

Preventing Downhole Scale Deposition Using Radio Frequency Signals from Surface to Extend ESP Run-Life.

European Artificial Lift Forum

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Overview

- Scale on ESPs
- Radio Frequency Technology
- Cases
- Summary

Mineral Scaling

Water Chemistries

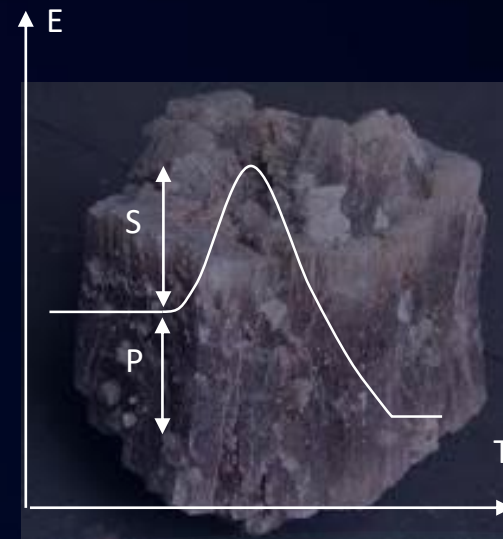
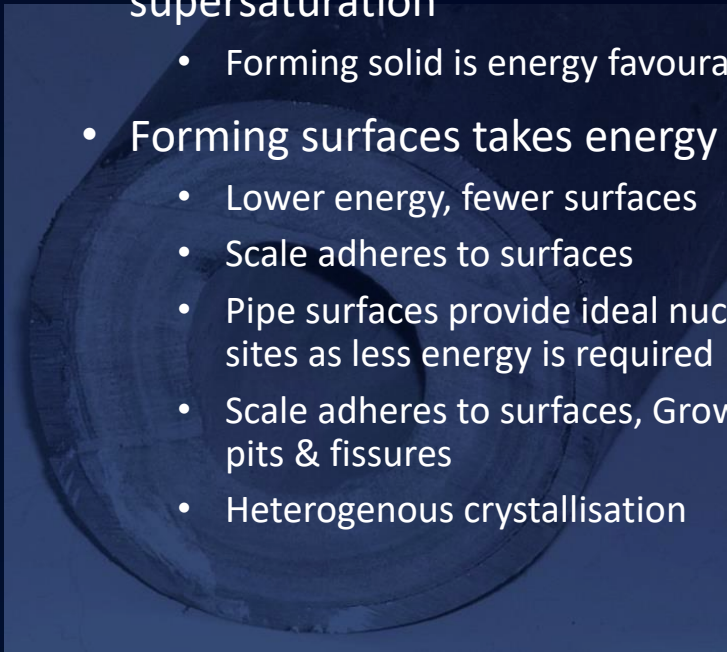
- P & T changes impact water chemistry
- Carbonate scales form as P drops or T increases
- Calcium Carbonate common
 - High $[Ca^{++}]$ present in waters
- Sulphate scales form as waters mix
 - Dissimilar producing zones
 - Injected seawater returns
 - SO_4^{2-} precipitates Ca^{++} (gypsum) Ba^{++} , Sr^{++}

Impact

- Adhere to pipewall and constrict flow
- Adhere to equipment & prevent functioning – ESP cooling
- Promote under-scale corrosion
- Can block a (gas) well in 12 hours!
- Carbonate scales
 - Acid soluble
- Sulphate Scales
 - Insoluble

Scale Deposition

- Precipitation requires supersaturation
 - Forming solid is energy favourable
- Forming surfaces takes energy
 - Lower energy, fewer surfaces
 - Scale adheres to surfaces
 - Pipe surfaces provide ideal nucleation sites as less energy is required
 - Scale adheres to surfaces, Grows in pits & fissures
 - Heterogenous crystallisation



Scale - ESPs

- Major ESP failure mode - decreasing production and increasing costs.
 - carbonate scaling most common
 - motor housing surface
 - NORM scale more problematic
- Deposited scale restricts fluid intake, causes pump impeller imbalance and motor overheating leading to deterioration in pump performance, premature failure and production loss.
- Mitigation
 - well intervention
 - pump replacement,
 - downhole chemical injection or
 - acid /chemical washing.
- Mineral scale deposition prevention in and below ESPs is thus problematic.

