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DRILLING, COMPLETIONS & PRODUCTION CONFERENCE

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Evaluation of Unique Cross-linked Acid and its Successful Application in Acid Fracturing in the Middle East

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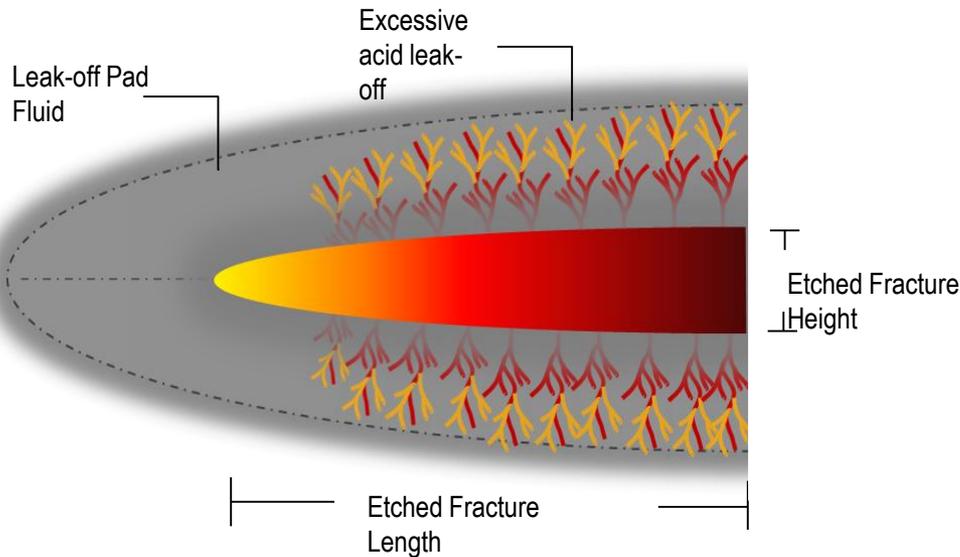
Background



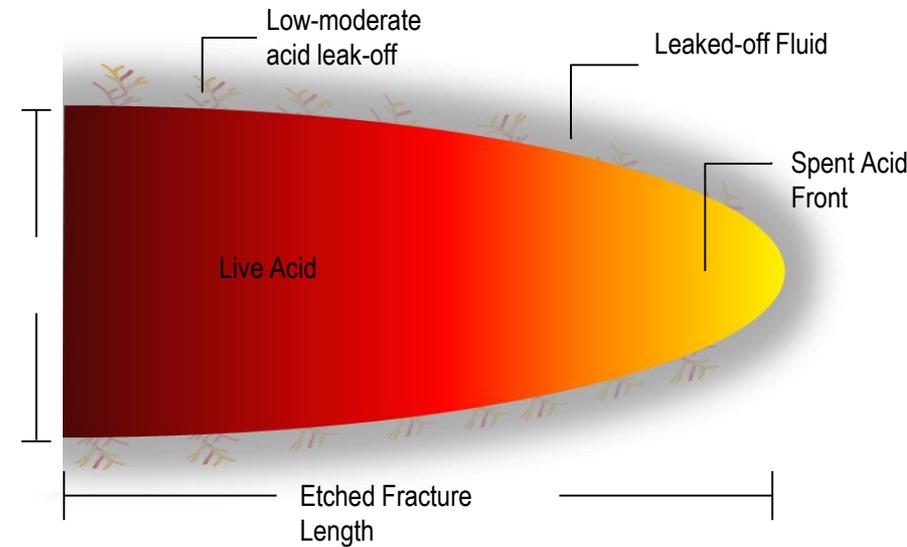
- Enhance the productivity for the current wells
 - Large mature oil field with low production
- Increase fracturing operation efficiency
 - Rig jobs
 - 3 days in average to complete a job
 - Multi-stage ?

