Completion Deployed Scale Inhibitor Applications in Deep-Water, West Africa

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Presentation Content

- Introduction to inorganic scale
- Concept of the pre production squeeze
- Field results for treatments in stimulation fluids
  - Liquid scale inhibitor within acid wash/overflush and frac gel
- Conclusions
- Acknowledgment

Common Oilfield Scales

$$Ca(HCO_3)_2 \rightleftharpoons CaCO_3 + CO_2 + H_2O$$

Calcium carbonate

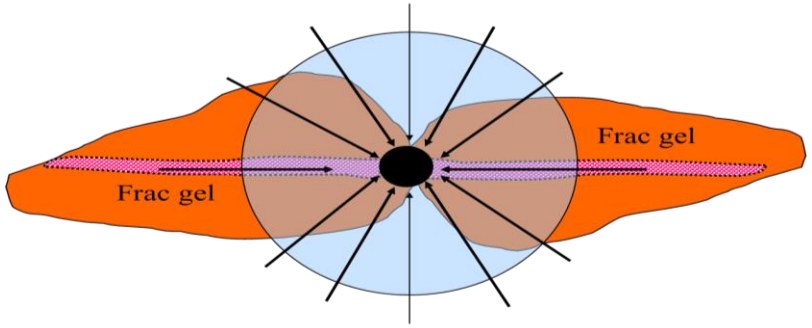
$$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$$

Barium sulphate

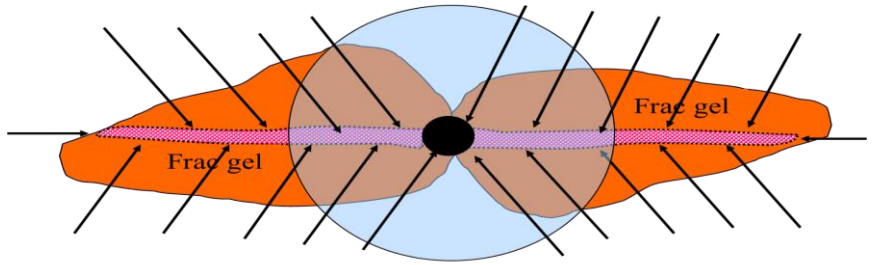
Pre-Production Scale Treatment

How is it deployed

- Scale inhibitor treatment applied during well completion
- Liquid scale inhibitor in the perforation cleaning acid and overflush and/or linear gel stages and/or cross linked gel
  - Compatible
  - Non-damaging
  - Good retention profile



Radial flow dominated brine inflow: best treatment option is radial matrix treatment



Linear flow dominated brine inflow: best treatment option is SI in linear frac gel

