SAHARA COMPLETE
PROXIMITY WITH AN EDGE

SAHARA CHEMICAL SOLUTIONS

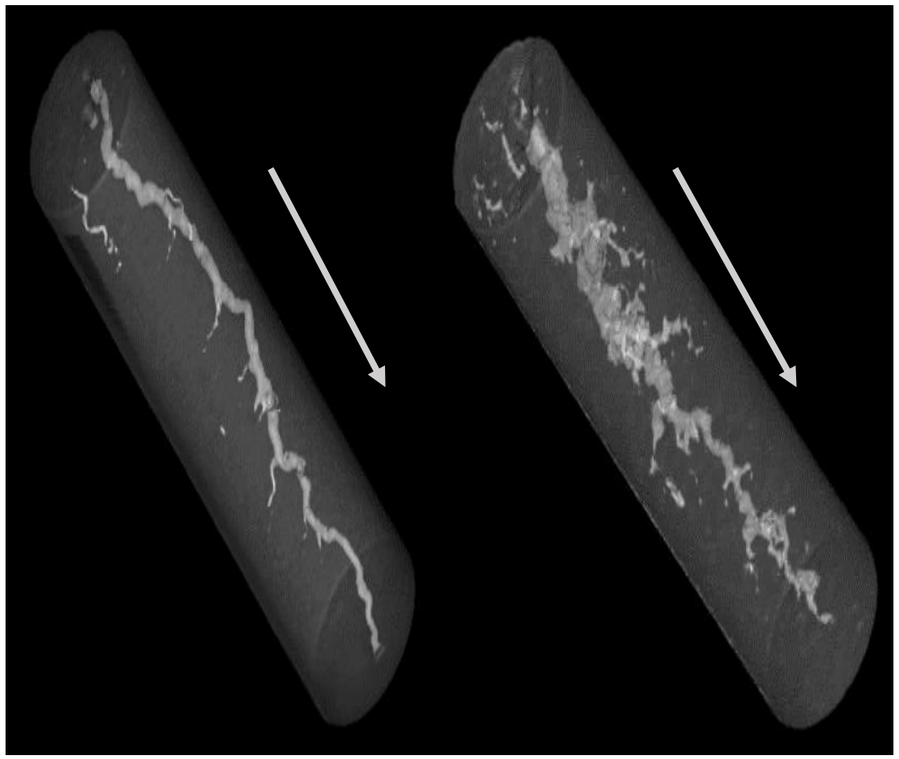
Scale Removal and Production Enhancement Chemical Engineering Solutions

SAHARA Chemical Solutions - SCS

SCS provides a broad range of high-quality and new innovated science based formulations to help and support oil & gas operating companies to meet their challenges through Chemical Engineering Solutions which are designed for:

- Scale Removal
- Production Enhancement

Scale Removal Operations



Formation Treatment

Chemical Engineering Solutions

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Scale – Most Common Types

- **Barite ($BaSO_4$)**
  - Generally formed when there is co-production of formation water (Ba^{2+}) and injection water (SO^{4-})
- **Calcium Sulfate ($CaSO_4$)**
  - Generally formed in three main forms (Gypsum, Bassanite, Anhydrite)
- **Iron Sulfide (FeS, FeS_2)**
  - One of the hardest scale can be found in the oilfield with many different forms (7 forms)
- **Calcite ($CaCO_3$)**
  - Formed due to the presence of calcium ions and bicarbonate ions in the produced water
  - Pressure changes may cause precipitation

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Impact of Scale

- **Oilfield scale costs are high because:**
  - Drastic oil and gas production decline.
  - Frequent pulling of down-hole equipment for replacement.
  - Re-perforation of the scaling producing intervals.
  - Reaming and re-drilling of the plugged oil wells.
  - Stimulation of the plugged oil-bearing formation.

Scale Consequences

- Formation Damage
- ID Restriction
- Corrosion

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Scale Dissolver Chemicals
SAHARA Chemical Solutions
Texas A&M Accreditation

Harold Vance Department of
PETROLEUM ENGINEERING
TEXAS A&M UNIVERSITY

Hisham A. Nasr-El-Din
John Edgar Holt Endowed Chair
Professor
(979) 862-1473
hisham.nasreldin@pe.tamu.edu

13 October 2017

Certificate of Accreditation

This is to certify that Sahara Petroleum Service Company (SAPESCO), Owns scale dissolvers SCSR-01 and SCSR-02 have been granted accreditation.

These innovative solutions are accredited in accordance with the recognized international standard of university of Texas A&M Lab authority showed high efficiency as a scale removal product for hard scale.

This accreditation demonstrates the technical competence for the above mentioned scale dissolver products.

Sincerely,

Hisham A. Nasr-El-Din, PhD
Professor
John Edgar Holt Endowed Chair

Mailing Address:
3116 TAMU
College Station, TX 77843-3116
Web - http://engineering.tamu.edu/petroleum

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407 Richardson Building
College Station, TX 77843-3116
Tel. 979.845.2241 Fax 979.86

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TEXAS A&M Study
SCSR: Fluid Properties, Coreflood Studies, Corrosion and Compatibility Test

Stimulation or Damage to different rock types

TEST CHEMICALS: SCSR-01

Compatibility of live/spent chemical with light/heavy crude oil

Corrosion Profile of SCSR with L-80 coupon

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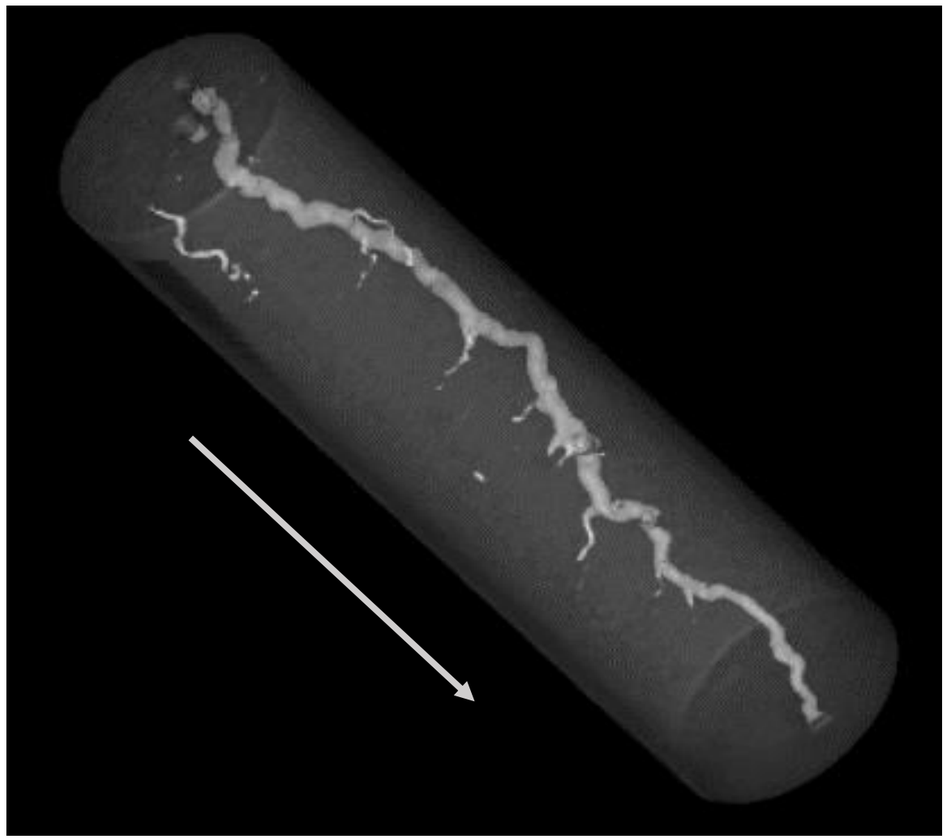
COREFLOOD STUDIES:
Indiana Limestone

