

Reservoir Simulation



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Agenda

1

DBI Group
Introduction

2

DBI Group's Contribution in the HENRI Project
Reservoir Simulation

3

Lessons Learned from Previous Projects in the DBI Group
Reservoir Simulation

DBI Group

➤ Introduction



Energie mit Zukunft. Umwelt und Verantwortung.

DBI
Gruppe

Milestones in the History of the DBI Group

Origin

Establishment of the gas technology department at the German Fuel Institute in Freiberg with a focus on the production, distribution and use of gaseous fuels

Spin-off

of DBI - Gastecnologisches Institut gGmbH Freiberg as a subsidiary of DBI Gas- und Umwelttechnik GmbH in order to implement non-profit research and testing more efficiently

Relocation

DBI Gas- und Umwelttechnik GmbH moves into new business premises in Leipzig ▪ Refurbishment and expansion of the test laboratories in Freiberg

Expansion

New chemical laboratories in Leipzig and new test laboratories in Freiberg

1966

1991

1998

2007

2011

2015

2018/2019

2020

Spin-off

of DBI Gas- und Umwelttechnik GmbH in Leipzig ▪ VNG, RWE, GDF were shareholders

Shareholder

The Deutsche Vereinigung des Gas- und Wasserfaches e.V. becomes sole shareholder of DBI Gas- und Umwelttechnik GmbH

Extension of departments

Gas Processing Technology and Energy Supply Systems / Renewable Energies

Restructuring

and expansion of the management in the DBI-Group



Leipzig

DBI Gas- und Umwelttechnik GmbH
Karl-Heine-Strasse 109/111
D-04229 Leipzig
Germany



Freiberg

DBI - Gastecnologisches Institut
gGmbH Freiberg
Halsbruecker Strasse 34
D-09599 Freiberg
Germany



DBI
Gruppe

Departments



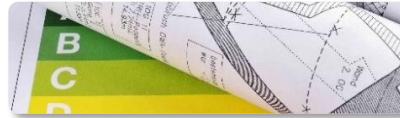
Gas Production
Gas Storage



Gas Chemistry
Gas Treatment



Gas Grids
Gas Facilities



Energy Supply
Systems/ Renewable
Energies



Gas Utilization -
Thermo Process-
ing Technology



DVGW-Test Laboratory
Energy



Gas Processing
Technology



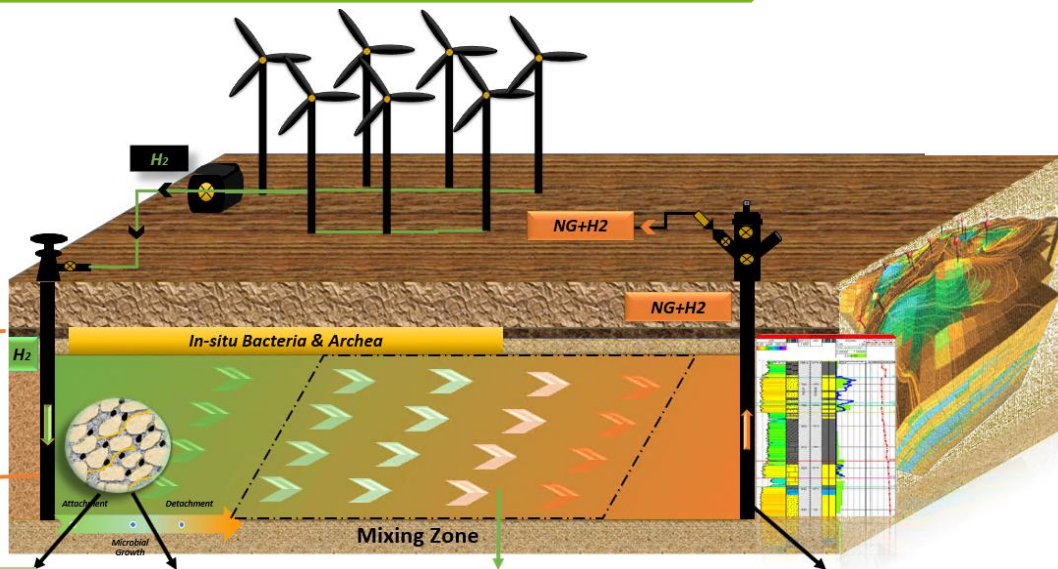
Freiberger DVGW-
Training Center Gas

DBI Group's Contribution in the HENRI Project

➤ Reservoir Simulation



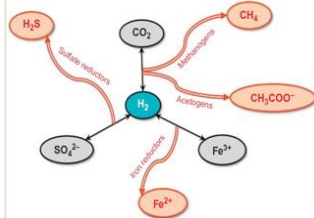
Why We Need Reservoir Simulation?



