



Curtin University

Impact of CO₂/rock/water interaction on fracturing performance and its influence on production capability of unconventional reservoirs

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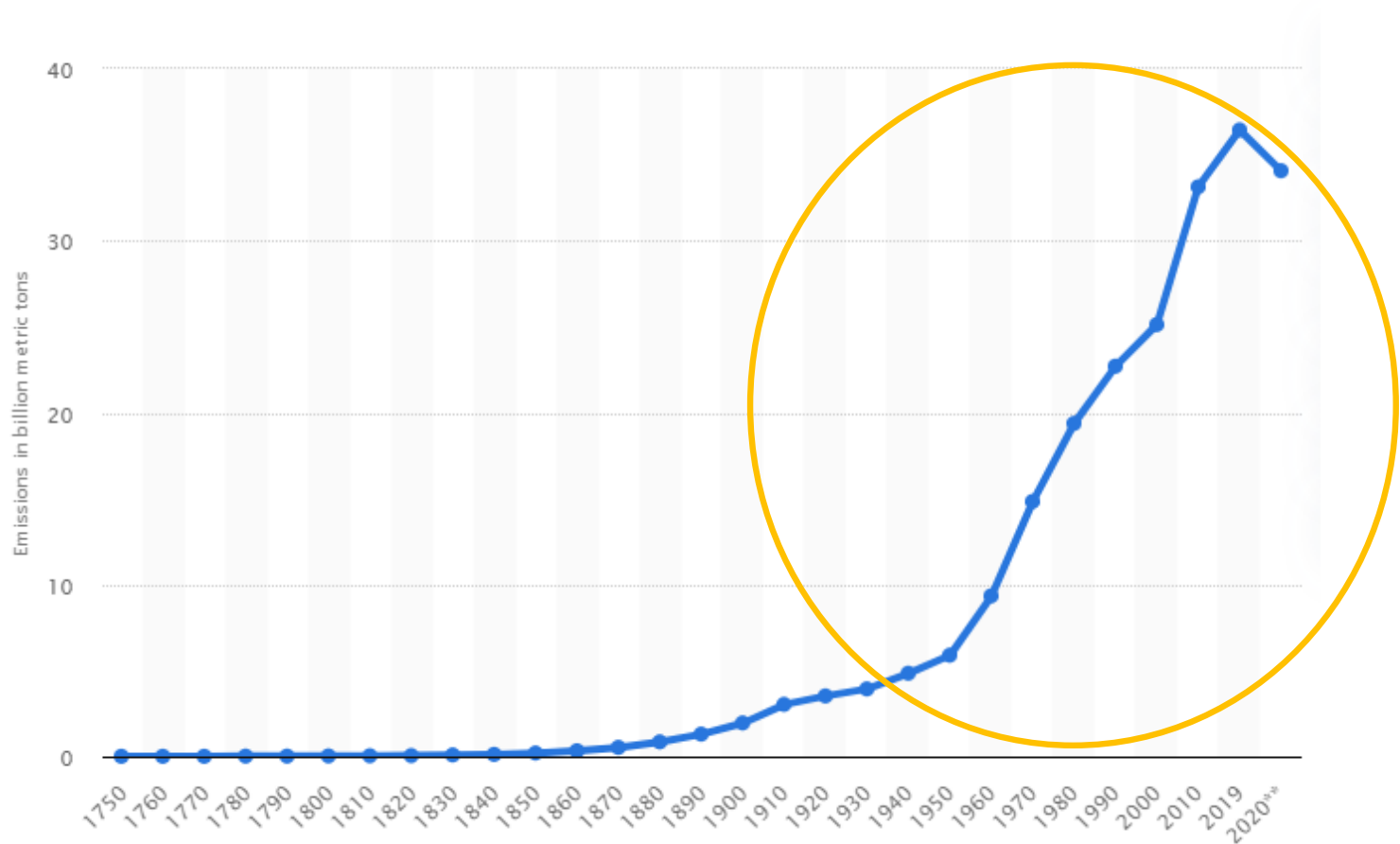
KAUST VIRTUAL RESEARCH CONFERENCE 2021, Enabling CO₂ Geological Storage within a Low-Carbon Economy