Goal in Acid Fracturing

Limited Treatment



Successful Treatment



At least 3 different fluids on location:

- Generate fracture – Pad fluid
- Reactivity control – Gel & emulsified acid
- Fluid loss control – self diverting acid, diverters

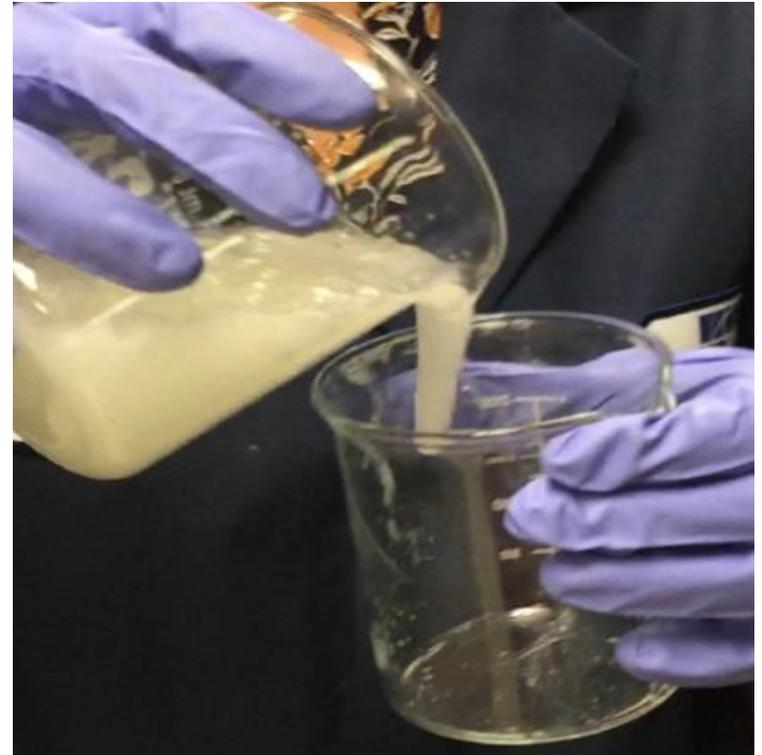
Acid was only 60% of total volume pumped

Cross-linked Live Acid Fluid

Fluid used in propped fracturing

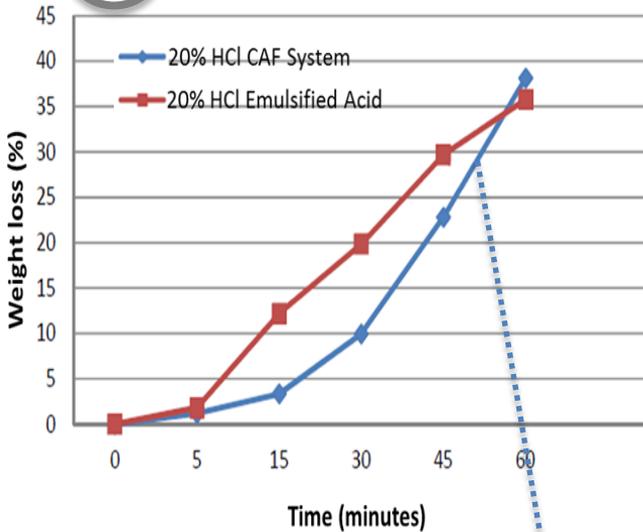


Cross-linked Acid



- One fluid for acid fracturing
- Acid is >90% of total volume pumped
- Less reactivity up front and better leak-off control