Scale Mitigation

Intervention

- Chemical treatment
 - Continuous Injection
 - Preventative Batch Treat
 - Acid Treatments
- Mechanical Treatment
 - Milling
 - Baling

Radio Frequency

- Zero intervention
- Energy pulse into well/flowline
- **Control precipitation**
- Flow Assurance
- Deposition Prevention

Pulsed Radio Frequency Scale Control

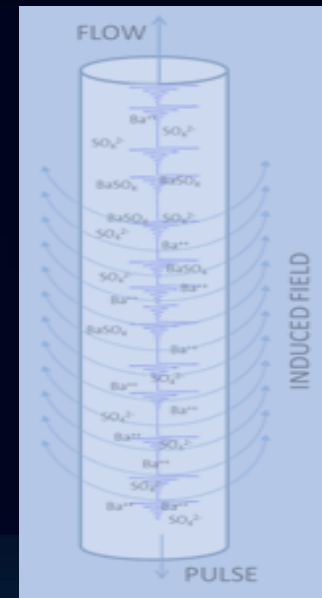
Energy Input

- RF signal generated
- Pulsed via wellhead injection point placed
- Signal propagates through the entire well or pipe run
 - Near field reverse antenna
- Pulsed RF field induced in wellbore



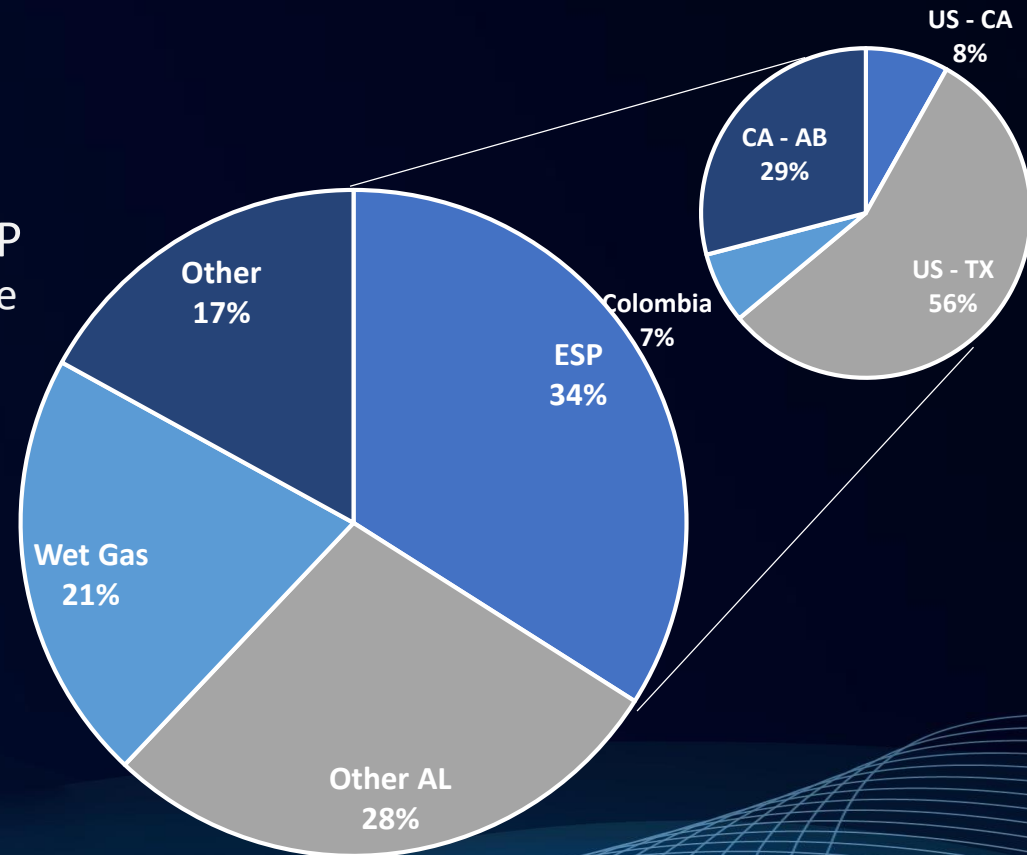
Nucleation Effect

- Charged scaling ions moving through electromagnetic field
- Entire tubular subject to field
- Energy input promotes nucleation of supersaturated solution
- Continual, controlled micro-precipitation, deposition decreased
- Dispersed micro-crystals travel through process system



ESP applications

- Largest single application is ESP
 - Impact on motor housing scale
 - Impact on in-pump scaling
 - Co-precipitation reduction
- Geographies
 - US land (CA & Tx)
 - (Single client 31 ESP deployments)
 - Canada (AB)
 - Colombia
 - Oman
 - New Zealand



ESP Experiences

Alberta, Fox Creek, Duvernay

Carbonate scale deposition, <12 month workover for ESP failure