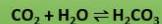
Cap Rock Integrity-
Geomechanical Stability
Hydrogen Diffusivity
Dissolution-Mineralization
Injection Rate and Volume

Joule Thomson Effect
(Thermal Simulation)
Cooling or Heat Generation
During Injection

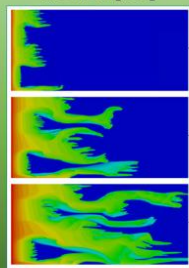
Microbial Activity in Reservoirs
(Bio-Methanation-Acetogenesis, Sulfate
reduction)



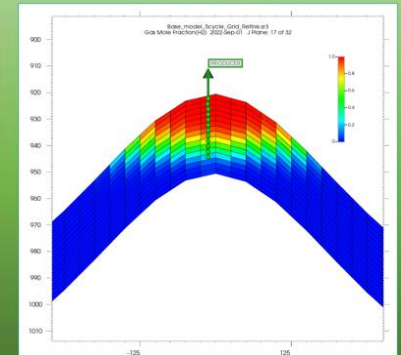
Geochemistry Modeling
(Dissolution-Mineralisation)



Viscous Fingering



Gravity Segregation



Operation Scenario
5 Injection-Production Cycle



Workpackages and Interactions with Partners

- Reservoir Simulation Modeling
 - Compositional Model Setup
 - Integrating of All Required Information in the Reservoir Model
 - Incorporating of Obtained Solubility Results from the Previous Project (Nafta)
 - » Conducted by Gas Chemistry Department in DBI Group
 - Implementation of Results from Geo-Chemistry Offer
 - » Reservoir Rock Alteration
 - » Interaction: Gas Chemistry Department in DBI Group
 - Implementation of Microbial Reactions
 - » Upscaling of Laboratory Results
 - » Interaction: MicroPro
 - Reservoir Simulation Comparison
 - » Interaction: TU Clausthal
 - Storage Operation Optimization



Reservoir Simulation Approach in Commercial Software

Reservoir Model Setup

ST 1: Compositional Model (PVT Modeling)

Gas Components (H_2 , CH_4 , ...)

Gas Properties
(Density, Viscosity, ...)

