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Scientific Technical Report STR15/03 - Data

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# Dataset of the Back-production Test at the CO2 Storage Pilot Site Ketzin, Germany

Scientific Technical Report STR15/03 - Data

*F. Möller, S. Martens, A. Liebscher, M. Streibel:*

# Dataset of the Back-production Test at the $CO_2$ Storage Pilot Site Ketzin, Germany

## 1. Introduction

The Ketzin pilot site has been the longest-operating European onshore $CO_2$ storage site. Between June 2008 and August 2013, a total amount of 67 kt of $CO_2$ has safely been injected into a saline aquifer. It consists of 630 m to 650 m deep sandstone units of the Stuttgart Formation of Upper Triassic age. They were deposited in a fluvial environment (Förster et al., 2010). A sequence of about 165 m of overlaying mudstones and anhydrites is sealing the storage complex and act as a caprock (Martens et al., 2012).

The research and development programme at Ketzin is among the most extensive world-wide in the context of geological $CO_2$ storage (Giese et al., 2009). Research activities have produced a broad data base and knowledge concerning the storage complex at Ketzin as well as generic cognition (Liebscher et al., 2013; Martens et al., 2011-2014; Würdemann et al., 2010; Schilling et al., 2009).

This publication compiles the operational data (wellhead and in-well pressure and temperature data, produced $CO_2$ and formation water) recorded during a field experiment on $CO_2$ back-production at the Ketzin pilot site in October 2014. Anyone should feel free to make use of the published data for any ethical purpose (civil use) – for example for process modelling and engineering.

Recommended citation for this publication is:

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## 2. Motivation and overview on the course of the test

The motivation for the test was to gather data on the pressure and temperature evolvement during the back-production of $CO_2$ from the storage formation as well as getting data on the chemical composition of produced brine and $CO_2$ (not part of this publication) and on the atmospheric $CO_2$ concentrations (not part of this publication).

Figure 1 gives an overview on the whole test:

The test has been carried out between October, 15$^{th}$ and 27$^{th}$ in 2014. Various rates have been realised on startup to check the technical feasibility. Afterwards a stable rate of 800 kg/h $CO_2$ has been produced until October 20$^{th}$. From then on, the rate has been doubled to 1.600 kg/h until October 22$^{th}$. From then on $CO_2$ has been produced in an alternating switch on (at 800 kg/h during day shift) and switch off regime (during night shift).

At the end, on October 27th, the production has been ramped down to determine the point when no more formation water was produced with the $CO_2$ stream. This has been the case for rates lower than 500 kg/h $CO_2$.