Content

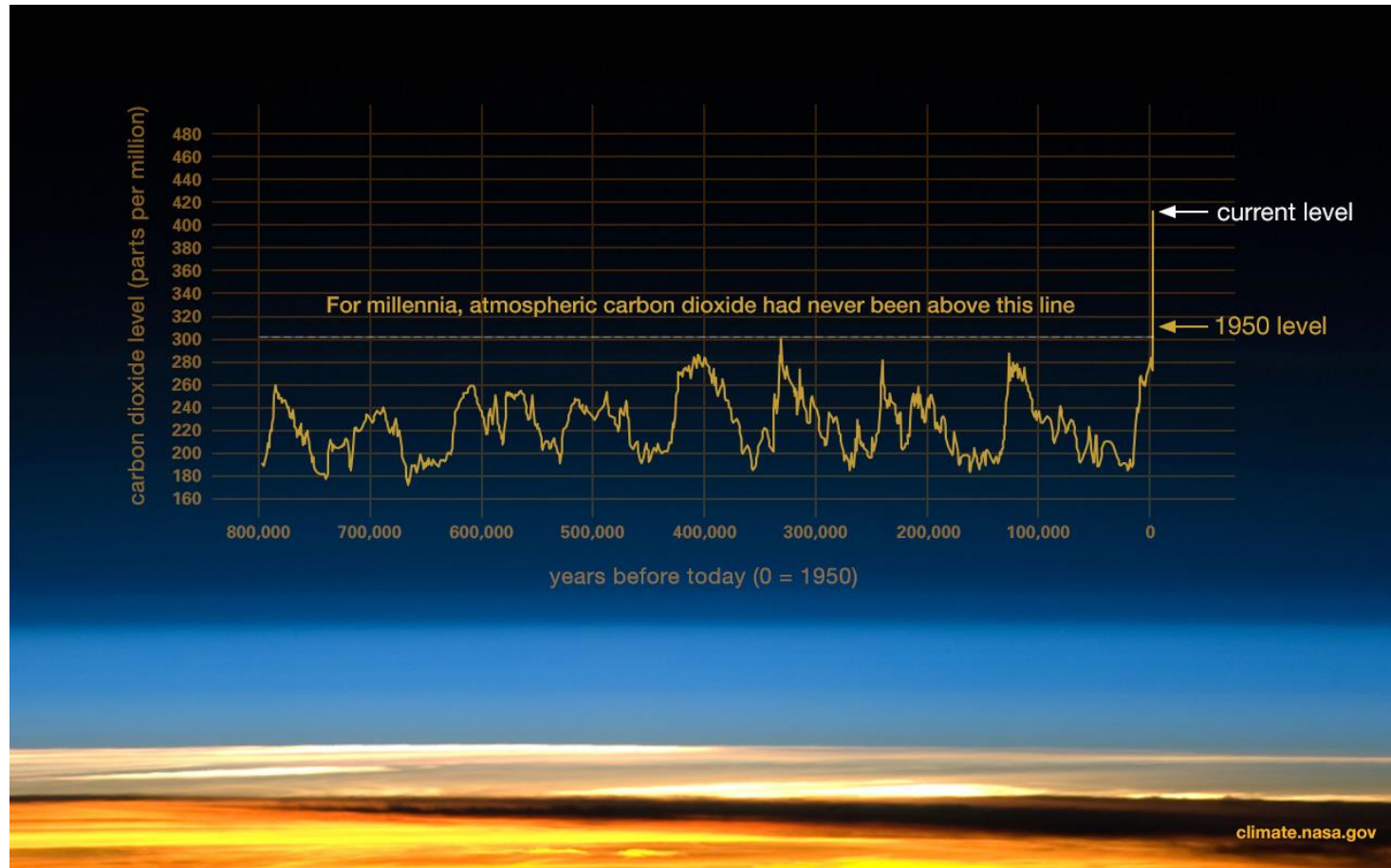
- Global CO₂ emissions since start of industrialisation.
- Current CO₂ level in the environment – an alarming situation
- Role of oil industry in low carbon economy
- Hydraulic Fracturing and its issues
- CO₂ Fracturing - Current Status
- CO₂ Fracturing – playing role in low carbon economy
- Problem Statement
- State of the art fracturing rig
- Work flow
- Results so far
- Summary



