ClearWELL

Chemical Free Scale Prevention Tool for Application in Geothermal Wells and Surface Facilities

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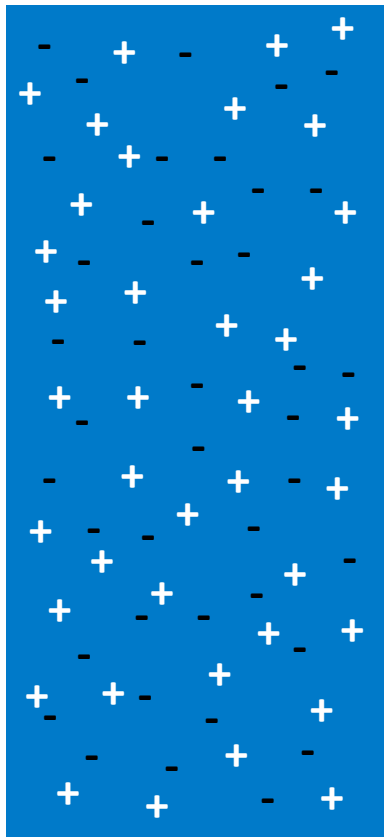
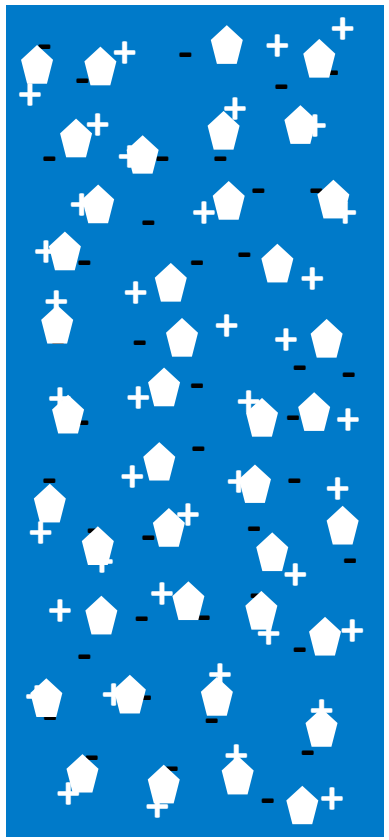
What is scale and why is it a problem?

- What is scale?
  - Scale is a hard, adherent deposit of inorganic mineral compounds that are present in water.
  - It may consist of one or more types of minerals deposited along with other debris (e.g., sand, organic deposits etc).
- How does scale form?
  - Precipitation of minerals from an aqueous solution is governed by:
    - Thermodynamics – temperature, pressure, composition
    - Kinetics – time dependency of a physical or chemical reactions
    - Hydrodynamics – fluid flow conditions (e.g. turbulent, laminar)