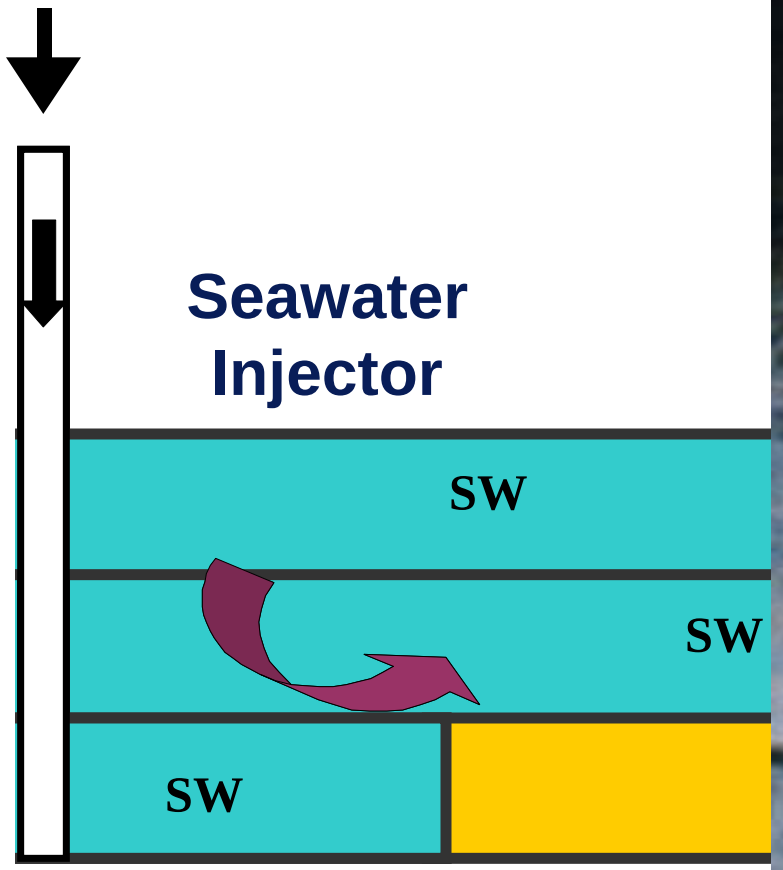
Pre-Production Scale Treatment

Why Consider this method of scale control?

- Uncertainties in water composition.
- Potential $BaSO_4$ and $CaCO_3$ risk.
- Risk of scale at low water cut and poor dispersion of continuous injection treatment.
- Chemical return data provides vital information for scale management program and future squeeze application, if needed.

Seawater (SW) Flood Schematic

Impact of a heterogeneous reservoir on $BaSO_4$ scale risk during SW flooding



Pre Production Scale Inhibitor Application

- Liquid scale inhibitors within fluids “lost” to the formation such as stimulation fluids (acids, linear gel, cross linked gel)
- Solid scale inhibitors (within frac propant or pre pack screens)

Monitoring and Location

Monitoring

- Well Test frequency
- Multiple wells in single riser

Geographic Location

- Analysis capability
- Chemical supply chain
- Equipment limitation
- Expert support

Nature of the WA Fields
Inorganic Scale Challenges

Reservoir Formation Waters and SW

Ion in mg/l	Reservoir B	Reservoir B1	Reservoir T	Reservoir L	Reservoir LN	Seawater
Na	23200	21000	24960	25894	17800	11019
K	150	136	144	140	272	408
Ca	2500	1180	2660	1000	884	422
Mg	380	117	515	318	107	1322
Ba	19	15	44	230	150	0
Sr	62	52	115	185	55	7
Cl	37600	31900	426500	44814	29010	19805
SO4	45	170	14	5	74	2773
HCO3	400	500	500	636	-	145
pH	7.4	7.2	7.3	5.8	6.1	8.4

Deep Water WA Field Results

- Frac packed wells
- Liquid scale inhibitor within stimulation stage and fracture gel stage
- Acid phosphonate inhibitor within acid perforation wash/overflush stages
- Neutral phosphonate inhibitor within cross linked gel stages
- Nine wells treated to date
- Three wells currently cutting water

Deep Water WA Field Results

Formation	Well code	Life time of the inhibition treatment
B	P1-ST1	15 months and still protected
B	P3-ST3	4 months and still protected
B1	P4	31 months and still protected
B1	P5-ST1	14 months and still protected
B1	P6	20 months and still protected
B1	P9	10 months and still protected
T	P1-ST3	13 months and still protected
L	P4-ST1	8 months and still protected
L	P2-ST1	11 months and still protected