1 Dissolution Rate, 160 °F

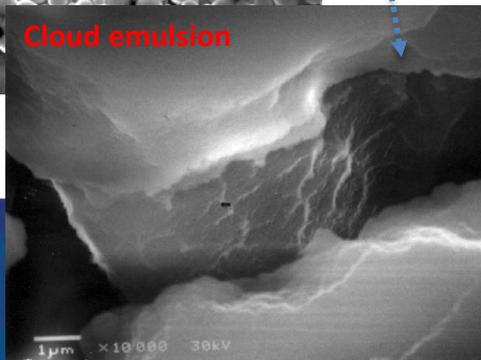
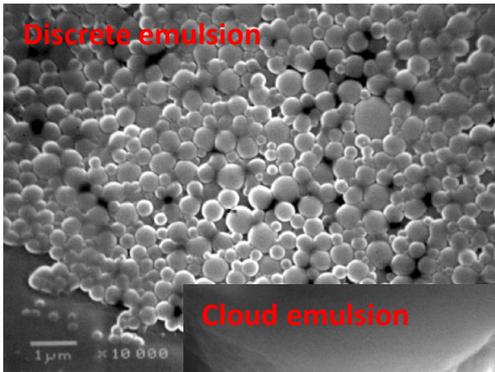
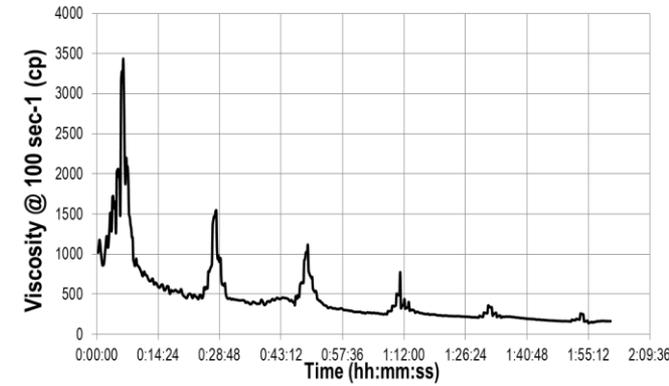


2 Corrosion Studies, 150 °F

Metal	Inhibitor Conc.(gpt)	Corrosion Rate (lb/ft ²)	Pitting
X	4	0.0042	1
	6	0.0039	1
Y	4	0.0045	1
	6	0.0056	1

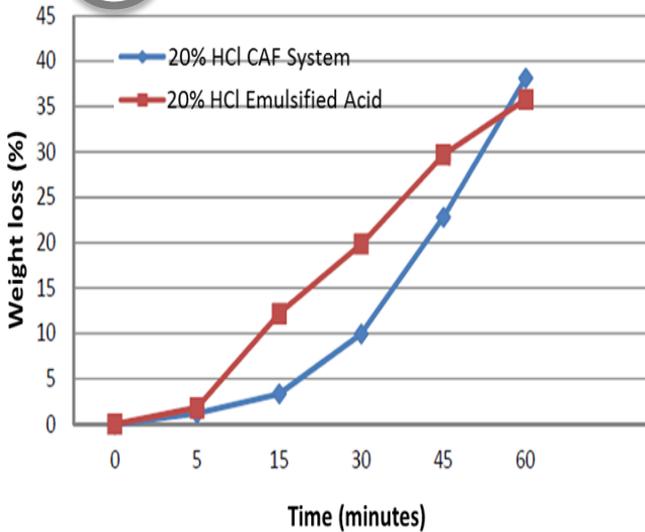
Corrosion standard requirement (0.05 lb/sqft).