CT image of limestone core after treatment



Significantly Straight Wormhole

No Branching

Negligible Tortuosity

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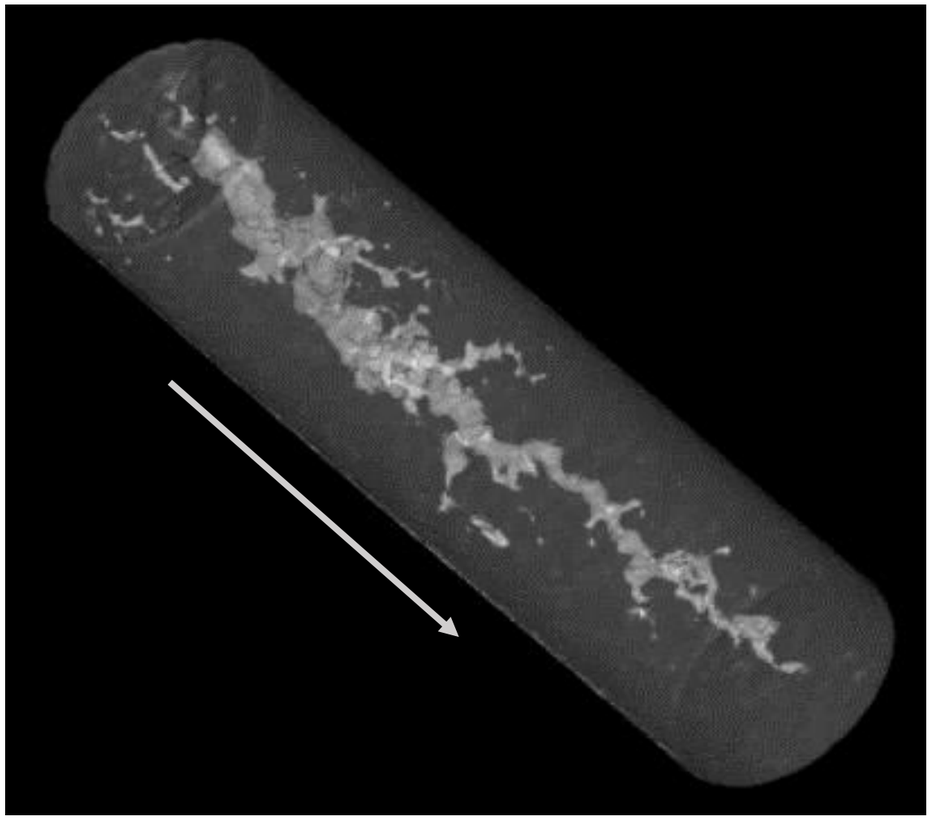
COREFLOOD STUDIES:
Dolomite

CT image of dolomite core after treatment



Single, Straight & Enlarged Wormhole

Negligible Branching & Tortuosity

SCSR Reaction With Dolomite – Slow

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CORROSION STUDIES

EXPERIMENTAL PARAMETERS

Coupon type & test duration	• L-80 • 24 hours
Coupon specifications (0.5 vol % CI)	• In inches, L: 2.317, W: 1.013, H: 0.068 • Weight: 19.1 g
Coupon specifications (1.0 vol % CI)	• In inches, L: 2.309, W: 1.015, H: 0.065 • Weight: 18.3 g
Temperature & Pressure	• 250°F • 1100 psi

CORROSION STUDIES RESULTS

Corrosion rate < 0.05 lb/ft2 for 24 hours exposure time

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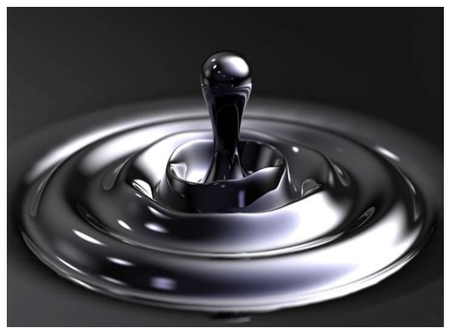
COMPATIBILITY TESTS

EXPERIMENTAL PARAMETERS

Crude oil density	• **Kinder Morgan oil – 0.82 g/cm3 at 73°F** • **China crude oil – 0.95 g/cm3 at 73°F**
Condition I	• **Room temperature & pressure** • **24 hours duration**
Condition II	• **500 psi and 250°F** • **2 hours after desired temperature**
SCSR/Oil ratio	• **50/50**



CRUDE OIL

SCSR SOLUTION

COMPATIBILITY

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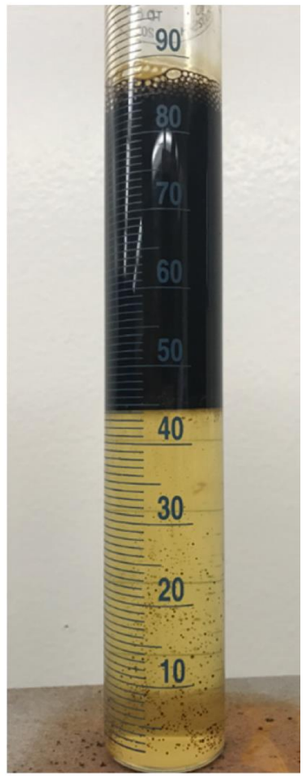
COMPATIBILITY TESTS

Kinder Morgan Oil + Spent SCSR-01 (73°F and 250°F):

Initial Mix, 73ºF

10 Min. Mix, 73ºF

12 Hours, 73ºF



250ºF

SCSR and oil, oil miscible for 60 seconds, followed by rapid separation of two phases

No asphaltene precipitation

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Conclusions
Coreflood Studies:

- Limestone – SCSR was able to stimulate the core. SCSR concentration in effluent sample is high, SCSR can be diluted further before injecting.

- Dolomite – SCSR was able to stimulate the core. SCSR can be diluted further before injecting.

