Pulsed Neutron Water Flow Detection

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Oxygen Activation Theory

Diagram:

- Spectral Gamma Ray Detector
- High Energy (14-MeV) Neutron Generator
- Oxygen Activation
- Beta Decay
- 7.13-second Half-Life
- Oxygen Activation
- Gamma Ray (6.13 MeV)
Oxygen Activation Theory

The magnitude of the oxygen activation response is a function of:

- The distance of the flowing oxygen from the tool
- The flow velocity relative to the tool
- The volume of water flowing past the tool
The Problem

fracture @11,210 ft MD

~ 8,500 bbl/d

25% less

Unknown hole locations?
Pulsed Neutron Tool String– Run One (Inverted)

- Gamma Ray (upper)
- Upward flow measurement
- TMD3D Neutron generator
- TMD3D Far Detector
- TMD3D Long Detector
- Downward flow measurement
- Gamma Ray (lower)
- Spinner
Oxygen Activation Stationary Stops

- Spinner response
- Temperature response
Oxygen Activation Stationary Stops
Oxygen Activation Results – Run One (Inverted)
Pulsed Neutron Compton Ratio

Compton Ratio, $CRAT = \frac{OAI}{OBI}$
OAI vs Spinner – 5000 bbd Injection

Flow Rate (bbd) vs Depth (ftMD)
Pulsed Neutron Tool String – Run Two (Standard)

- **Gamma Ray (upper)**
- **TMD3D Long Detector**
- **TMD3D Far Detector**
- **TMD3D Neutron generator**
- **Gamma Ray (lower)**
- **Spinner**
- **Upward flow measurement**
- **Downward flow measurement**
OAI vs Spinner – 9000 bbd Injection

Flow Rate (bbd) vs Depth (ftMD)

- Up-flow
- Down-flow
Observations and Conclusions

- Characterisation of the pulsed neutron tool oxygen activation response allowed for a more accurate interpretation of the water flow rates.
- The flexibility of running the tool in inverted and standard mode allows for detection of water flow in both directions.
- Up flow was detected predominantly on the outside of the liner using pulsed neutron oxygen activation.
THANK YOU