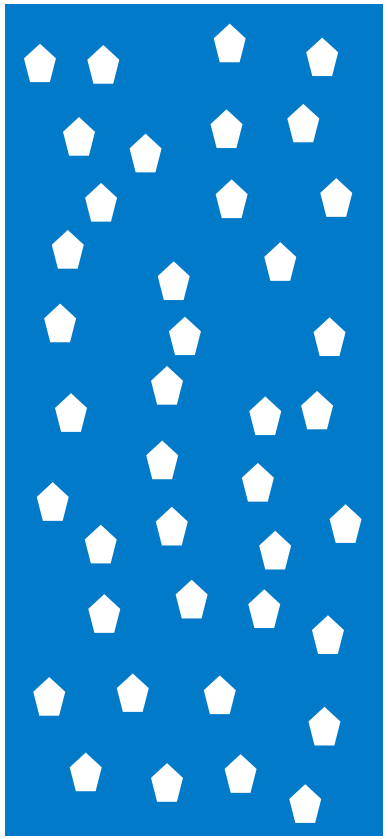
The Scale Formation Process



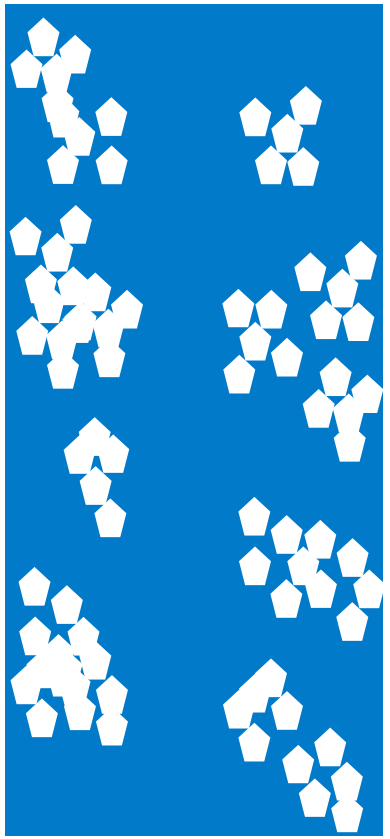
Supersaturated Solution



Nucleation



Crystal Growth



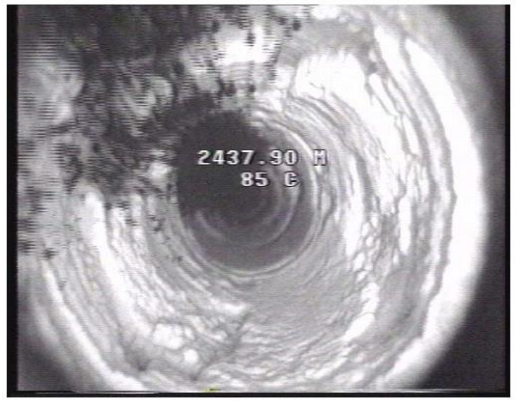
Adherence

What is scale and why is it a problem?

- The formation of scale can occur anywhere in the production system from the formation, surface facilities and re-injection wells.
- The formation of scale can cause the following problems:
  - Blocking of perforations or near wellbore area.
  - Restrictions to tubing diameter.
  - Damage to downhole equipment such as artificial lift or safety equipment.
  - Reducing the efficiency of surface equipment such as separators, filters and heaters.
  - Re-injection wells including pore blocking of reservoir.

Common scale types

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



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

Common types of inorganic scale:

- **$CaCO_3$ (calcite): Oilfield and Geothermal**
- **$BaSO_4$ (barite): Oilfield**
- **$CaSO_4.2H_2O$ & $CaSO_4$ (gypsum & anhydrite): Oilfield**
- **$FeCO_3$ (siderite): Oilfield and Geothermal**
- **Heavy metal sulphides e.g., FeS (several forms), Pbs & ZnS: Oilfield and Geothermal**
- **NaCl (salt): Oilfield**
- **Silica and metal-silicates: Geothermal**