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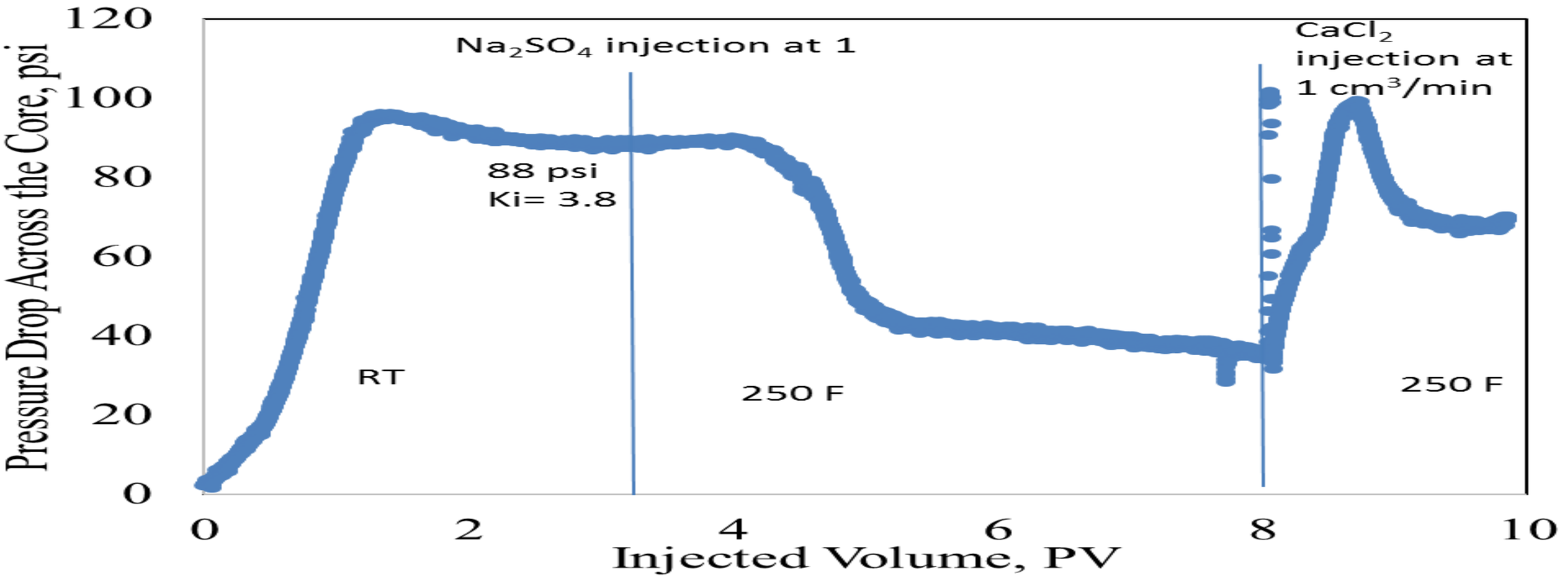
SAG-01 Coreflood Studies for Bandera sandstone

Bandera sandstone with permeability of 4 md was initially saturated with 10 wt.% Na2SO4, then 10 wt.% CaCl2 was injected to the core to induce CaSO4 scale precipitations. NH4Cl brine was then injected to the core as a preflush and to measure the damage permeability. SAG01 was then injected for 1 pore volume and the final permeability was then measured with NH4Cl brine.



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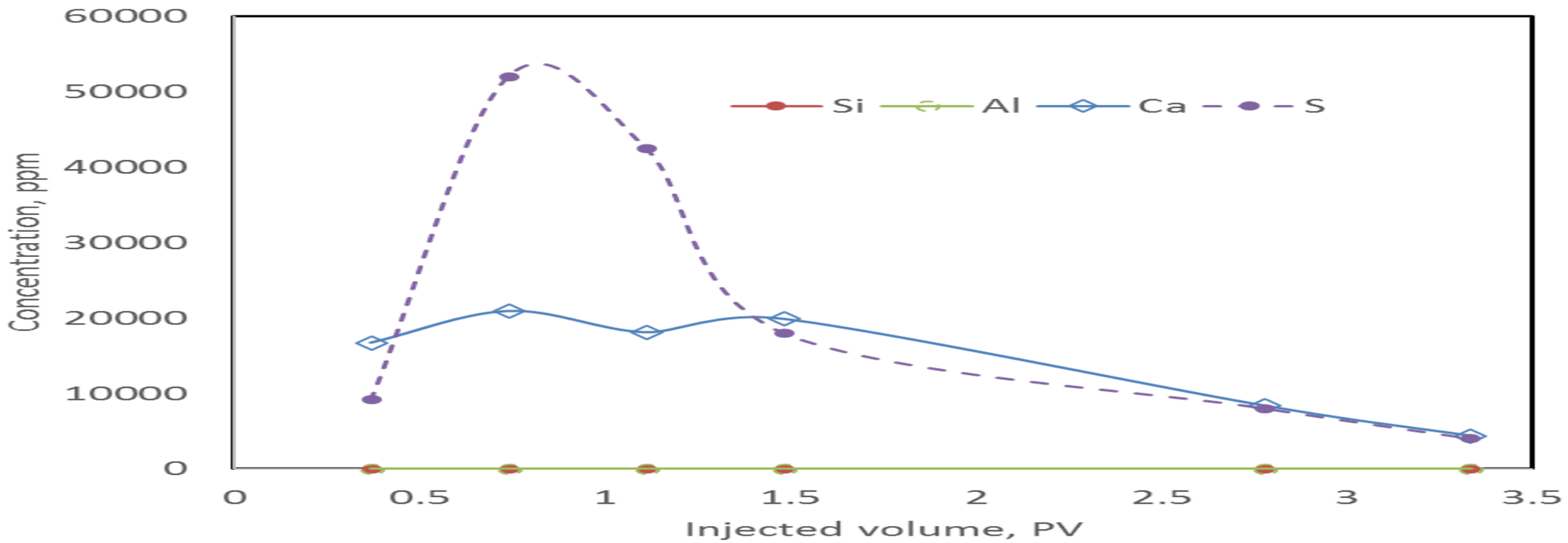
SAG-01 Coreflood Studies for Bandera Sandstone

ICP analysis for the effluent samples show the dissolution of CaSO4 from the presence of S and Ca on the effluent samples. It also show that SAG01 didn't react with aluminum silicate minerals (Quartz, Clays) from the sandstone core where Si and Al concentrations were zero.



ICP analysis for the effluent samples.

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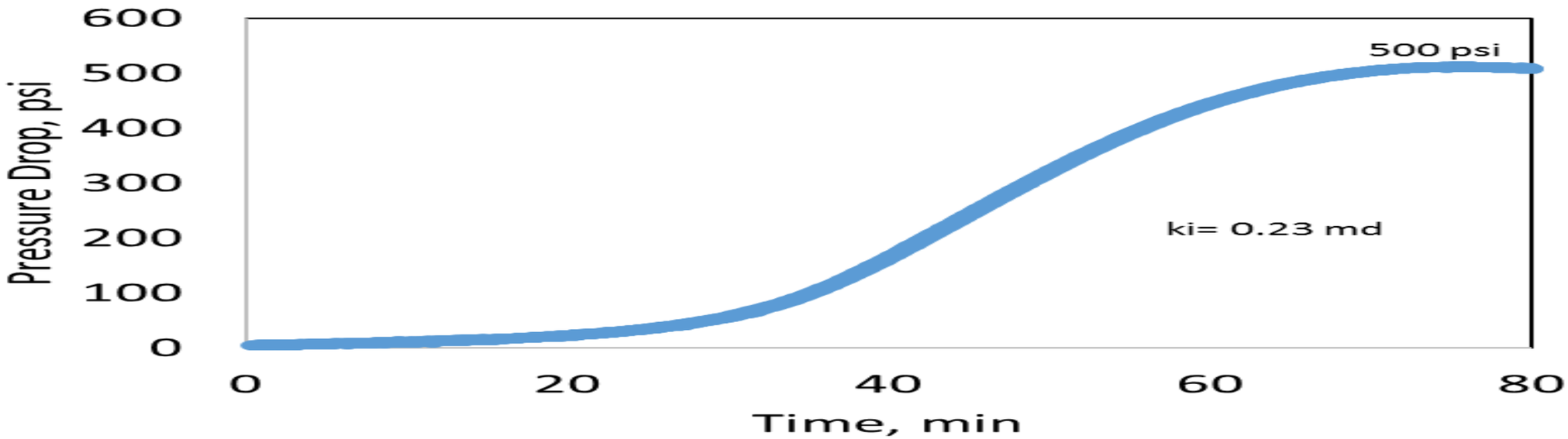
SAG-01 Coreflood Studies
Dolomite Core with Anhydrite Content

Core flood Experiment

Core flood experiment was conducted on dolomite core from Sanandres dolomite formation with anhydrite content of 30 wt.%.

