Der Puls unserer Stadt

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Efficient methods to prevent carbonate scaling at geothermal wells
Results of EvA-M2 project

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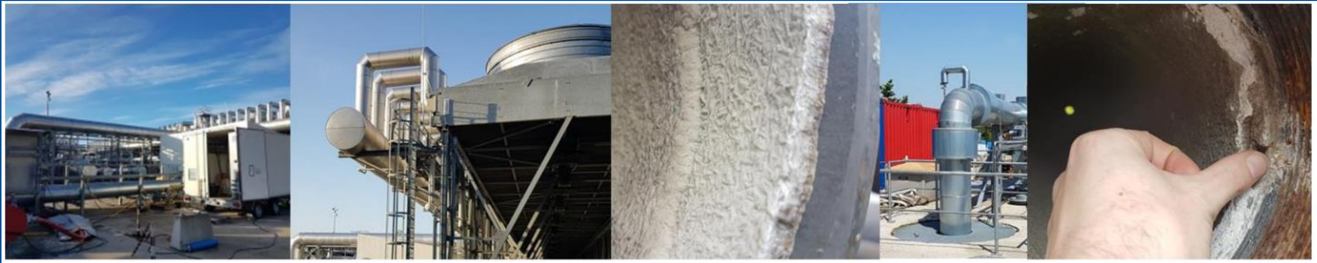
23.10.2024