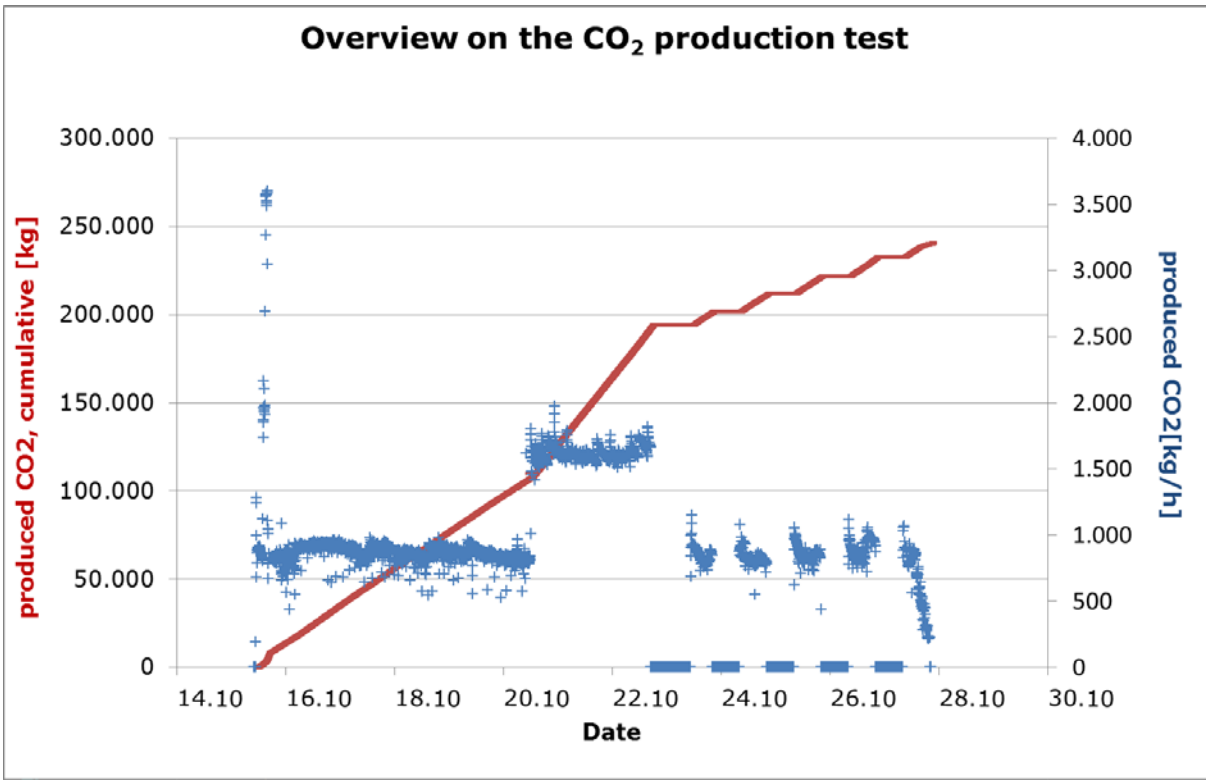


Figure 1: Overview on the $CO_2$ production test showing the rates of produced $CO_2$ (blue crosses, right axis) and the cumulative mass of produced $CO_2$ (red solid line, left axis)

# 3. Infrastructure

## 3.1. Wellbores

At the Ketzin pilot site, a total of five wellbores exists. Four of them reach down to the storage formation and one shallower well (P300) ends above the cap rock. The wells with the respective coordinates of the deep wellbores are depicted in Figure 2. An overview on the technical data of the wellbores relevant for this publication (Ktzi 201, Ktzi 203) is given in

Table 1. Further information on the wellbores can be found in Prevedel et al. (2009) and Möller et al. (2012).

Data published in this contribution refer to these wellbores as follows:

- CO2 Ktzi 201/2007 – *abbreviated as*: **Ktzi 201** (production & monitoring)
- CO2 Ktzi 203/2012 – *abbreviated as*: **Ktzi 203** (monitoring)

Table 1: Technical Overview on the Wellbores Ktzi 201 & Ktzi 203

| | Ktzi 201 | Ktzi 203 |
|---|---|---|
| **Diameter (innermost casing)** | 5 ½'' with 3 ½'' production string | 3 ½'' |
| **True Vertical Depth** | 755 m | 645 m |
| **Connection to reservoir** | Filter screens at: 632-636 m; 637-642 m; 645-649 m; 650-654 m | 631-636 m (48 perforation shots at 10 shot/m) |
| **End of injection string packer (transition to 5 ½'')** | 560 m | N/A |
| **Pressure/temperature gauge at** | 550 m | 305 m & 610 m |