BHT 109 °C WHT 25 °C

BHP 420 bar WHP 30 bar

Oil 30 bbl Water 90 bbl Gas 353 MSCFD with 2% H₂S

Currently on 40 months without failure and steady performance



ESP Experiences

Alberta, South, Duvernay

Carbonate scale deposition,
frequent workover for ESP failure
average 14 weeks. Associated wax
co-precipitation:

Monthly chemical wash

Well depth ~2200m

BHT 90 °C WHT 40 °C

BHP 215 bar WHP 15 bar

Production Rates 80 – 750 bopd,
100 - 800 bwpd

4 unit test Q4-17, >50% increase in
run time, currently running 11 units



ESP Experience

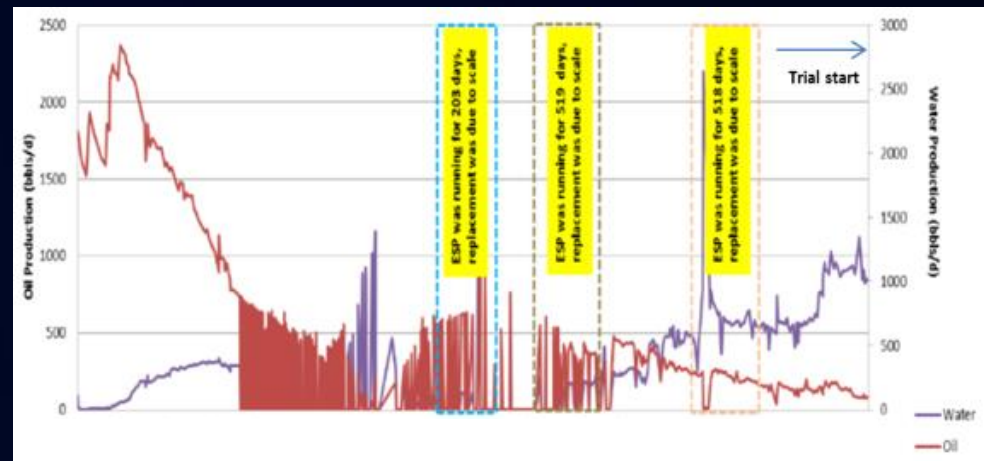
Middle East, Oman

Celestite deposition

Long horizontal, ESP at 5500'

ESPs pulled for maintenance following a failure after 205 days then after 420 days for scale related failure

ESP was then operated for 540 days without failure and removed for routine maintenance



“Intake screen clean. No scale in the housing of the equipment. The cable was in good condition. First and second protector chambers have water. Motor electrically and physically in good condition” PDO

Summary

- Zero Intervention
- Surface Equipment giving downhole effect
 - ESP run-life extension
- Currently ~150 Artificial Lift applications



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