Core initially saturated with 5 wt.% KCl brine and then the initial permeability was measured at 0.5 cm3/min. the initial permeability was estimated to be 0.23 md.



initial permeability measurements

The system was heated up for 3 hrs. to 250 °F. The pressure stabilized at 214 psi. 2 PV of SAG01 was then injected and effluent samples were collected every (1/3) PV. SAG01 was then displaced with 5 wt.% KCl brine until stabilization at 60 psi.

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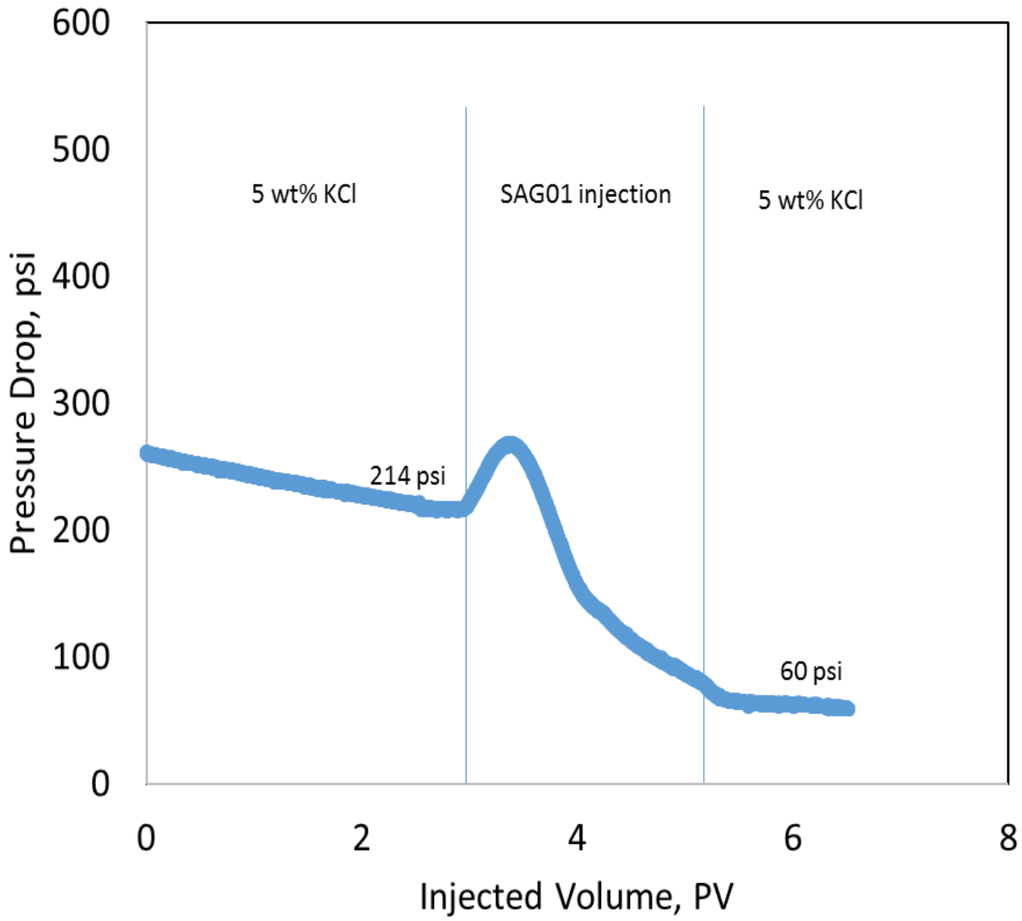
SAG-01 Coreflood Studies
Dolomite Core with Anhydrite Content



SAG01 treatment

The oven was turned off and the system left to cool down to room temperature then final permeability was measured.
Final permeability was estimated to be 1 md.
Permeability enhancement = 4.3.

CT scan analysis show a reduction of CT number in some spots which is an indication for anhydrite dissolution.
ICP analysis for the effluent samples show the dissolution of anhydrite not dolomite as the Ca ions concentration equals S ions concentration with no presence of Mg ions in the solution.

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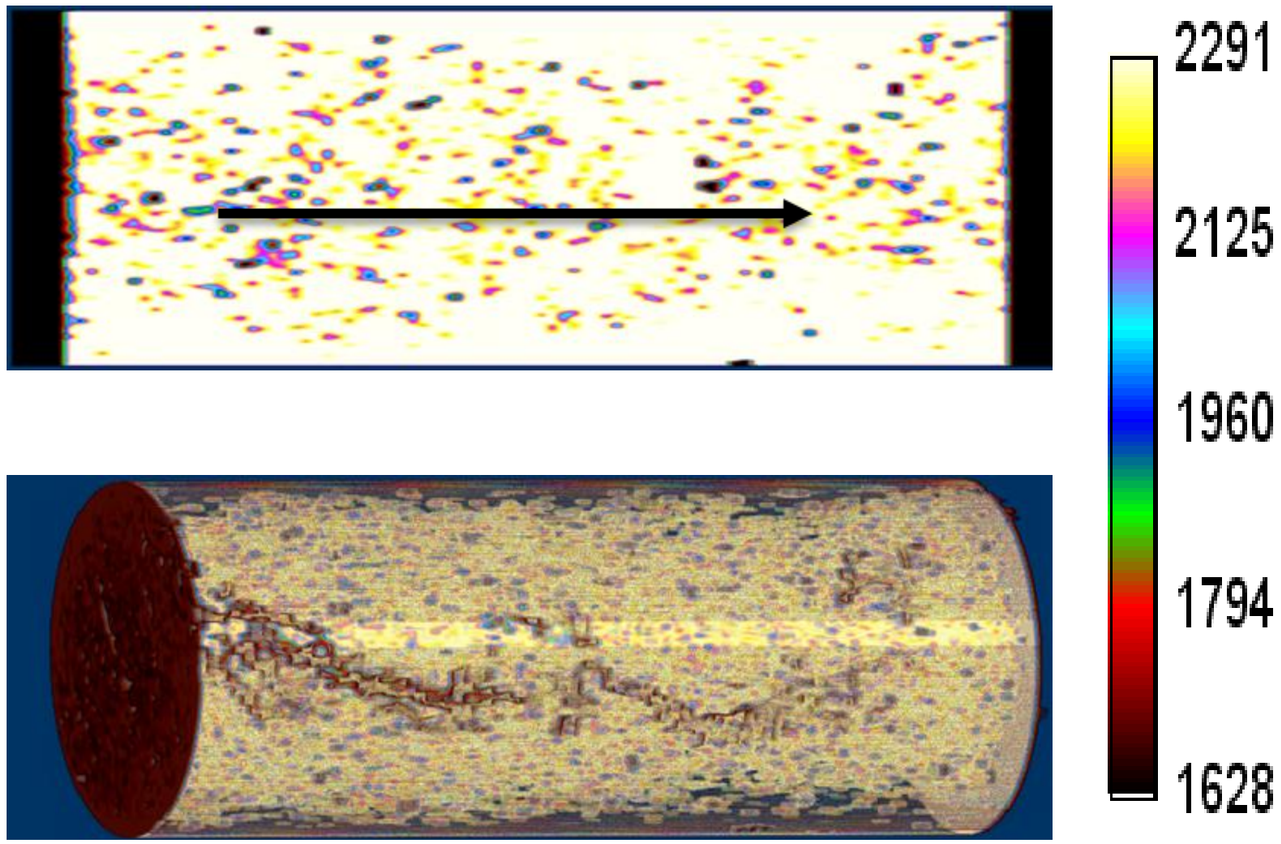
SAG-01 Coreflood Studies
Dolomite Core with Anhydrite Content

CT scan analysis for the core after treatment.