How to deal with scale deposition

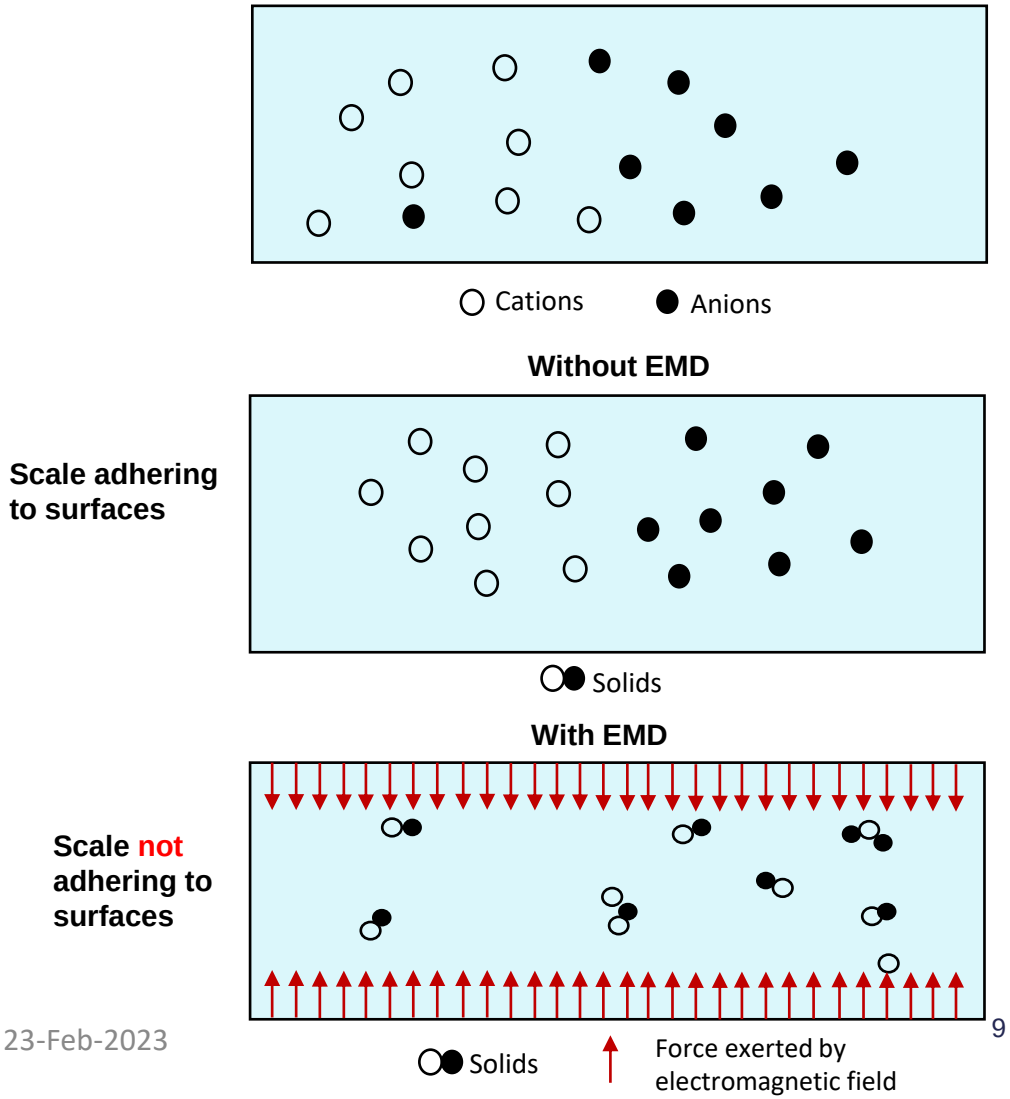
- Traditionally the energy sector has relied on either:
  - Scale inhibitors
  - Scale dissolvers
  - Mechanical removal

- Although all can be effective and practical solutions, they can present challenges:
  - Environmental regulations
  - High temperatures
  - Expensive equipment either CAPEX or OPEX
  - Well Interventions

What is the alternative?

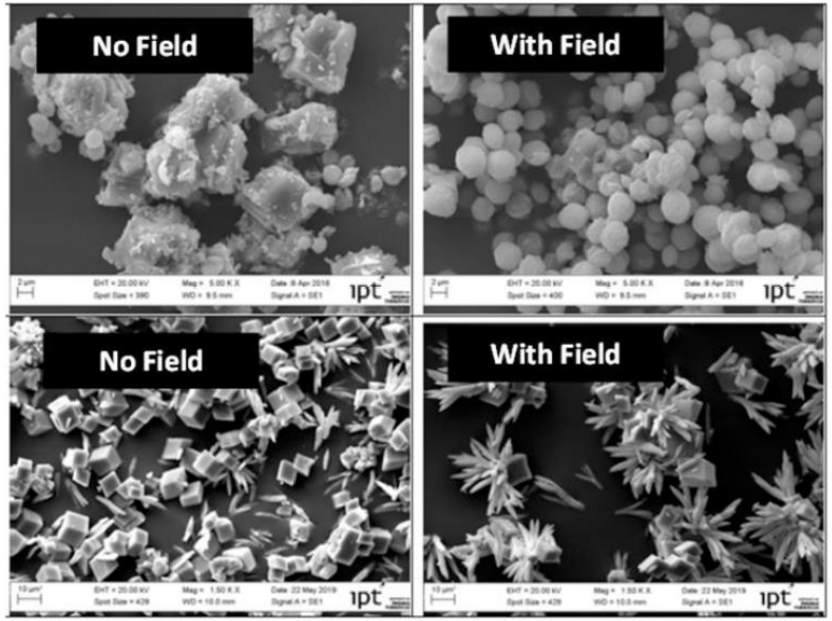
Using an electromagnetic device (EMD) to prevent scale deposition