Fluid Phase Behaviour

ST 4: Feasible Operation Scenario & Prediction

ST 2: Coupling

Structural Framework

Reservoir Properties

Solubility Model

Diffusion-Dispersion

Hysteresis Effect

Lab Results-Upscaling

Methanogenesis

Acetogenesis

Iron- Reduction

Sulfate- Reduction

Bacterial Growth- Decay

Bio- Reactive Transport

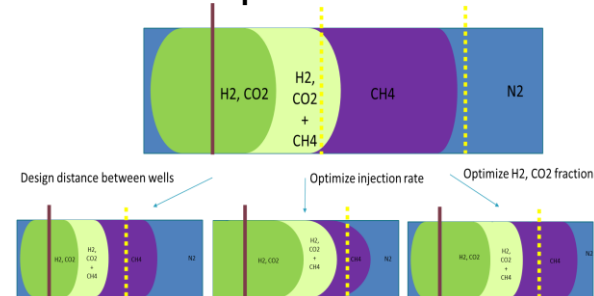
Geochemistry Modeling

pH Dependency

Salinity Dependency

Mineral-Solid/
Aqueous Reactions:
Mineralisation-
Dissolution

ST 3: Sensitivity Analysis For Optimization



- Injection Rate
- Injection Volume
- Production Rate

- Mixed Gas Compositions
- Hydrodynamic Dispersion

- Well Selection
- Well Pattern
- Suitable Area & Layer

Lessons Learned from Previous Projects in the DBI Group

➤ Reservoir Simulation



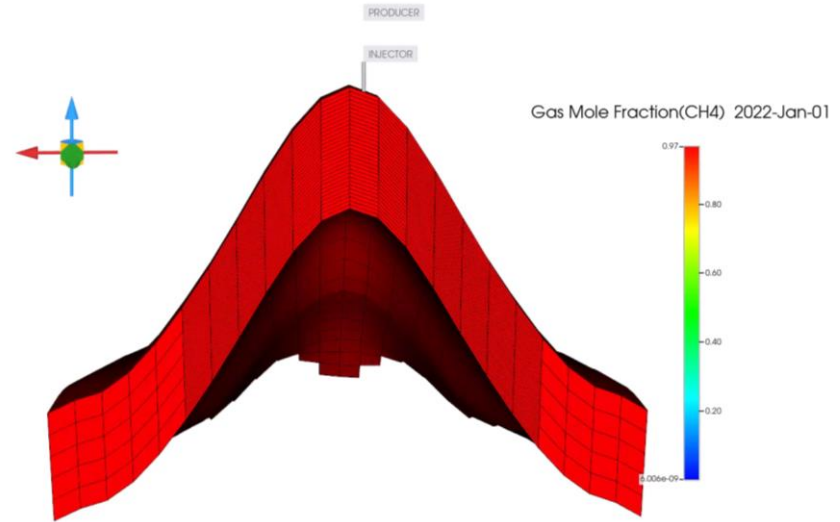
Research Project on Gas Mixing: Conversion of UGS to UHS

- Effects in Porous Media

- Interactions between storage gas, cushion gas and reservoir water
- Gas mixing behavior of hydrogen and natural gas (cushion gas) in pore reservoirs

- Gas Quality and Operational Performance

- Effects on the withdrawal gas compositions (H_2 & Natural Gas e.g. CH_4) incl. co-conveyed water
- Analysis of flow processes in the reservoir
- Requirements for surface gas treatment



Simulate & Predict Reservoir

Mixture Behavior

Fluid Flow and Transport

Hydrogen Recovery Efficiency

Reservoir Characteristics

Operation Scenarios

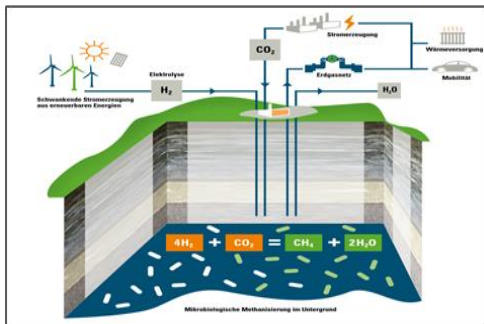
Mixing Process

Reservoir Pressure & Temperature

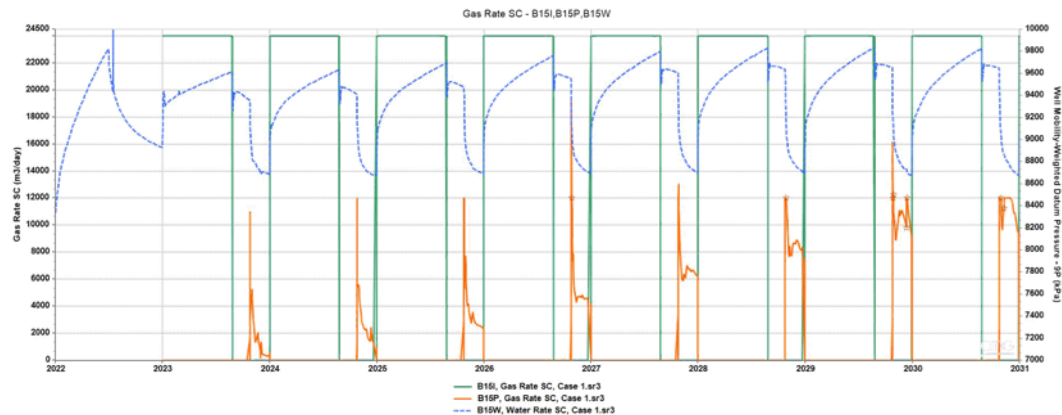
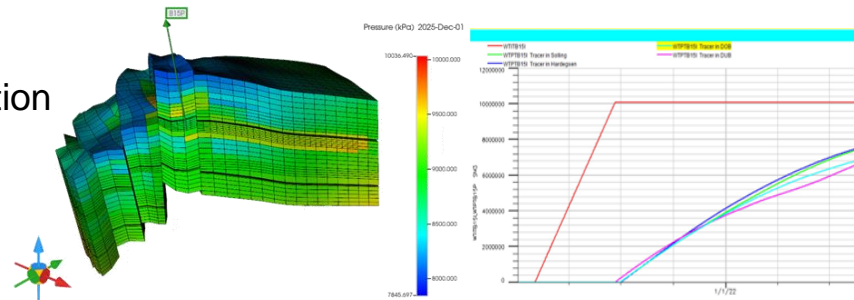
Research Projects on Underground Bio-Methanation (UMAS & Bio-UGS): Conversion of UGS to UBM

