



# SPE Virtual Workshop: Bridging the Gap Between Geothermal and Oil & Gas

1-3 December 2021 | Online



## Learnings from the oil industry applied to geothermal wells

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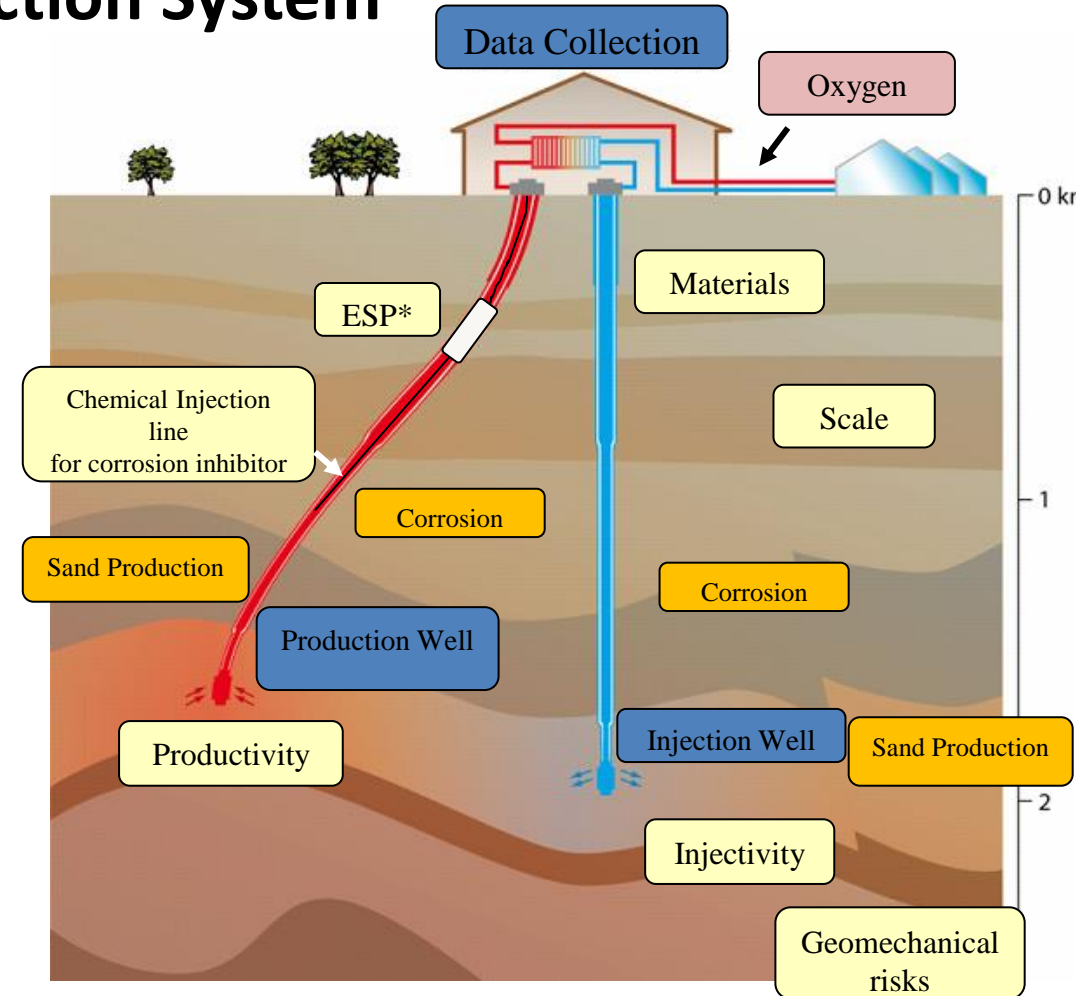
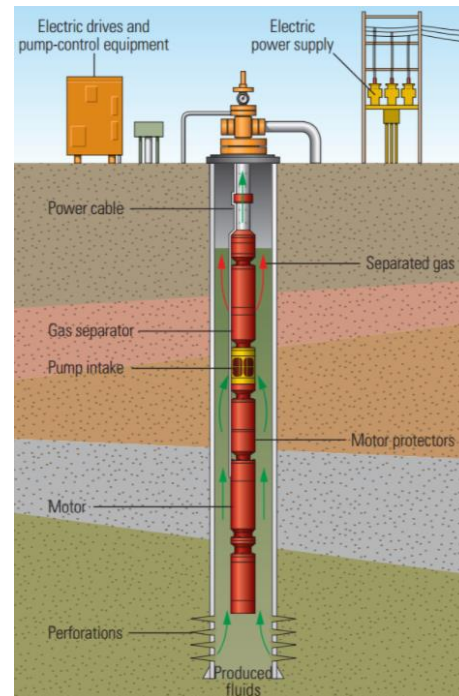