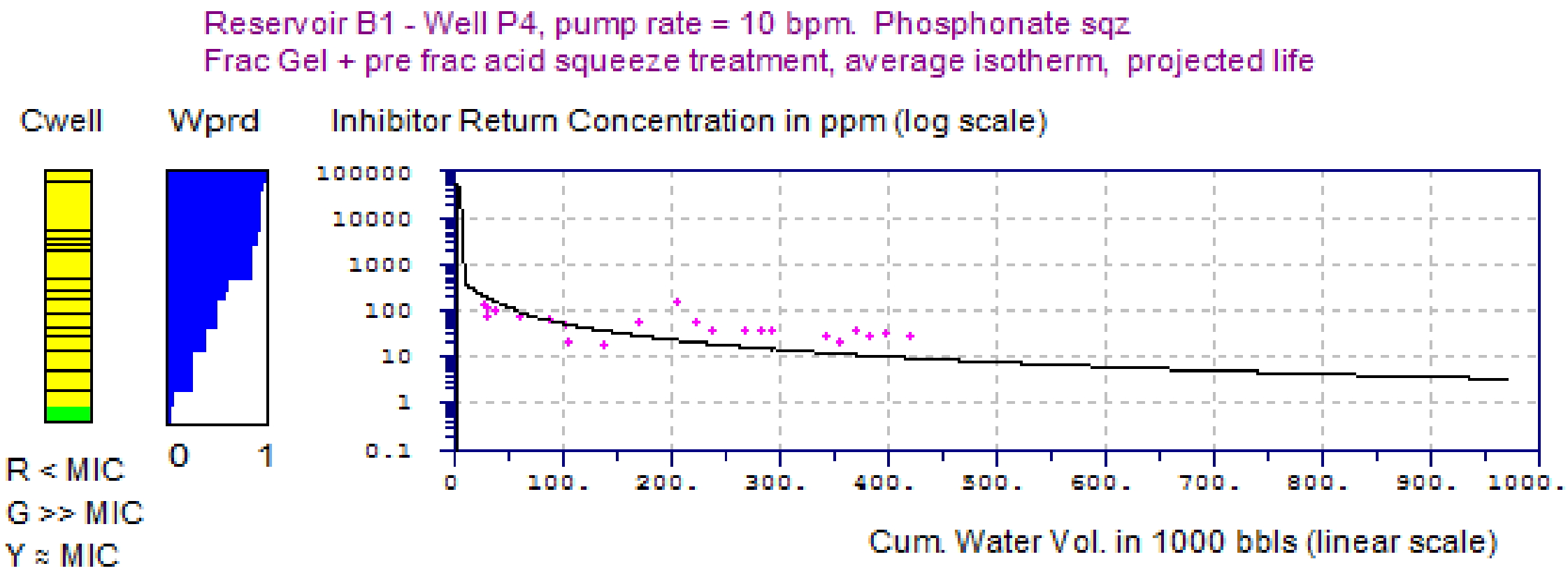
- Observed duration of protection for the nine wells treated

Deep Water WA Field Results

Well code	Reservoir	Volume acid plus SI conc.	Volume overflush plus SI conc	Volume Frac Gel plus SI conc	Design protected water volume (bbls) for Acid/overflush	Observed or predicted protected water volume (bbls) for Acid/overflush	Observed or predicted protected water volume (bbls), Acid/overflush plus Frac Gel
P1-ST1	B	190 bbls (5.4%)	380 bbls (7.7%)	812 bbls (4.6%)	500,000	520,000	1,000,000
P4	B1	577 bbls (5%)	1154 bbls (7%)	1956 bbls (5%)	550,000	490,000	965,000
P5-ST1	B1	308 bbls (5%)	576 bbls (7.8%)	1725 bbls (4%)	375,000	320,000	860,000