Global CO₂ emissions since the start of industrialisation



Current CO2 level in the environment – an alarming situation



Role of oil industry in low carbon economy

EOR/EGR

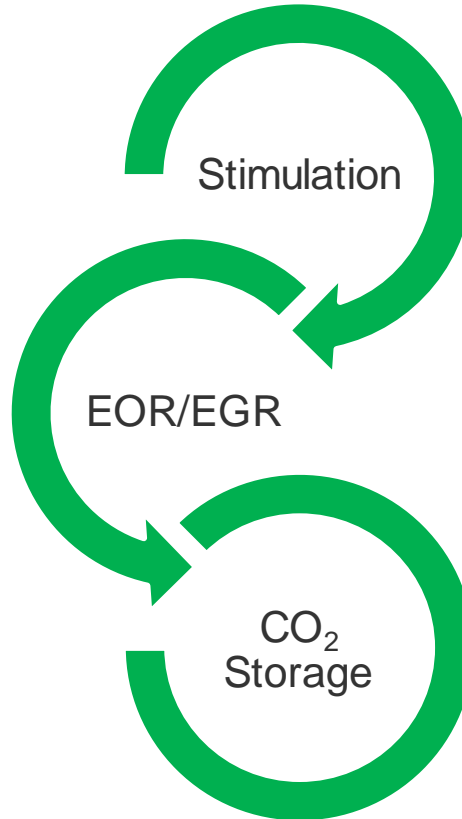
CO₂ Storage and
Sequestration

CO₂ Fracturing

CO₂ Fracturing – Current Studies

- Continuous research to find alternates to current water based fracturing fluids.
- scCO₂ as a fracturing fluid is under investigation by different researchers.
- Physical properties of scCO₂ such as extremely low surface tension and lower viscosity make it an attractive option. *(Deng, Yin et al. 2018)*
- If proved as an effective fracturing fluid, it has the potential to turn shale gas formations a possible mean for carbon sequestration. *(Middleton, Carey et al. 2015)*
- Shown in the laboratory to create more complex fracture network at around 50% lower initiation pressures than HF in shale samples. *(Zhou, Liu et al. 2016)(Zhang, Lu et al. 2017)*
- Created multiple irregular cracks with higher tendency to connect existing natural fractures than HF. *(Zhang, Lu et al. 2017)*. Similar sort of results shown by Ishida on Granite samples. *(Ishida, Aoyagi et al. 2012)(Ishida, Chen et al. 2016)*
- Zhou in his experiments on PMMA samples showed the fracture propagation rates of scCO₂ induced fractures twice faster than HF. *(Zhou, Zhang et al. 2018)*
- Higher affinity to adsorp to shale than methan, contributing in EGR. *(Khosrokhavar, Wolf et al. 2014)*