KIT Karlsruher Institut für Technologie

SW//M Stadtwerke München

HoME Hochschule Merseburg University of Applied Sciences

GTN

Hydroisotop

Sebastian Teitz Laboranlagen, Sensorik Automation

BWG Geochemische Beratung GmbH Zur Untersuchung von Wasser und Gas

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

Agenda

- Introduction
- Results
- Comparison
- Summary & Outlook

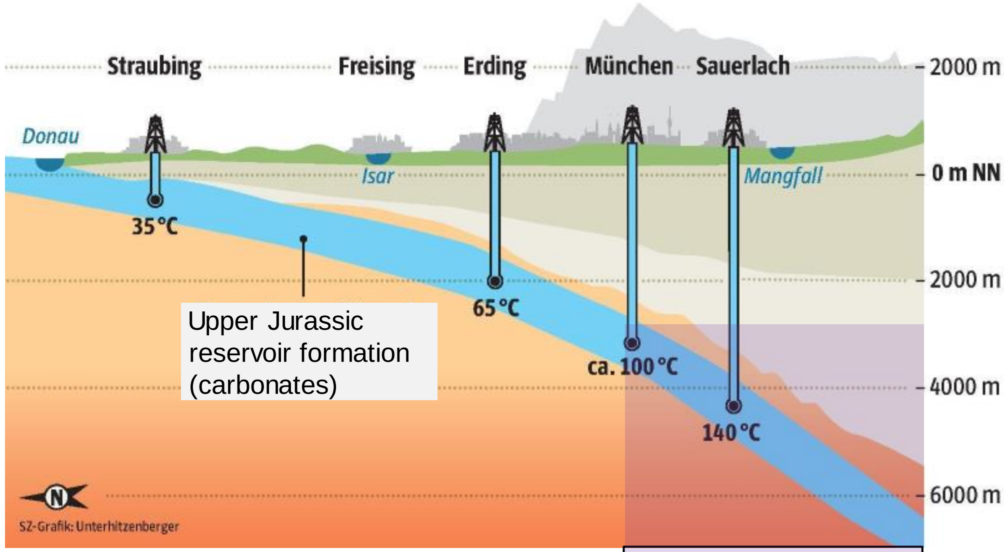
Fundamentals

Calcium carbonate scale formation occurs at higher brine temperatures

→ Scaling related, periodic clean-ups and equipment failures

Two methods have been tested to prevent scaling precipitation

- Scale inhibitor addition
- CO_2-injection



Molasse basin cross section

Scale formation

Periodic clean-up and equipment failures

Filter system

ORC evaporator

ESP stage

ESP intake

Scale inhibitor addition at site Dürrnhaar

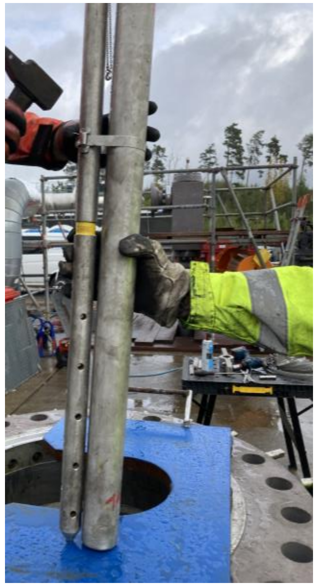
Testing started in September 2021

Addition of premixed scale inhibitor ~100 m below ESP

Determination of minimum effective dosage at test site

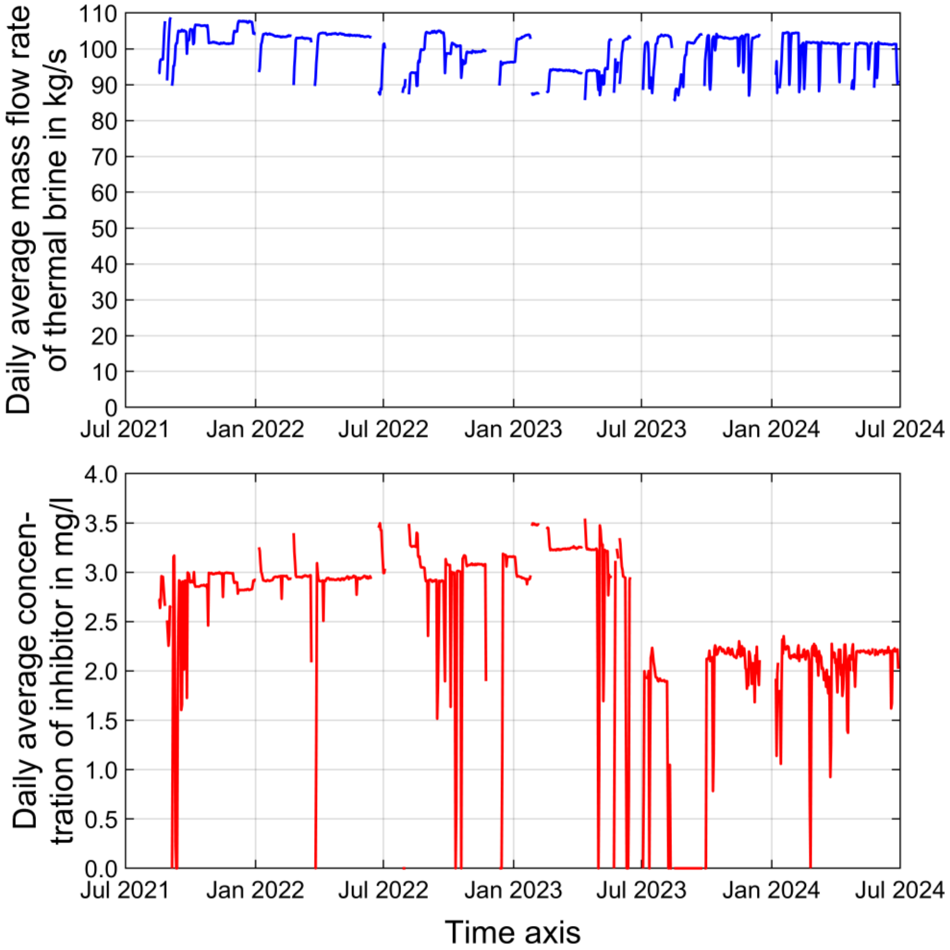
- Initially 3 mg/l and **2,2 mg/l** after presence of oil film in evaporator

Inhibitor dosage station



Injection system

Addition of scale inhibitor



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CO_2-injection at site Sauerlach