• Background

- Energy transition, integration of renewables
- Fluctuating generation of power from renewables
- Provide renewable energy independent from generation
- Carbon footprint reduction, re-cycling CO₂
- Reduction of imported fossil fuels
- → **Combining H₂, CO₂ and storage?**
- → **Underground Bio-Methanation**



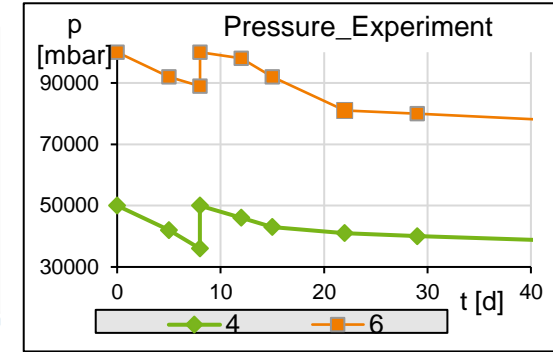
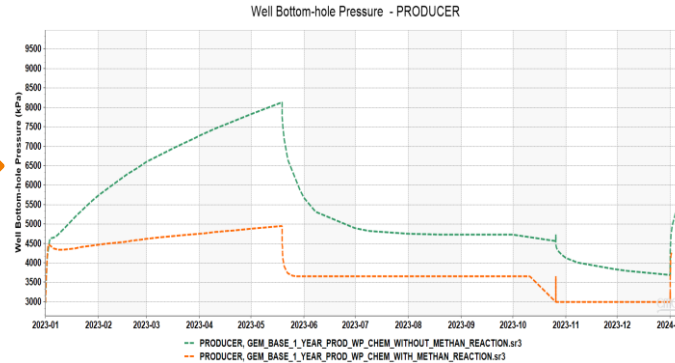
Tracer Simulation Area & Well Selection Planning for Suitable Operation Scenarios



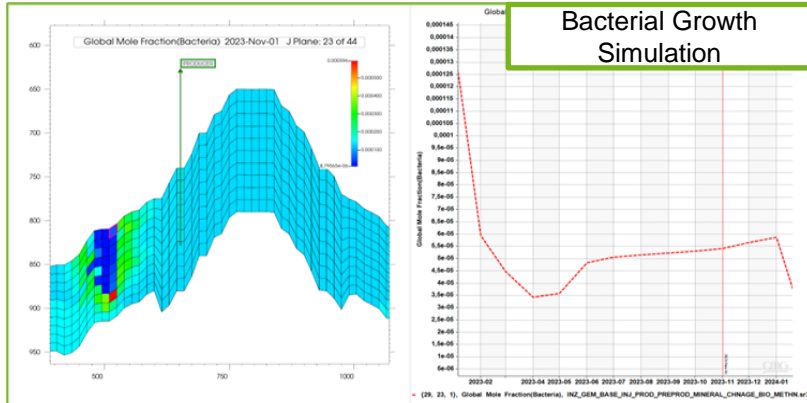
Research Projects on Underground Bio-Methanation (UMAS & Bio-UGS): Conversion of UGS to UBM

Input from Laboratory Experiment

- Conversion Rates (Bio-Methanation, Acetogenesis,...)
- Upscaling and History Matching



Implementation of UBM Process- Geochemistry Modeling in Compositional Model



Thank you very much for your attention!

Your contact

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