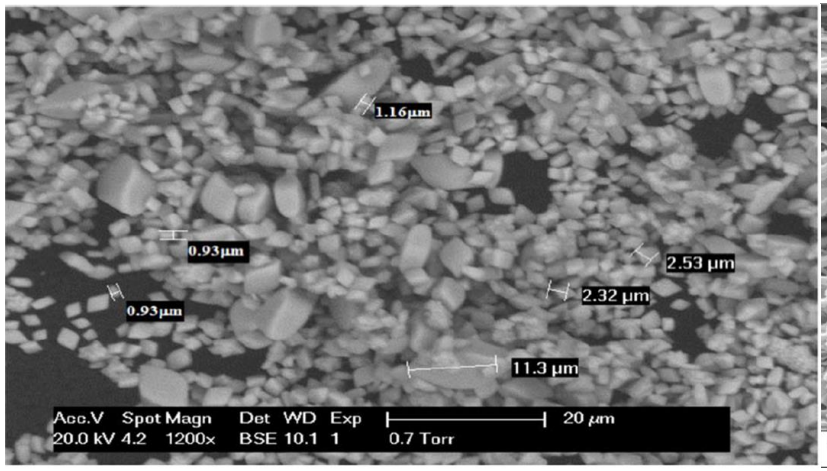
- The propagation of an electromagnetic field (EMF) from a metallic surface changes the energy of the system, impairing heterogenous nucleation, (surface) and favouring homogenous nucleation (bulk).
- Common inorganic scale types contain diamagnetic ions e.g. Ca^{2+} & Ba^{2+} which are repelled by a magnetic force.

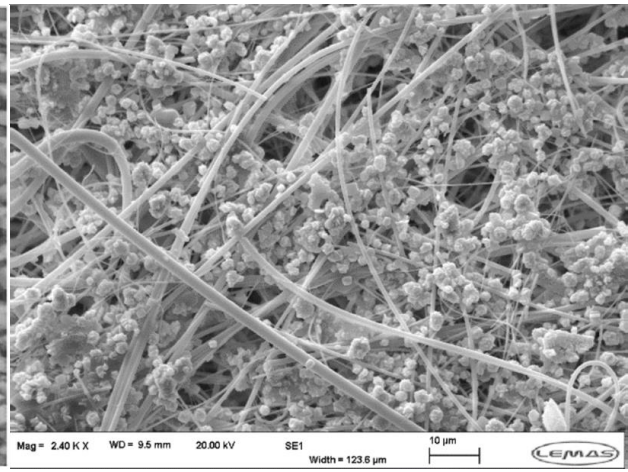


Using an electromagnetic device (EMD) to prevent scale deposition

- Studies have shown that the presence of an EMF changes the crystal phase of calcite resulting in crystals that are mobile and wont adhere.
- The presence of an EMF generates lots of tiny crystals in the fluid.
- Crystals are washed away in the flow stream.
- Doesn't remove pre-existing scale.