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Conclusions
SAG-01 Coreflood Studies

- Core flood results show increasing the permeability of the core to 4 times of its initial value and ICP results show 1:1 calcium to sulfur concentrations and no reaction with dolomite.

- The second core flood shows that SAG-01 complete dissolve the induced calcium sulfate scale with no reaction with the sandstone core.

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SCS New Formulations
Scale Dissolver Products Summary

Scale Type	SCS Scale Dissolver
Carbonate	SCSR-01, SCSR-03
Iron Sulfide	SCSR-02, SCSR-08
Calcium Sulfate	SAG-01, SCSR-09
Barium Sulfate	SCSR-04, SCSR-05
Strontium Sulfate	SCSR-06
Vanadium Pentoxide, Trabzonite, and Siderite	SCSR-07
Sulphur deposition New	**SC-07**

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Scale Dissolver Chemicals
SAHARA Chemical Solutions
De-Scaling Key Attributes

- Providing High Dissolution Capacity
- No precipitation or harmful by-products
- High thermal stability
- Readily Biodegradable
- Minimum corrosion rates (below 0.05 lb/ft2)
- Good HSE aspects
- Increased production with minimal risk

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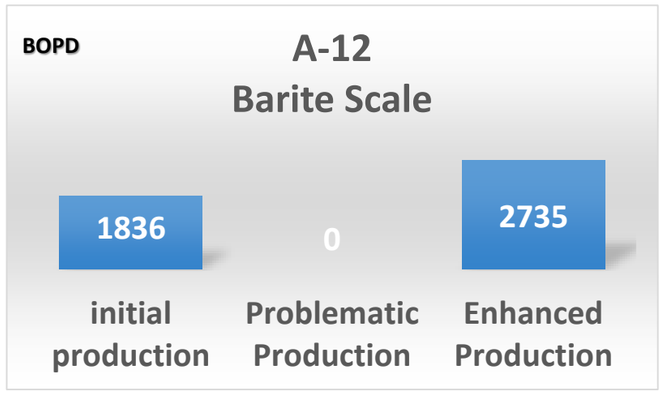
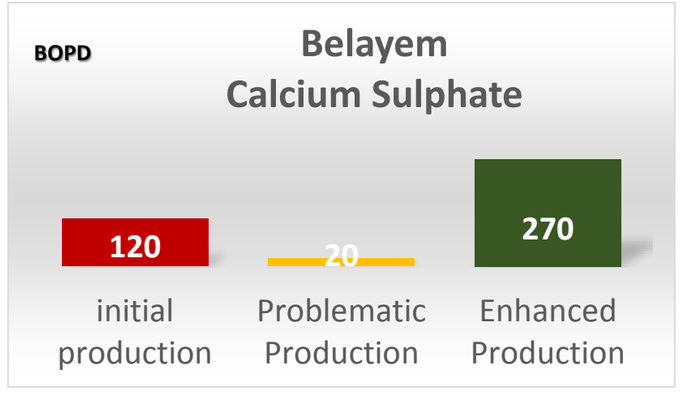
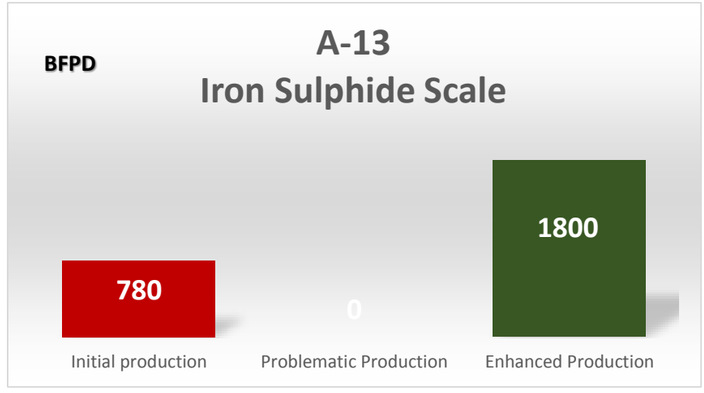
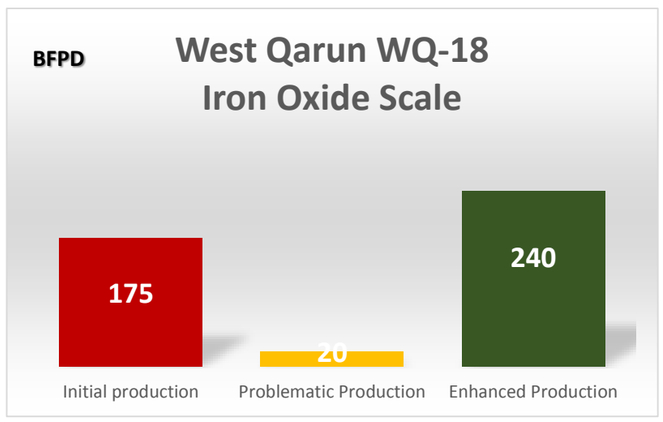
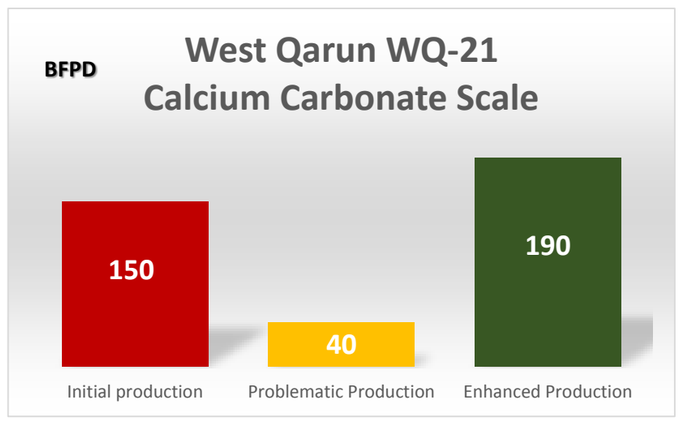
Scale Dissolver Chemicals
SAHARA Chemical Solutions
Improve Production