3 Rheology, 150 °F



Laboratory Evaluation

1 Dissolution Rate, 160 °F

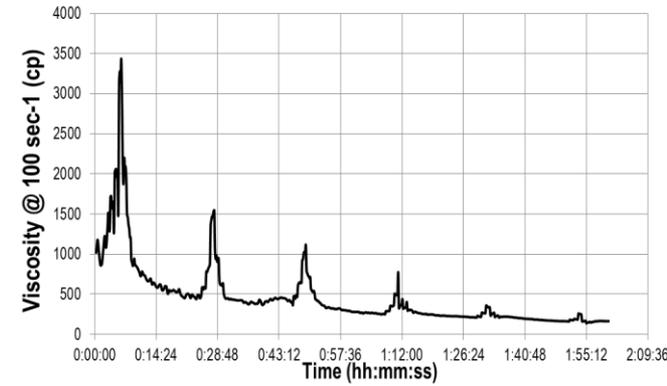


2 Corrosion Studies, 150 °F

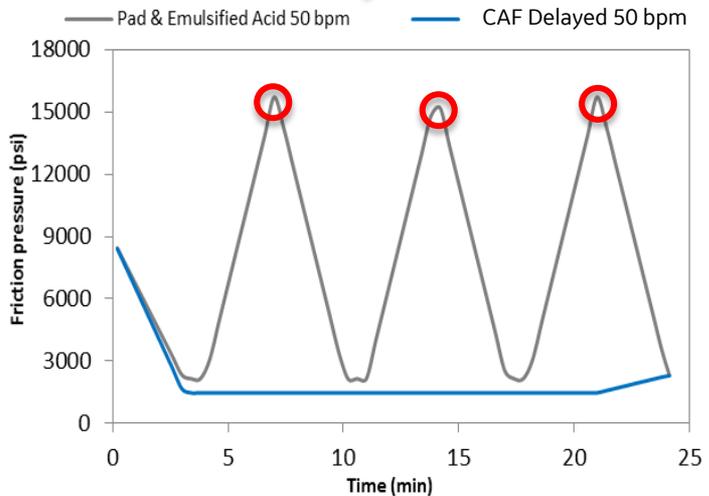
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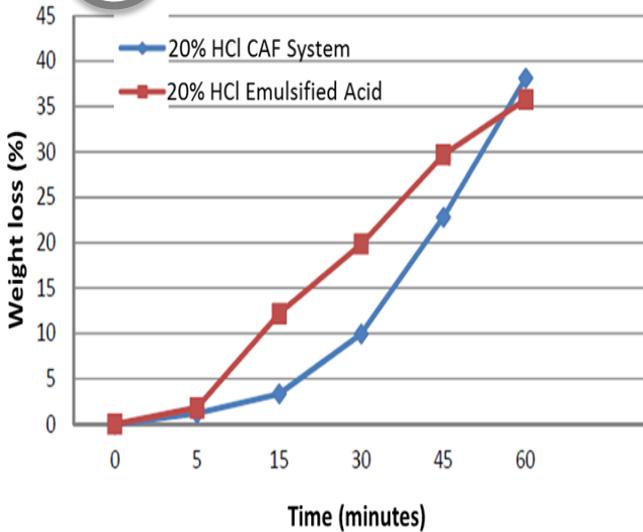
3 Rheology, 150 °F



Less friction pressure



1 Dissolution Rate, 160 °F

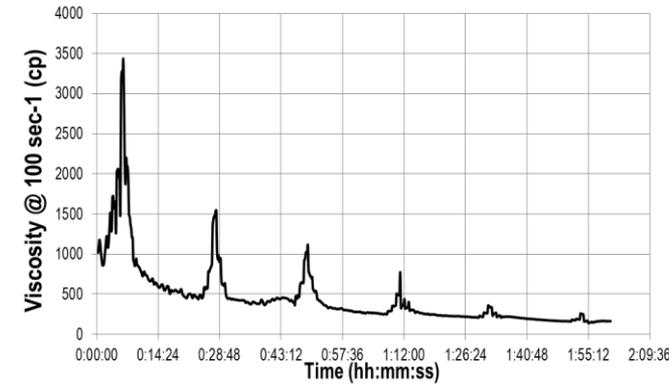


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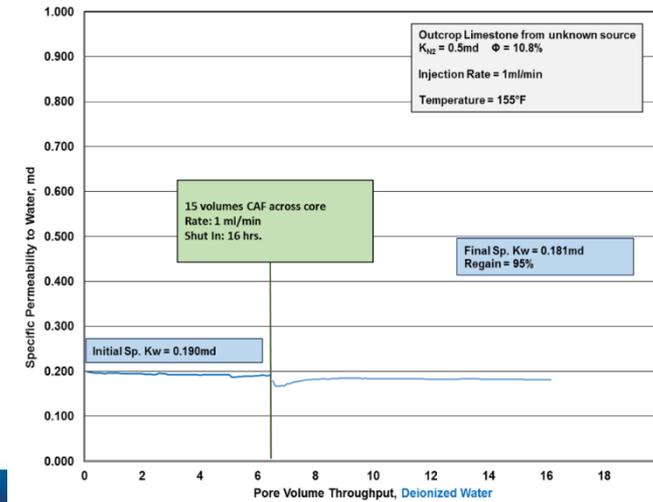
4 Oil Compatibility, 150 °F