## The Geothermal Well Production System

### Low enthalpy geothermal systems:

- Doublet (producer & injector) provide heat to greenhouses and heat networks
- Large throughput of water: 50,000 bpd per well, requiring big ESP's
- Water contains CO<sub>2</sub>: corrosive
- Designs not always catered for sand production
- Injectivity decline due to impairment

### \*) Electrical Submersible Pump

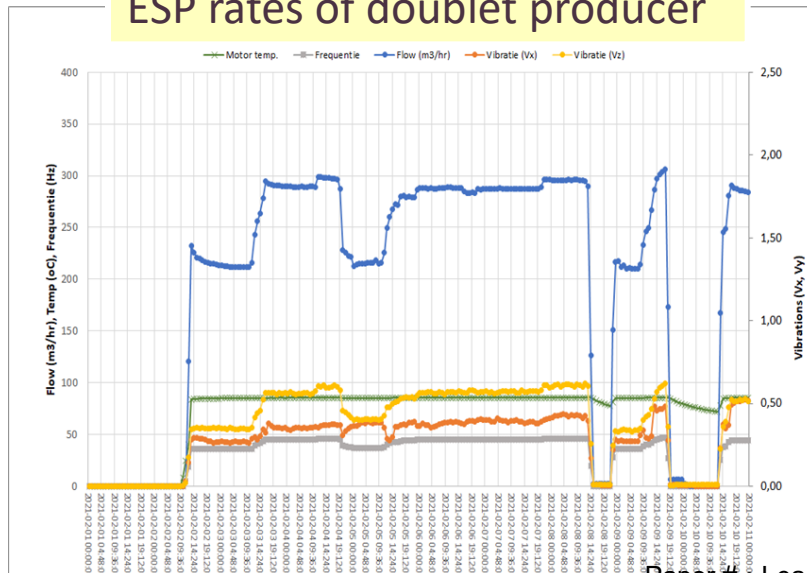


## Causes of water injectors to fail

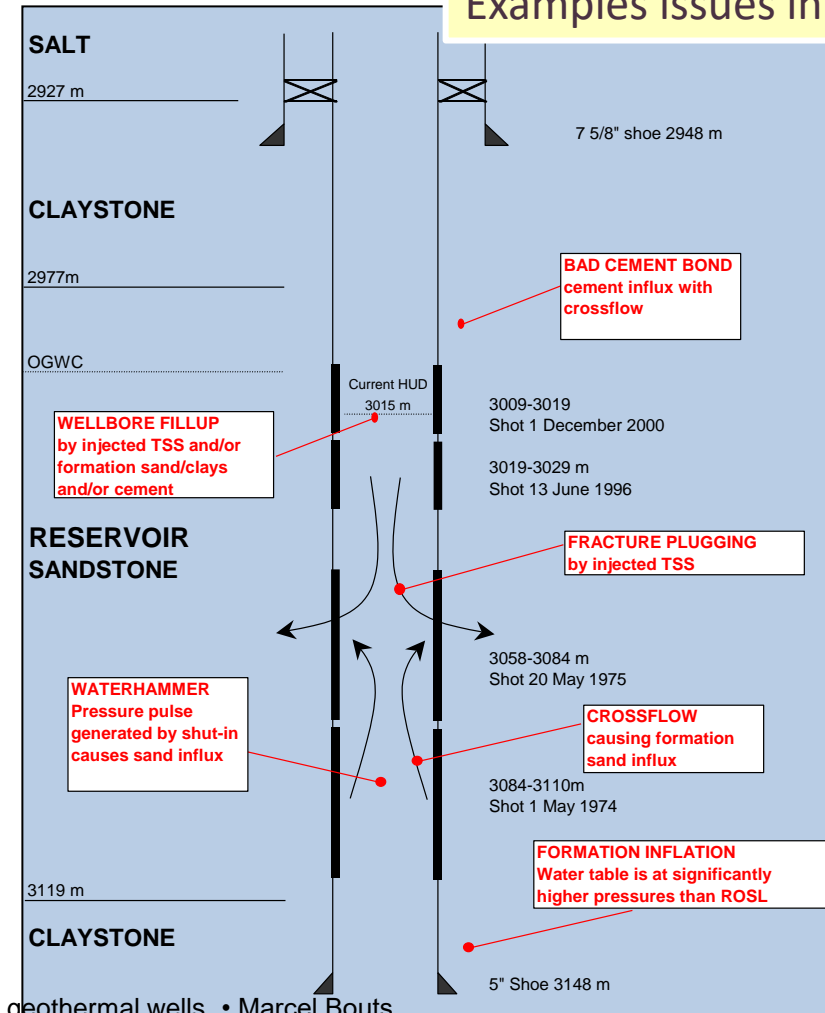
High rate water injectors present challenges such as :