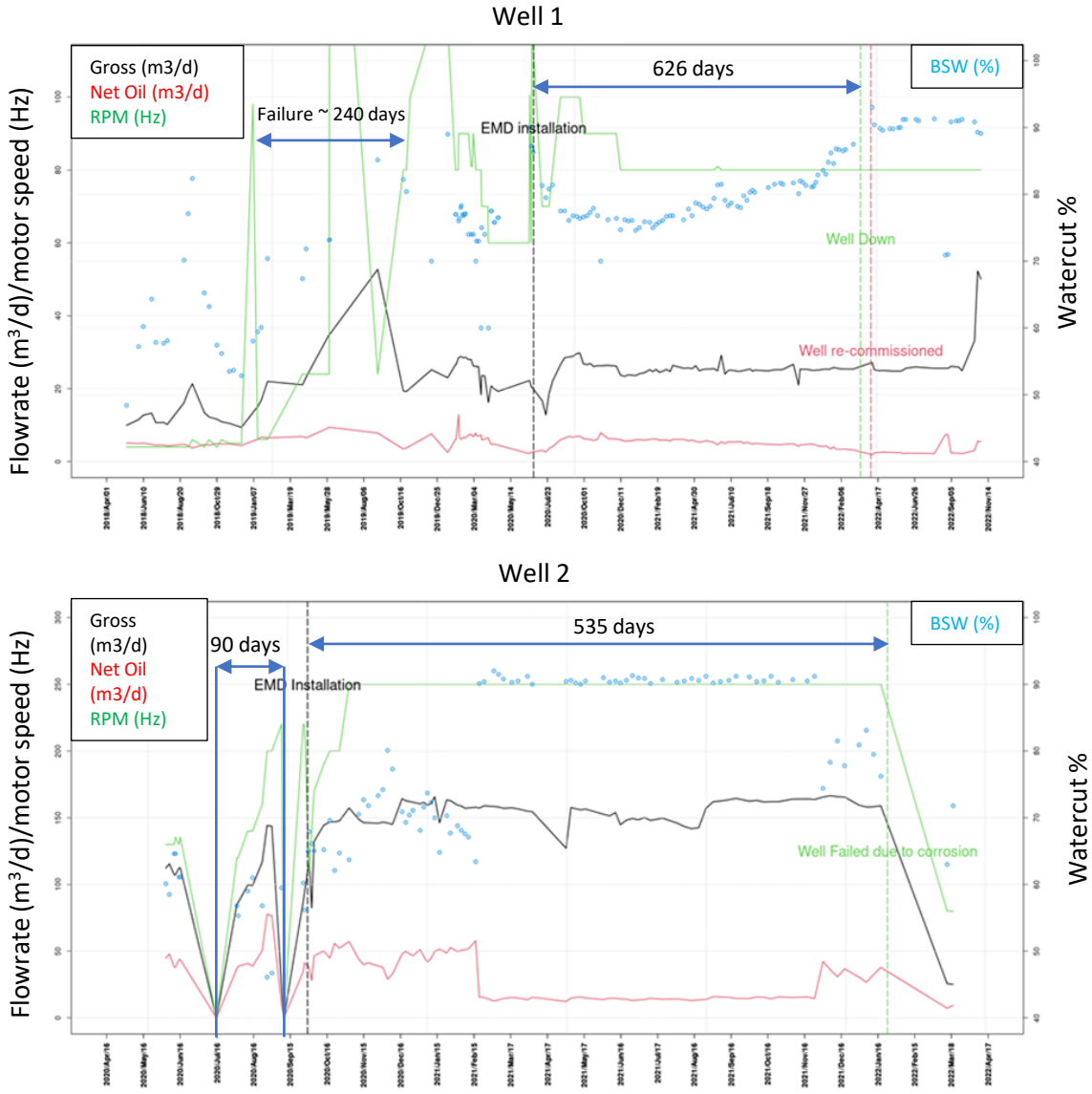


Advantages of EMD's over conventional methods

- The EMD is connected at the surface (wellhead) without intervention to the well or any associated downtime.
- EMD can propagate an EMF to parts in the well not reachable by chemicals e.g. pumps, if no downhole chemical line in place/scale deposition below injection level.
- EMD can be fitted and monitored remotely avoiding logistical issues with chemical deployment to site & reducing carbon footprint.
- Geothermal wells are typically higher in temperature and have more stringent environmental regulations making it difficult to qualify effective scale inhibitors.
- The use of corrosive chemicals in scale dissolver treatments can result in integrity issues and require well interventions.

Field cases with EMD in Oil and Gas production

- Two progressive cavity pumped (PCP) wells experiencing calcite scale resulting in equipment failures every 6-8 months.
- Both wells are high watercut wells 80-90%.
- Following a trial with EMD, both wells more than doubled their run-life.
- Pumps were recovered scale free in both wells.



Field cases with EMD in Oil and Gas production

- The case below shows how effective an EMD is to protect a sand screen from calcite.
- EMD is particularly effective on downhole artificial-lift equipment where scaling occurs on the outside of the equipment.

Well type: Rod pump well (pump depth – 2110m)
Normal run-life: 5-6 months before pump screen plugged with scale.

EMD Installation

After 5 months of continuous production, it was reported that no scale had been found on the pump screen.

Summary

- Scale deposition in geothermal wells and surface facilities is a common problem that will effect most plants.
- Traditional scale control techniques can be challenging to apply in the geothermal sector.
- EMD's have been used successfully in the oil and gas sector for many years.
- EMD's are well suited to geothermal wells operating with artificial lift systems.
- The devices are easily installed and can help reduce downtime and well interventions to remove scale deposits.

Thank you for listening

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