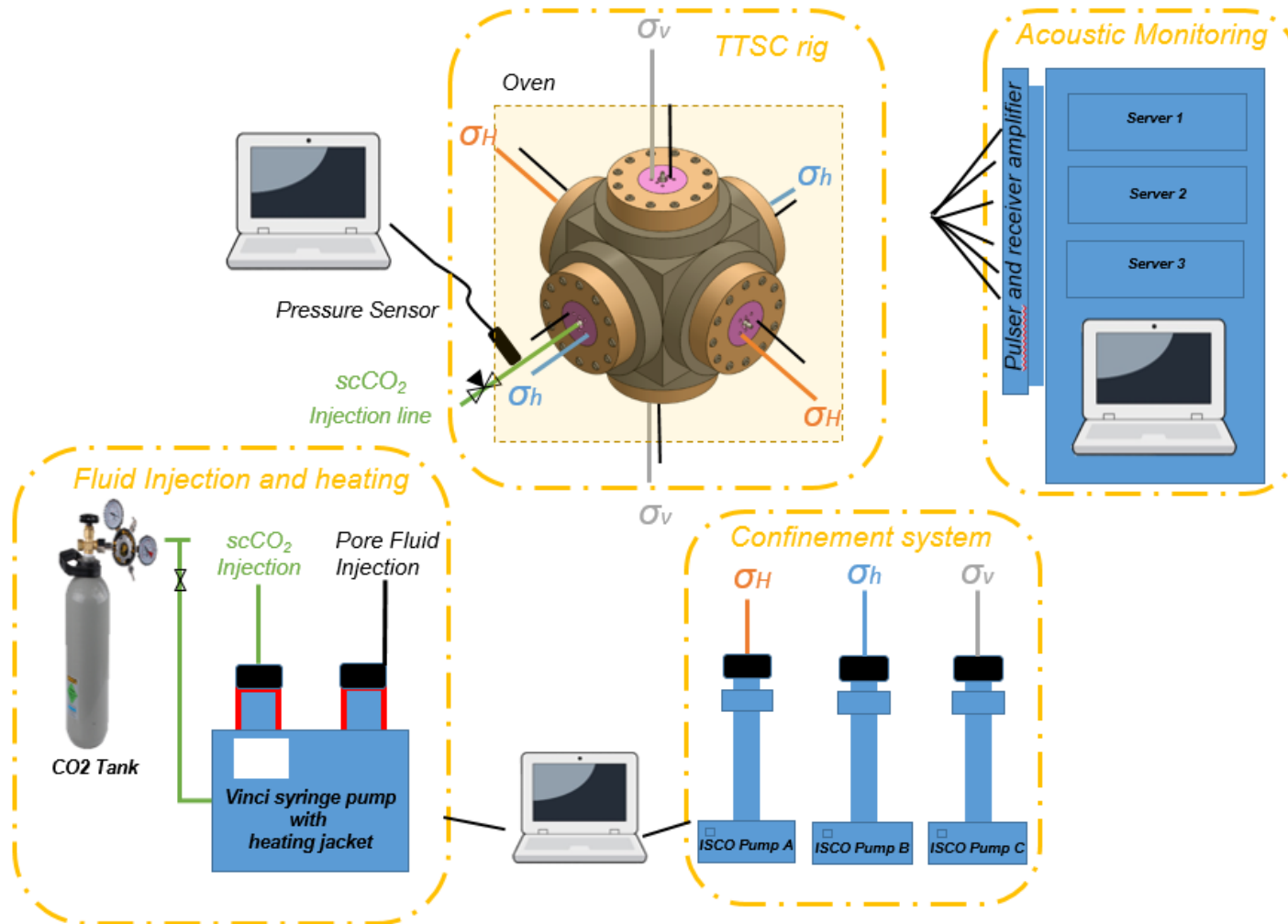
CO₂ Fracturing – playing role in low carbon economy



Problem Statement

- scCO_2 could be reactive in the subsurface environment and hence critical to understand its interaction with the host rock.
- Possible Mechanisms:
 - Extracting the organic matter
 - Dissolving and precipitation of the rock minerals
 - scCO_2 adsorption
- Possible Impacts on rock properties:
 - Geomechanical
 - Petrophysical
 - Fracture Network

State of the art Fracturing Rig



WorkFlow

Pre-Fracturing

Contact Angle Measurements

High Energy Computed
Topography Scan (CT)

Porosity and Permeability
Tests

Geo-mechanical properties
testing

Rock Mineralogical Tests

- Scanning Electron
Microscopy (SEM)
- X-ray Diffraction (XRD)
- Energy Dispersive x-ray
spectroscopy (EDS)

Fracturing Test

Micro-seismic event
recording

Pressure, Temperature
and Flow rate recording

Dynamic Stream Potential
(Zeta) recording

Production Monitoring

Post-Fracturing

CT Scans

Micro-seismic data
processing

Integration of MS data on
CT images

Contact Angle
Measurements

Porosity and Permeability
Tests

Geo-mechanical
properties testing

Rock Mineralogical Tests

Results so far

- Have got some exciting results so far which are on their way for publishing.
- Lab results so far show the significance of scCO_2 /rock/fluid interactions as changes are observed during CO_2 fracturing.
- Further testing is ongoing on different rock types to establish the screening criteria to select the best candidate reservoirs for CO_2 fracturing.

Summary

scCO₂ has the potential to replace water as fracturing fluid and can contribute positively to a low carbon economy

scCO₂/water/fluid interactions are important during CO₂ fracturing and can create changes to the host rock properties and hence should be studied in detail

THANK YOU