- Frequent start/stops
- Crossflow,
- Backflow
- Water hammer due to rapid shut-ins which lead to fines building up inside the sand screen/liner completion and impaired injectivity.
- Within 2-3 hrs shutdowns – start-ups to 300m<sup>3</sup>/hr: resulting in sand production
- Adjust SU/SD procedures may avoid this

### ESP rates of doublet producer



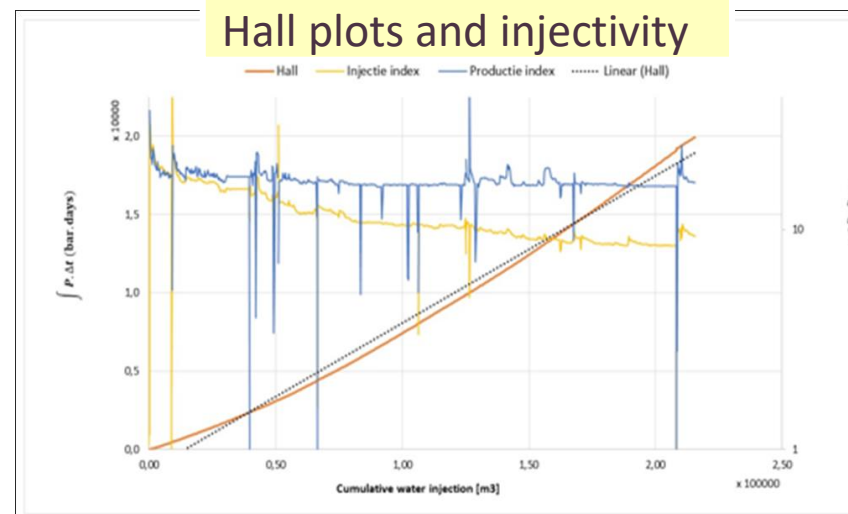
### Examples issues in water injectors



## Injectivity decline example

### Injection monitoring:

- Construct “Hall plots”
- Injectivity was declining to level that required rates could not be reached anymore
- Injectivity index declined from 11.3 to 8.5 m<sup>3</sup>/hr/bar (ini. 20) with skin of 3



### Observation from downhole samples:

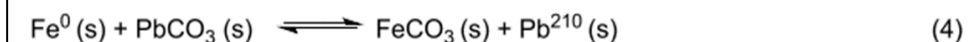
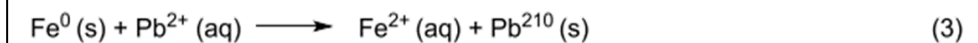
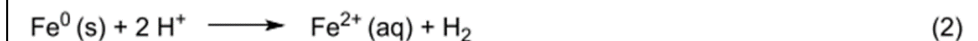
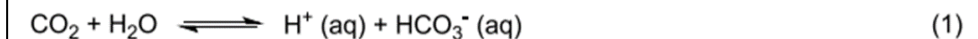
- Contains Iron (Fe) and Lead (Pb<sup>210</sup>)
- Fe from corrosion and Pb<sup>2+</sup> is present in reservoir water
- Electrochemical reactions result in Pb<sup>210</sup> deposits:

### Mitigations

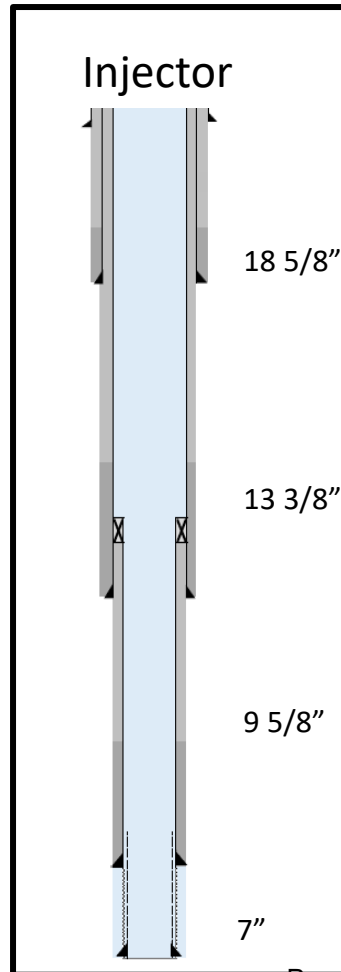
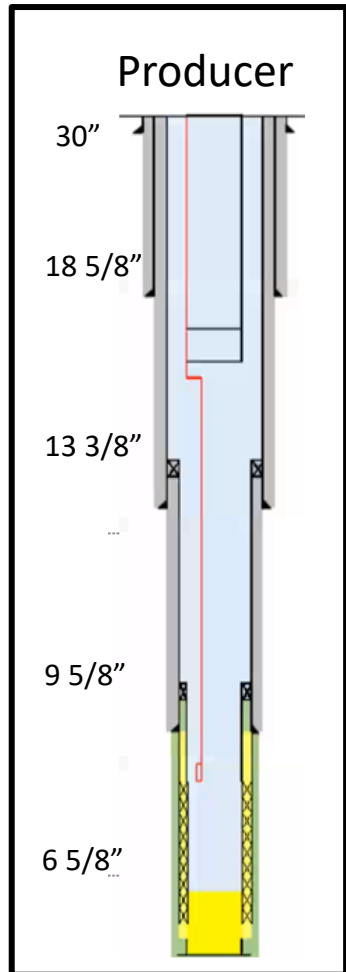
- Well cleaning by removing sand and jetting clean the completion and possible stimulation

### Avoidance:

- Corrosion / Iron control

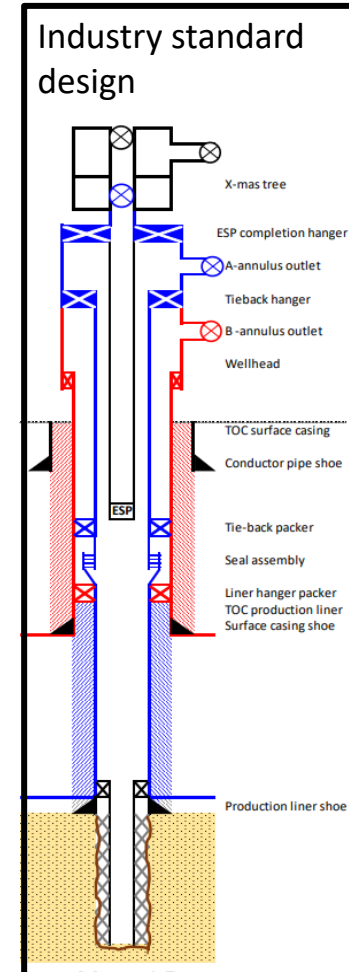


## Geothermal Well Design: Key To Success



### Initial designs:

- Single barrier design; Carbon Steel materials
- Producer: Chemical injection line to top screens.
- ESP at 500-800m depth (producer)
- Reservoir completions:
  - 6-5/8" perf. base pipe/ WWS or 7" pre-perforated liner



### New wells design:

- Double barrier; GRE materials to avoid corrosion
- No chemical injection required
- Reservoir completion tailored to sand properties:
- The right sand control type (if required) based on reservoir properties



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## ACKNOWLEDGEMENTS / THANK YOU / QUESTIONS

Acknowledgement:

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