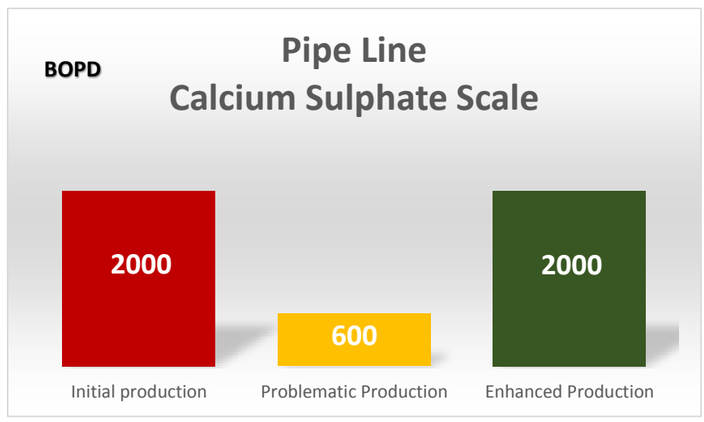












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Scale Dissolver Chemicals

Published Papers

IPTC International Petroleum Technology Conference
10–12 December 2014
KUALA LUMPUR CONVENTION CENTRE
Kuala Lumpur, Malaysia
Innovation and Collaboration: Keys to Affordable Energy

IPTC-18139-MS

Challenge and Successful Application for Scale Removal in Oil Field, Egypt: Field Study

M. A. Bakr, A. A. Hay, SAPESCO,
Samir Sisostris, Mohamed Anwar, Petrobel, Omar El Farouk,
Cairo University

SPE International Conference and Exhibition on
OILFIELD SCALE
30–31 May 2012 · Aberdeen, UK
Aberdeen Exhibition and Conference Centre

SPE-154455
A Successful Removal Inorganic Hard Scale Deposits in an Offshore Pipeline in Gemsa Oil Field, Egypt: Field Study

Mohamed A. Bakr, Ahmed Abdel Hay, SAPESCO; Emad Hamdy, GEMPETCO

Society of Petroleum Engineers

OMC 2017
MARCH 29-31, 2017
PALA DE ANDRE - VIALE EUROPA
RAVENNA, ITALY

INNOVATION TECHNIQUE AND SUCCESSFUL SCALE REMOVAL JOB WITH COILED TUBING IN BELAYIM OIL FIELD, EGYPT: A CASE HISTORY

Mohamed Anwar, PETROBEL ; Luca Cadei, ENI ; Mohamed A. Bakr SAPESCO

This paper was presented at the 13th Offshore Mediterranean Conference and Exhibition in Ravenna, Italy, March 29-31, 2017. It was selected for presentation by OMC 2017 Programme Committee following review of information contained in the abstract submitted by the author(s). The Paper as presented at OMC 2017 has not been reviewed by the Programme Committee

SPE Western Regional Meeting
23–26 April 2019
San Jose, California, USA

SPE- 195313-MS

Evaluation of a New Treatment to Remove Calcium Sulfate Scale: Lab Studies and Field Application.

Ahmed Ibrahim, Hisham Nasr-El-Din, Texas A&M University
Mohamed Abd El-baqi, Ahmed Abdelhay, SAPESCO
Hossam Farouk, Ahmed Aref, Ahmed Reda, MohamedRafaat, Mohamed Gamal, ZEITCO

SPE ATCE Since 1924
Society of Petroleum Engineers
Annual Technical Conference and Exhibition
24–26 September 2018
Dallas, Texas, USA
Kay Bailey Hutchison Convention Center

SPE-191448–MS
Removal of Iron Sulfide Scale with a New Formulation: A Field Application in a Sandstone Reservoir in Egypt

Mohamed Abou Bakr, Ahmed Abd El-Hay, SAPESCO
Ahmed Farid Ibrahim, Hisham Nasr-El-Din, Texas A&M University
Ehab Amin, ZEITCO

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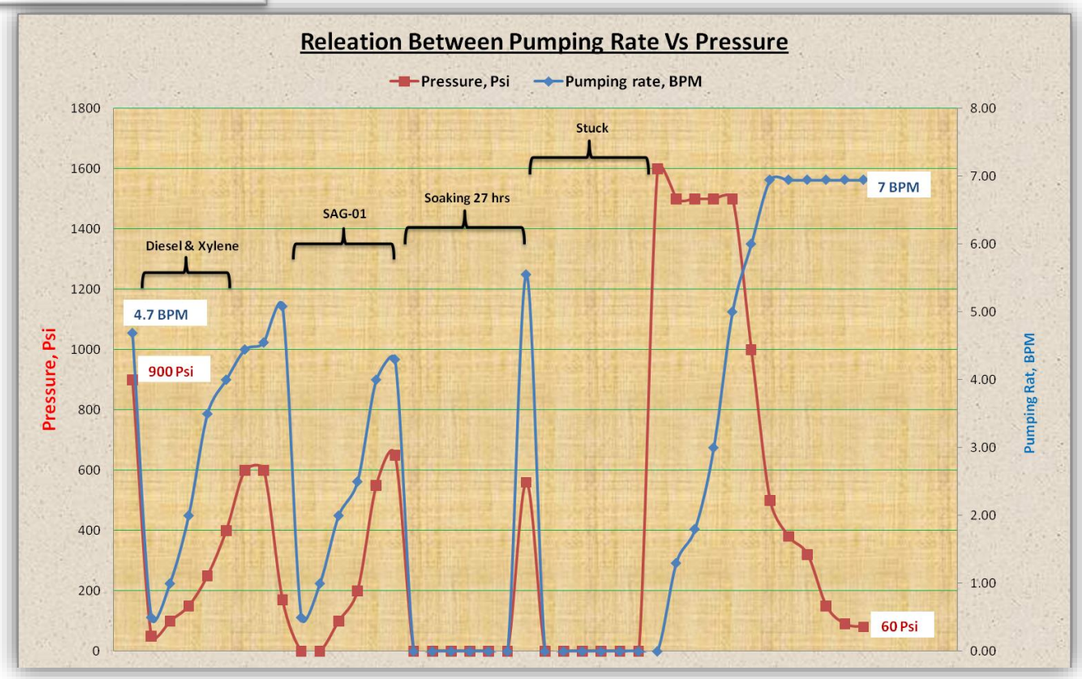
Scale Dissolver Chemicals
SAHARA Chemical Solutions
Gemsa Pipeline

Blocks of Scale inside the line before the chemical job

Pipeline Scale Sample Analysis	
Components	Percentage
Hydrocarbons	6.5%
Chlorides	3.1%
Calcium Sulfate (Gypsum)	89.0%
Sand	1.4%
*** Oil API 30.68*	
*** Paraffin Content 7.6 wt%*	
*** Pour Point 27°C*	



After cleaning Successfully retrieved about 500 drums deposits (Scale & hydrocarbon, sand, cement and chloride)