Clear separation between crude and CAF

100-mesh screen after fluid passed. No-sludge observed

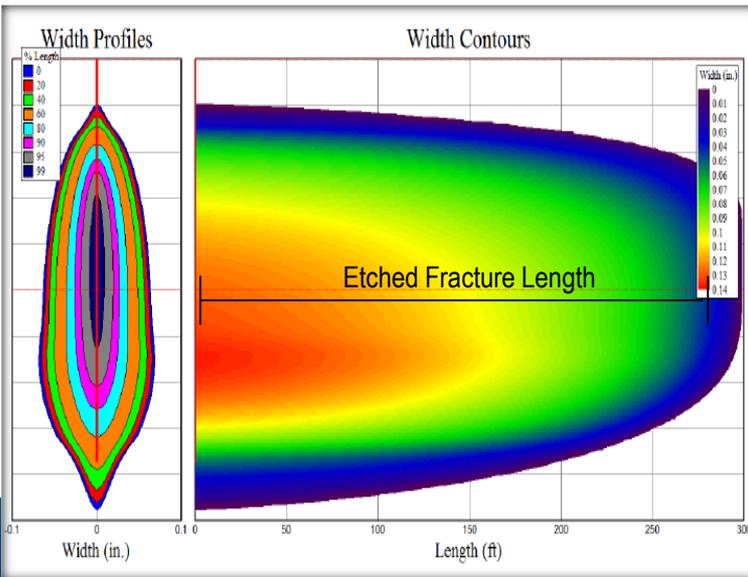
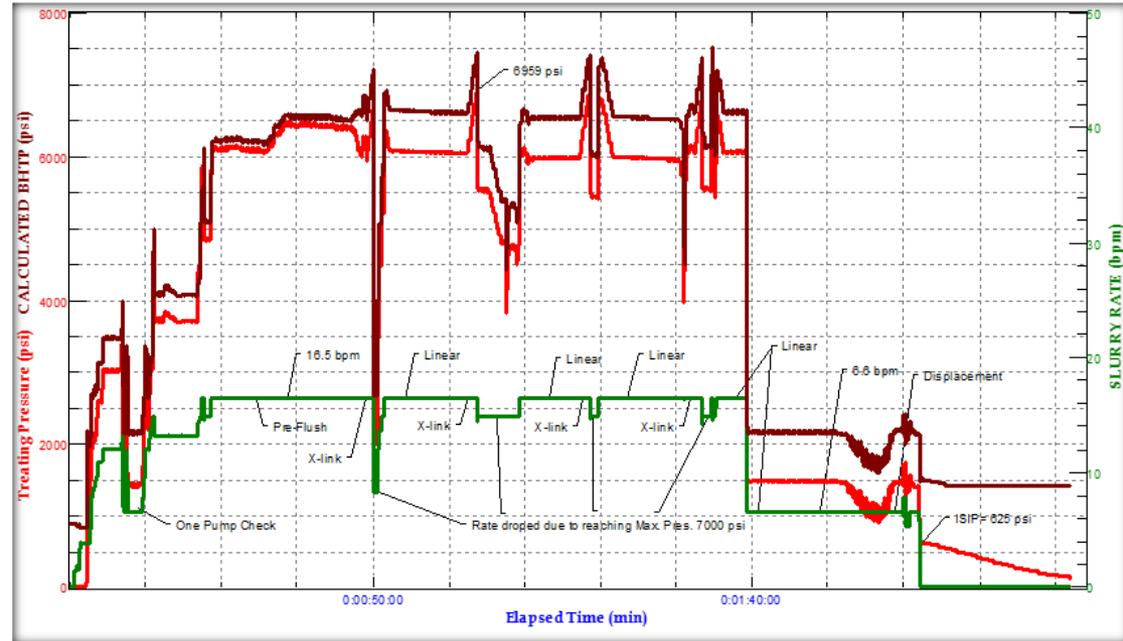
5 Regained Permeability, 150 °F



