Intelligent Inflow Tracer monitoring of an Autonomous ICD Completion

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Discover more • www.resman-themovie.com
What flows where and how much?

FPSO
Inflow Tracer Functionality Basics

Unique tracer molecule

Engineered Polymer Matrix

Tracer Systems
85 RES • Oil + 70 RES • H2O
unique intelligent molecule IDs

Integration into well completion

RIH

FLUID CONTACT DETECTION
Oil or Water

Molecule Release
Constant release rate
(Flow rate independent)
Inflow Tracer Reservoir Surveillance

1: Tracer deployment
2: Fluid flow to surface
3: Sampling
4: Lab Analysis (ppt)
5: Inflow Interpretation

Inflow Tracer
Reservoir Surveillance
Based on publications to date

- No downhole monitoring from heel to toe
- Flow loop testing
- Only by surface measurements

SPE 159634

Increased oil production at Troll by autonomous inflow control with RCP valves
Martin Halvorsen, Geir Elseth, SPE; Olav Magne Navdal, Statoil ASA

Figure 14: Troll P-13 BYH – Gas oil ratio development as function of production time
Yuri Korchagin field
- Thin oil rim reservoir 20m thick
- Massive gas cap approx. 100m in height
- Strong aquifer drive
- 16 ERD wells
- Passive ICDs have failed to control gas
- PLT & DTS have been run in passive ICD with great difficulty
Well Trajectory and Completion

- 16 producing zones isolated by swell packers
- 8 zones monitored by unique intelligent tracer signatures
- Oil and water monitoring capability in each zone
Monitoring Hardware

Tracer systems installed in:

- Taper string 5 ½” and 6 ⅜” wire wrap screen drainage area
Monitoring Hardware

Tracer systems installed in:

- Taper string 5 \(\frac{1}{2}\)“ and 6 \(\frac{3}{8}\)“ wire wrap screen drainage area

Rate Controlled Production (RCP) valve

- Bernoulli’s principle
- Floating disk
- Gas exhibits higher velocity and creates a low pressure region on top of disk
- Causes higher pressure under the disk to reduce flow

Illustration courtesy of Tendeka
Sampling During Well Start Up

- Collected samples: 88
- Analyzed for oil tracers: 42
- Initially flowed well to clean up
- 14 hours shut-in
- Re-start well
Qualitative Interpretation

- Tracer transient profile for each monitored location
- ALL 8 installed oil tracers detected – verifying flow
- Note different arrival times due to distance travelled
Heel Compartment - Zone 8

- Dramatic decline in signal response (Point A)
- Evidence of cyclic behaviour (Point B)
  - High flow rate
  - Gas production
  - AICD choking
  - Oil production
Shut-in generates locally high concentration *tracer shot*

- Displacing tracer shot during re-start; *flush out*
  - Steep decline curve = high production rate
- Model matching by tuning flow dependent parameter $k$
- *Patent granted in 2013*

![Graph showing tracer flux over time](image-url)

- Tracer Flux [unitless]
- Time [unitless]
Quantitative Interpretation

- Percent of total flow for each zone
- Matched modelled fit to measured concentration profile
- OS-1 & OS-2 are substantially lower than other zones
- OS-8 is highest but character of signal demonstrates choking
Conclusions and Observations

• Wireless **Autonomous** control and **Chemical** monitoring solution
  
  • NO Cables
  
  • NO Electric Power – Flow Powered
  
  • NO Intervention
  
  • NO Risk

• Identify the locations of gas breakthrough
  
  • Choking of production is occurring in Zones 1 and 2
  
  • Zone 8 dramatic decline in signal response indicates Autonomous ICD action

• Quantification of inflow distribution RCP AICD

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<th>Relative flow contribution</th>
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Closer to GOC
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