality Data
Interactive Engineering Applications available
Communication Functionality, Documents & Status Reports

All made available through dedicated Client FRIEND® Web Portal
Summary - Conclusions

• RSWI a viable solution
  • increase in injection capacity
  • minimised impact on existing facilities
  • re-deployment possible?
• Robust proven technology – a new application
  • reliable – 100% uptime since start up one year ago
  • in depth qualification of “new” elements
Summary - Conclusions

• Take the opportunity of high specification
  • e.g. single controls system
  • supports economic viability
  • simpler, efficient interface

• Mitigating project risks
  • key elements with a single “system provider”
  • additional extensive testing performed filter and SCM
  • comprehensive SIT, wet & dry test (Framo Subsea test dock); made a huge difference. ”Testing beyond the normal; built operational confidence”
• Operations from the beginning
  • Intervention designed in....
  • Operations involvement with comprehensive training
  • Life time support: FRIEND
• Relationships
  • CNR and Framo worked closely to resolve challenges