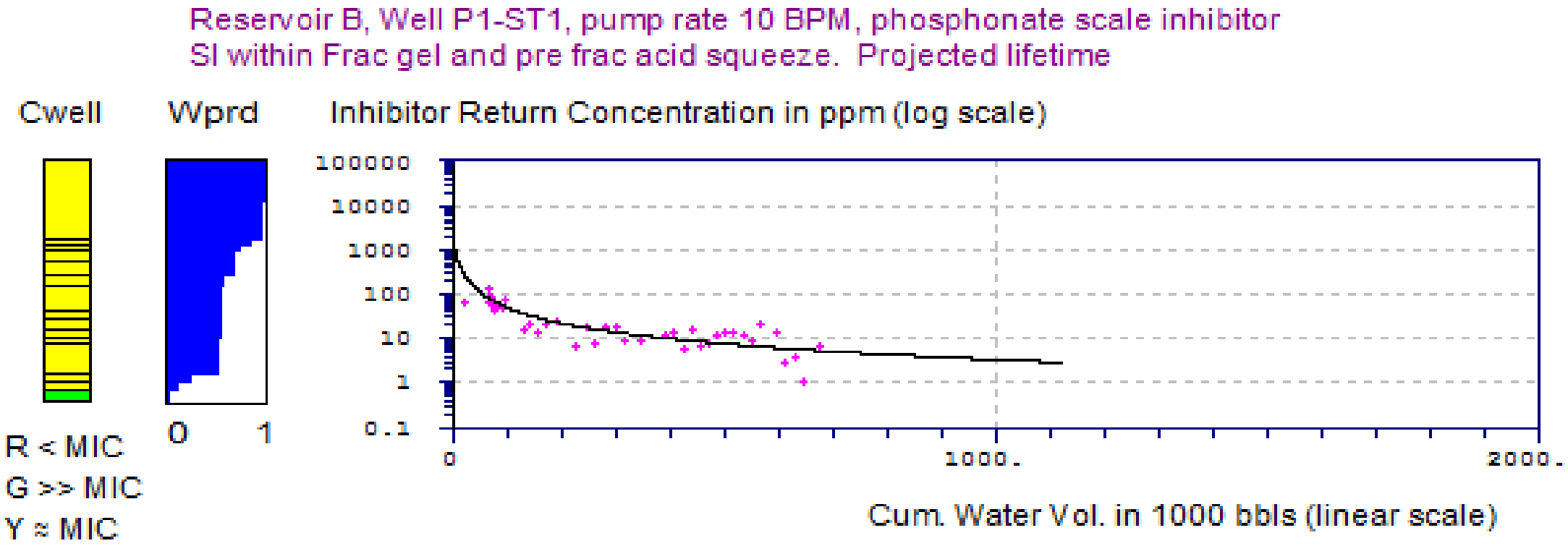
- Fluid stages, inhibitor concentrations and produced water protected

Well P4 Projected Treatment Life



- If all deployed inhibitor is contacted by produced water potential squeeze life 960,000 bbls water protected

Well P1 ST1 Projected Treatment Life



- If all deployed inhibitor is contacted by produced water potential squeeze life 1,000,000 bbls water protected

Conclusions

Many factors influence the suitability of pre-production squeeze treatments for application while completing production wells these include : -

- Scaling tendency of the produced water,
- The geographic remoteness of the asset,
- The challenge of monitoring scale control,
- The completion type itself controls the location and stage of the completion program where chemicals can be added,
- The cost of these types of application relative to stand alone classic squeeze treatments need to be considered.

Conclusions

- The presence of scale inhibitor in the initial produced water reduces the risk of a scaling event if the onset of injection water breakthrough is missed in deepwater, subsea wells with limited well test availability.

Acknowledgements

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Back Ground Publications

- NACE 2011, paper no.17984

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CORROSION
NACE CORROSION 2011 CONFERENCE & EXPO
MARCH 13-17, HOUSTON, TEXAS, USA, GEORGE R. BROWN CONVENTION CENTER

- Patterson, D., Kendrick, M. William, W. and Jordan M.: “Squimulation” – Simultaneous Well Stimulation and Scale Squeeze Treatments in Deep-Water, West Africa, SPE 151863.
- Jordan, M.M., “Simultaneous Well Stimulation and Scale Squeeze Treatments in Sandstone and Carbonate Reservoirs”, SPE 160703.
- Jordan, M.M., “Completion Deployed Scale Inhibition Applications in Deep-Water, West Africa”, SPE 170293.