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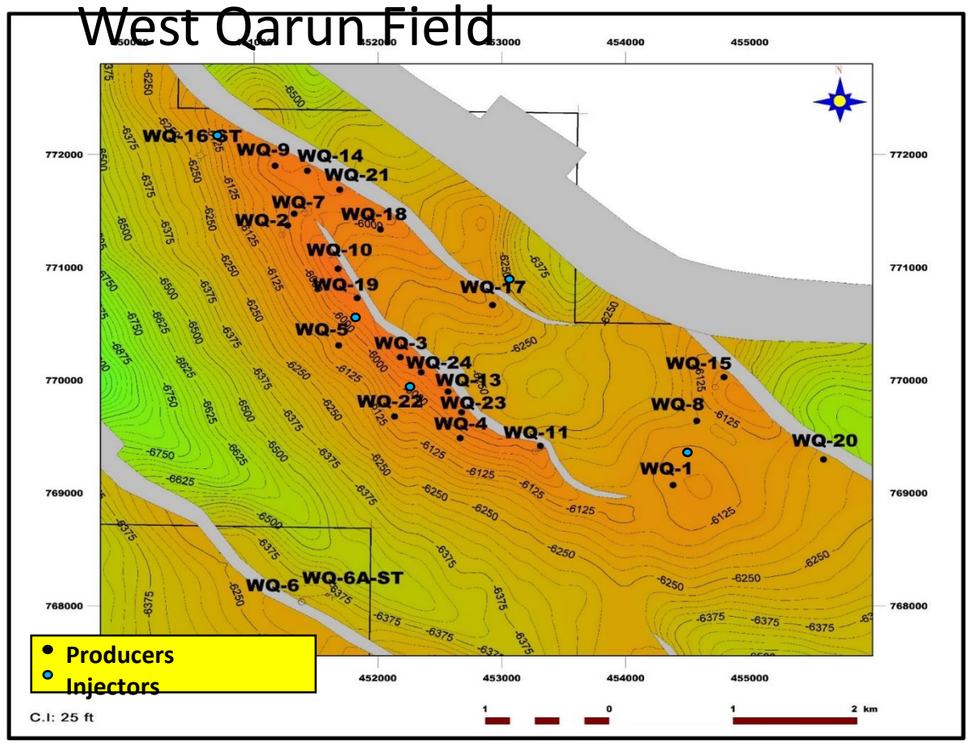
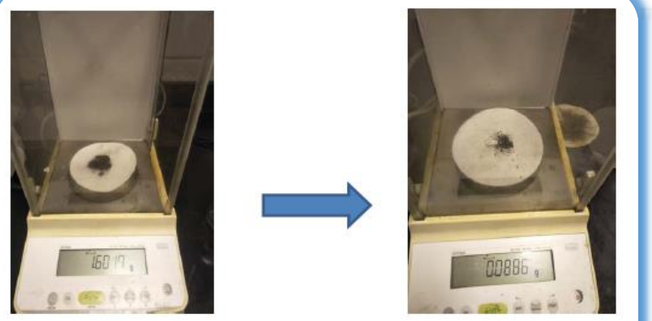
Scale Dissolver Chemicals
SAHARA Chemical Solutions

Formation Damage with Iron Oxide Scale (Sandstone formation)

West Qarun Field



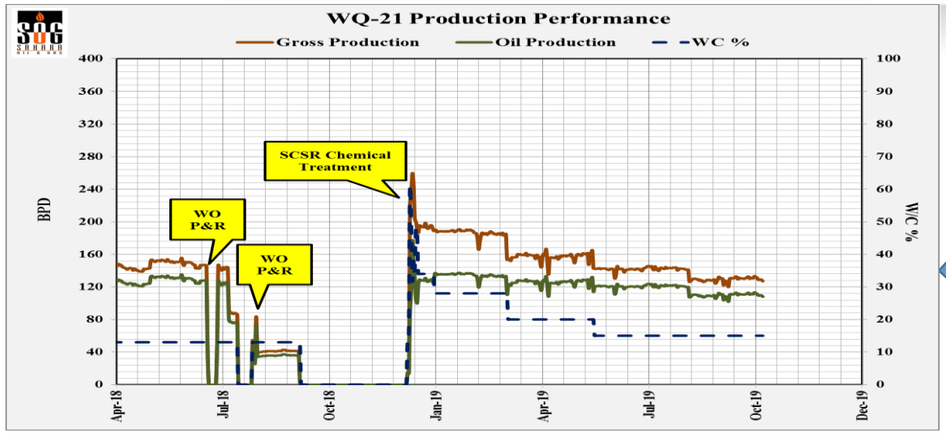
Sample (gm)	Dissolver (ml)	Soaking Time (hr)	The percentage of wt. Loss (%)	Comment
1.6017	50 ml of SCSR	6	95 %	The structure of the sample came to be very friable after six hours that means it is an indicative of the sample being easily crumbled and so friable aspect.



The sample weight loss after dissolution

Solution after soaking 6hr.

Case	P.I (BBL/Day/Psi)	Fluid Rate (BFPD)
Original	0.36	150
After Damage	0.10	40
After Stimulation	0.46	190



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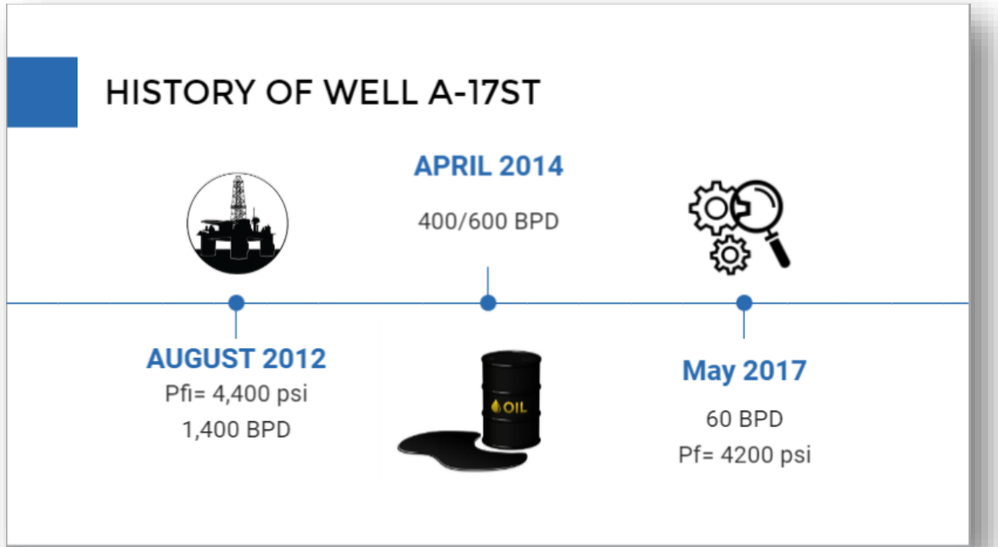
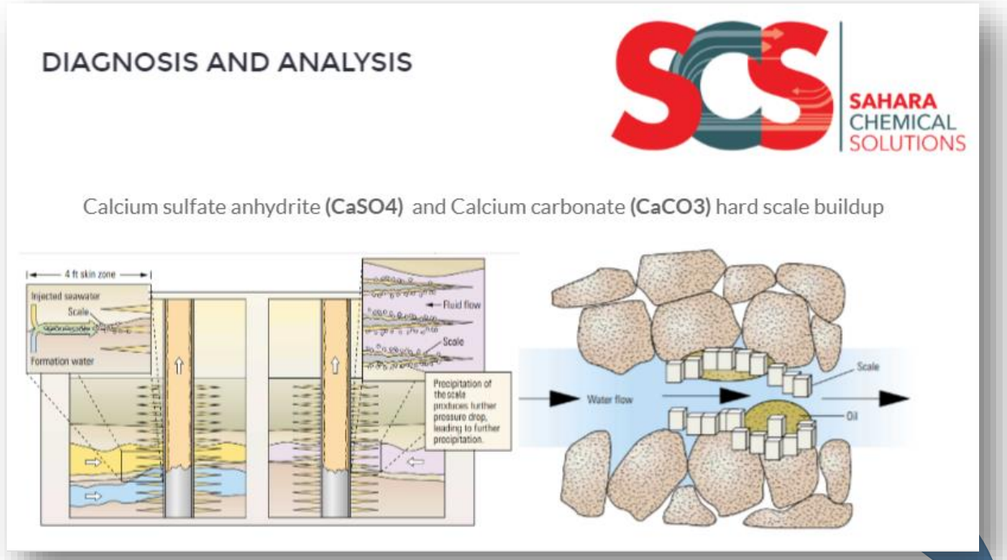
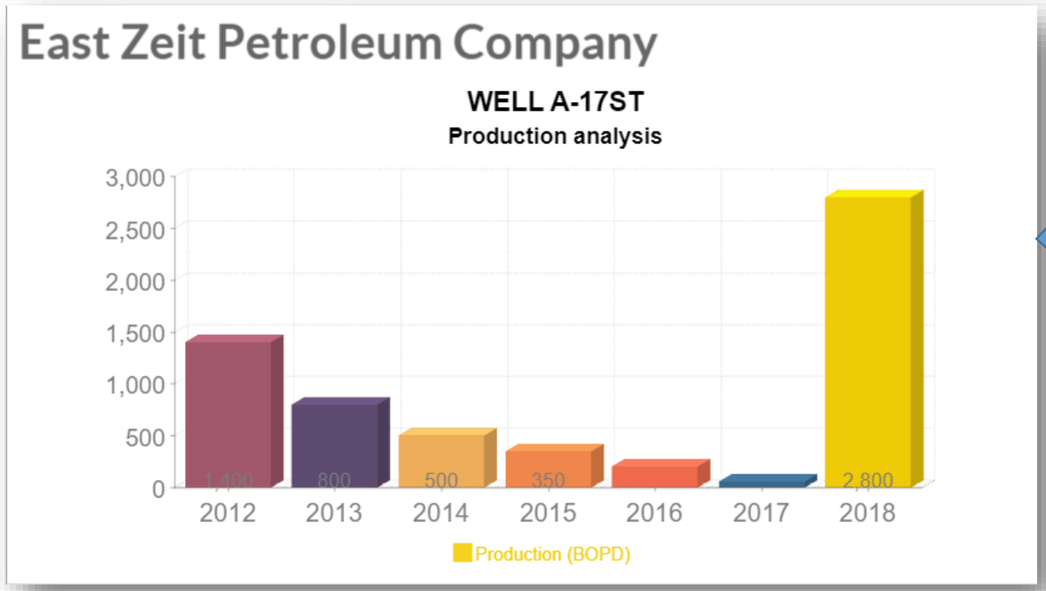
Scale Dissolver Chemicals
SAHARA Chemical Solutions
Calcium Sulfate and Calcium Carbonate Scale (Sandstone formation)