Testing started in February 2023, stable injection since December

Addition of gaseous CO_2 ~100 m below ESP

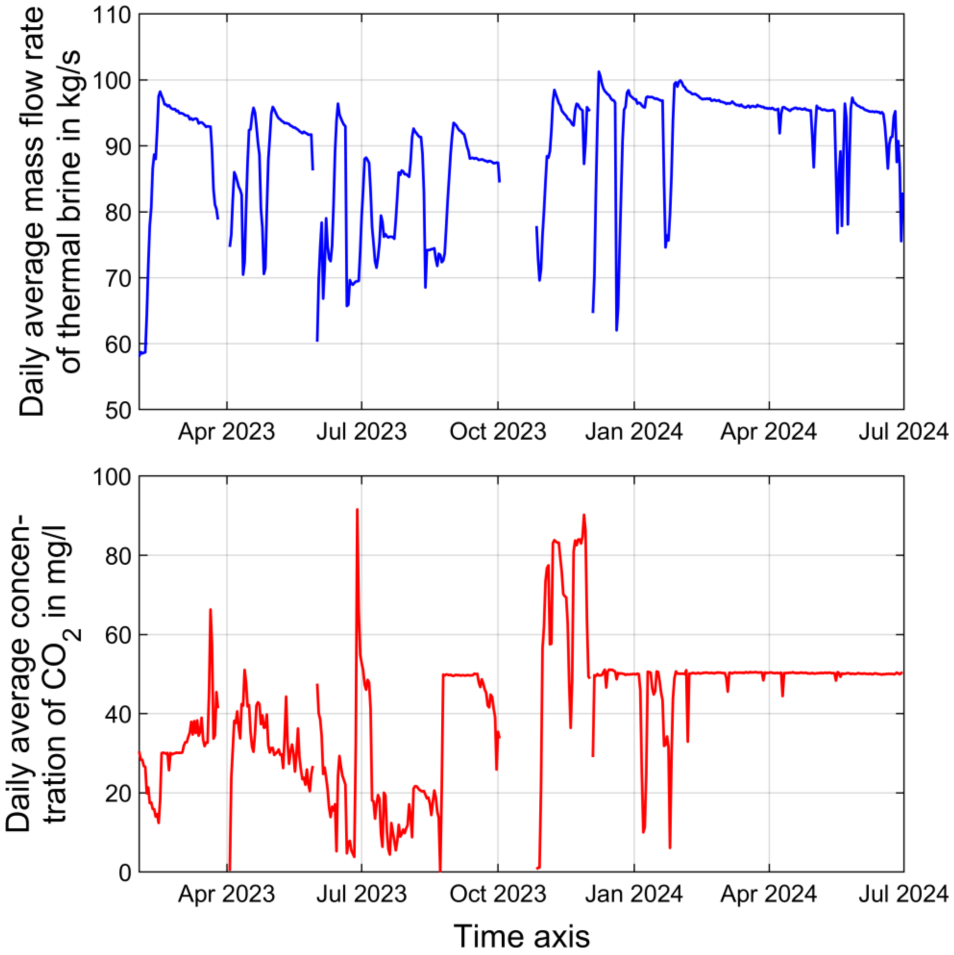
Determination of minimum effective dosage is in progress

- Dosage rate at **50 mg/l**

CO_2 tank

Injection system

Injection of carbon dioxide



Results of scale inhibitor addition at site Dürrnhaar

Site is **scale free** since start of inhibition

→ Saving of periodic clean-ups

→ Longer operational time

→ Reduction of plant pressure

→ Increase of ESP life time

- Easier to overhaul
- Longer service life

Build up of oil film temporarily reduced electric power output

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Results of CO_2-injection at site Sauerlach

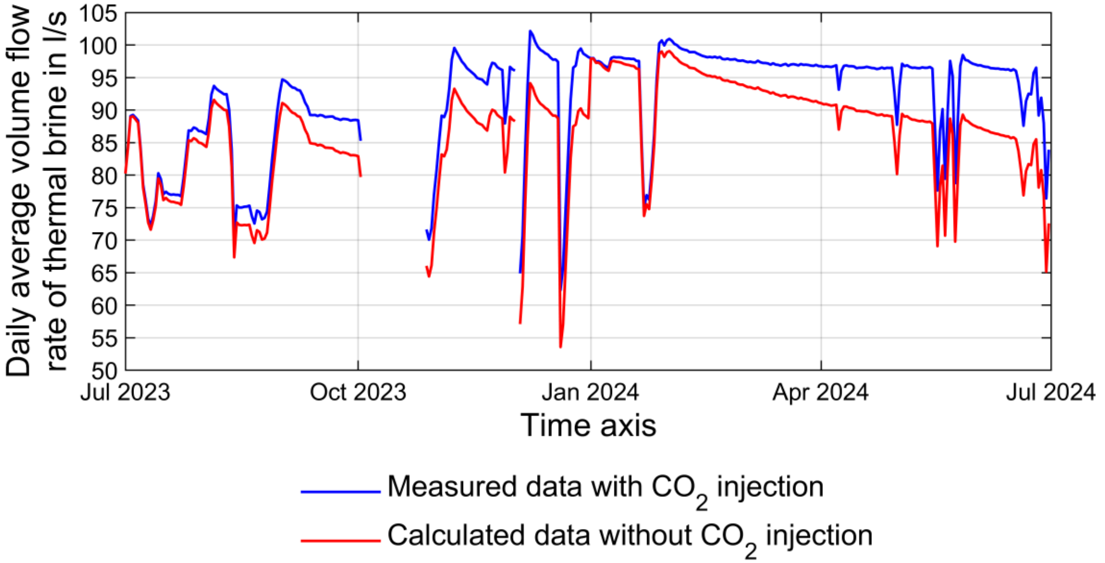
Preliminary results indicate site is **scale free**