Overview Job Execution

Example of Pumping Schedule - 1 stage

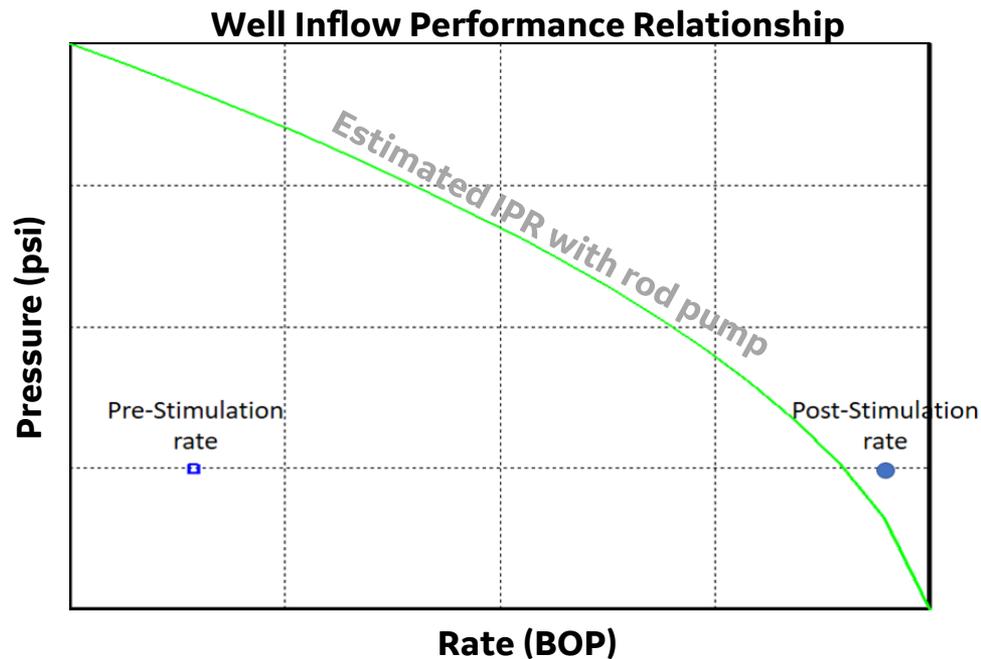
Stage #	Stage Name	Rate (bpm)	Volume (Gal)
1	Pre Flush	15	21000
2	XL Acid - Frac Extension	15	2000
3	Linear Acid - Etching	15	8000
4	XL Acid - Frac Extension & Leak-off Control	15	2000
5	Linear Acid - Etching	15	8000
6	XL Acid - Frac Extension & Leak-off Control	15	2000
7	Linear Acid - Etching	15	8000
8	XL Acid - Frac Extension & Leak-off Control	15	2000
9	Linear Acid - Etching - CFA	15 - 6	8000
10	Displacement	6	840



Description	Value	UOM
Etched Length	293	(ft)
Fracture Conductivity	11325	(mD-ft)
Dim. Fracture Conductivity	3	-
Upper Fracture Height	34	(ft)
Lower Fracture Height	54	(ft)

Performance Highlights

- Reduced operation time from 3 days to 1.5 days
- Saved customer rig time by up to 50%.
- 14 jobs executed , single stage and multi stage up to 10 stages.
- Increased production by five-fold in average . Production is sustained



Acknowledgements

Pressure Pumping Saudi Arabia Team

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