Case Study

East Zeit Petroleum Company
Well A-17ST
Formation Stimulation



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Scale Dissolver Chemicals
SAHARA Chemical Solutions
Tubing Scale Removal for Iron sulfide Scale

Scale Problem Overview

Well # A13 (Nubia Sandstone Formation)

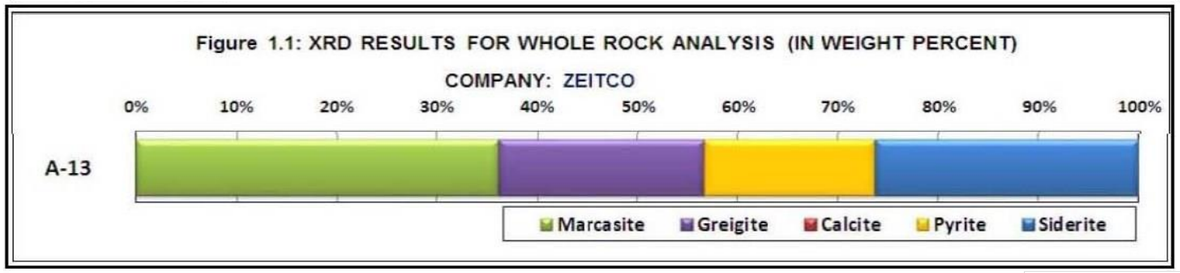
A scale sample was taken from downhole at 11,000 ft and an XRD analysis was made on it; results were:

Table 1.1: Semi-quantitative analysis obtained by X-Ray diffraction for whole rock sample.

Well Name	MINERALOGY (WEIGHT %)					TOTAL
	Marcasite	Greigite	Calcite	Pyrite	Siderite	
A-13	36.09	20.60	-	17.09	26.22	100.00

Notes:
Marcasite: FeS_2
Greigite: Fe_3S_4

Figure 1.1: XRD RESULTS FOR WHOLE ROCK ANALYSIS (IN WEIGHT PERCENT)



Proposed Solutions

Scale samples and XRD results with all required data were delivered to four big service companies specialized in chemical solutions for consultancy

"NO WAY!"

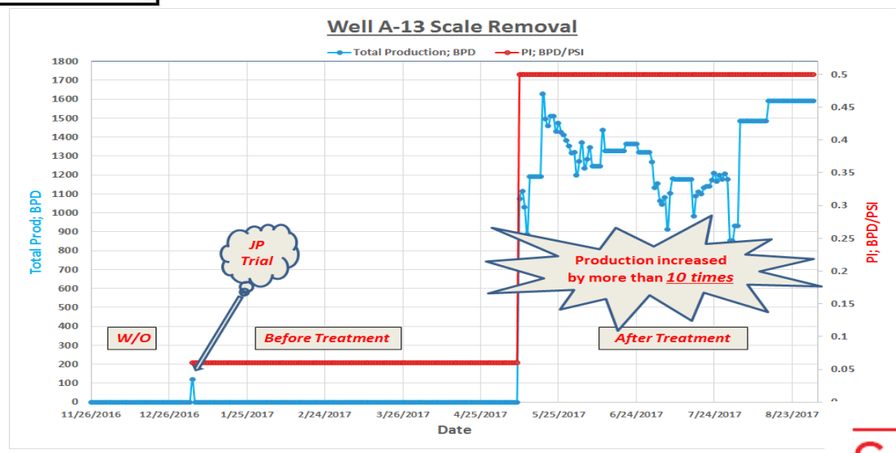
This one couldn't dissolve more than 2%

"MILLING!"

Mechanical solution requires time and money

"SCSR-02"

A unique chemical solution proposed by **SCS**



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Scale Dissolver Chemicals
SAHARA Chemical Solutions

Permeability Enhancement for Injector Well# WARD JM B#31
BASA Oil Company USA

Challenge:

An obvious decline in the daily injection rate with noticeable increase in the WHP value due to very low permeability of the formation zone and formation matrix damage status that in need to a special chemical treatment.

Scale interpretation that has been done on water analysis and reports collected suggested that the mineral content of the Scale to be Barite scales. Super saturation condition has been indicated that lead to significant damage and subsequently much lower injection rate than calculated.

Table 1.1: Semi-quantitative analysis obtained by X-Ray diffraction for scale sample.

MINERALOGY (WEIGHT%)		
Mineral Name	Barite	Weight(%)
Percentage	100	100
Crystal Lattice	Orthorhombic	
Chemical Structure	BaSO4	
Crystal Shape		

XRD results of the sandstone formation

Treatment Results:

	Before	After	Gain
Water Injection Rate	1,223 bbl/Day	1,813 bbl/Day	48%
Injection Pressure	960 psi	960 psi	

Solution:

SCSR-05 Chemical squeeze in the formation to remove the target barite scale for permeability enhancement through Bull Heading operation.

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Thank You

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