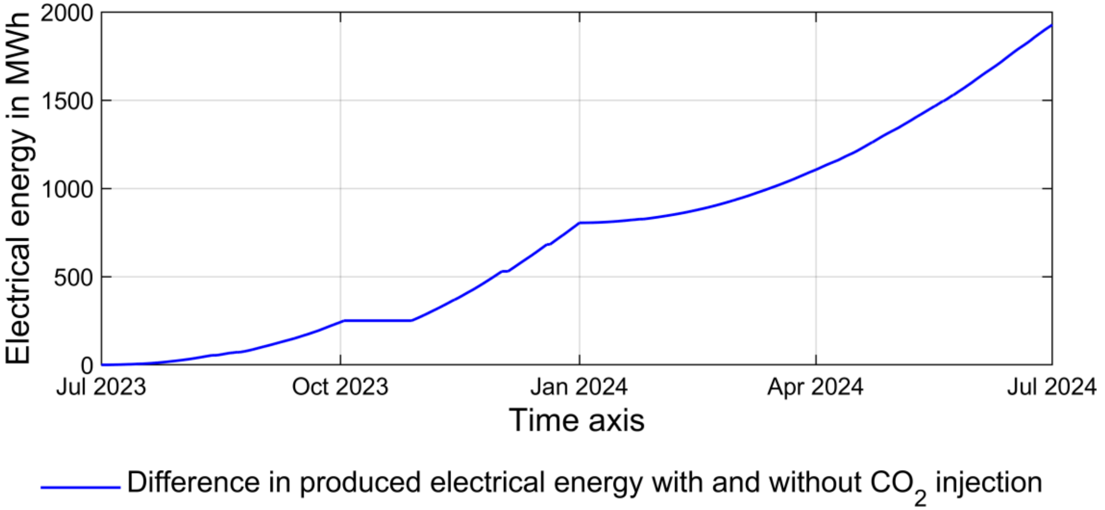
→ Improvement of regular clean-ups, operational time and ESP life time

→ Reduced scaling related production rate degression

Determination of flow rate degression

- Calculation of electric energy output without CO_2-injection using data-based ORC models
- Results
  - Production rate: +2 kg/s per 30 days
  - Annual electric energy output: +1928 MWh





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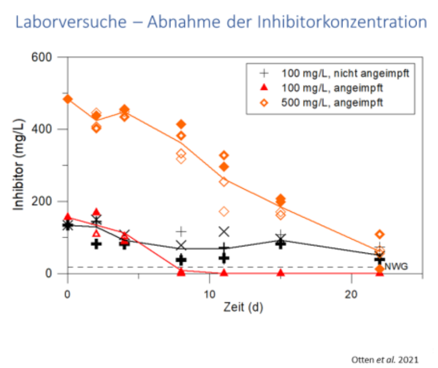
Scientific results (holistic view)

- Comprehensive hydrochemical monitoring confirms prevention of precipitation
- Spectroscopic (UV/VIS) and liquid chromatographic (HPLC) methods are suitable for inhibitor detection
- The **degradability** of the inhibitor could be confirmed in situ
- The corrosion rate remained low during the test period
- Laboratory tests and plant parameters show no negative interactions with the reservoir



Inhibitor degradation

Thermal and microbial

Corrosion monitoring

Rate remained low

Rock flow tests (inhibitor)

No negative interaction with reservoir

Otten et al. 2021

Baur 2024

KPIs

Saving of clean-up costs

Annual clean-up costs
100%
reduced

Amortisation period

Inhibitor Dürrnhaar
<1a

CO_2 Sauerlach
<1a

Saving of ESP costs

Operational time ESP
>685 days

Record!

Production

Reduced plant pressure
-20.8%

Flow rate degression
+7.8%

Scale inhibitor versus CO_2

Evaluation criteria	Inhibitor addition (Dürrnhaar)	CO_2-injection (Sauerlach)
Effectiveness	Very high Preferred use with low calcium content in thermal brine	(Very) high Preferred use for deeper geothermal wells
Economic performance	High without reduced heat transfer	High
Environmental sustainability	Medium - high Water hazard class 1, easily degradable under plant conditions	High Naturally occurring, increases calcium carbonate solubility
Challenges	Oil film (heat transfer), approval by authorities	Amount of deliveries, space, potential long-term effects

Summary and Outlook

Summary

- Two effective methods for scaling prevention
- Economic optimization potential depends on the local conditions
- Direct comparability of scaling prevention methods is **not** yet given

Outlook

- Methods to determine the minimum effective dosage are required (e.g. dynamic scale loop tests)
- Testing of scaling prevention methods at different sites (forecast)
- Effective removal of scaling (ROSIGER project)

Thank you
for your attention.