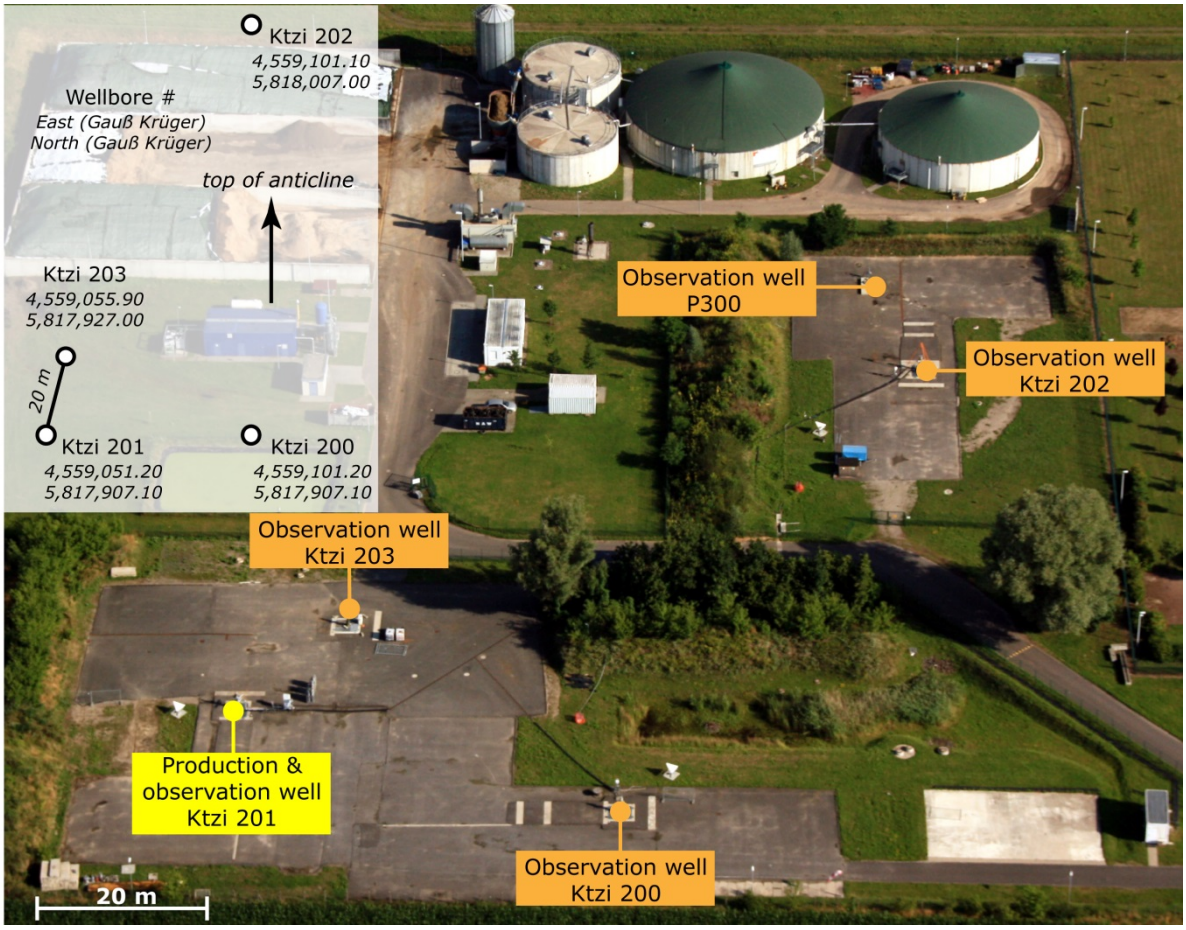


Figure 2: Aerial view on the Ketzin pilot site with focus on the wellbores.

## 3.2. Test layout

Professional equipment and personnel has been hired from an oil & gas service company to conduct the test. The piping and instrumentation flowchart is shown in Figure 3.

$CO_2$ has been released via the Ktzi 201 wellbore and passed a surface safety valve. It has then been heated to approximately 45 °C in order to avoid forming of dry ice while depressurising to atmospheric pressure in the vent-off stack ("silencer").

The flow rate has been adjusted with the choke manifold. Water from the storage formation has been separated inside the “3-phase separator”. This device is normally deployed in oil & gas applications and in this case refers to the three phases oil, water and gas. For the Ketzin case, only gas ($CO_2$) and water have been separated within the device.

Formation water has been unloaded into a gauge tank and then disposed of.

$CO_2$ has been vented to the atmosphere with a silenced vent-off stack.

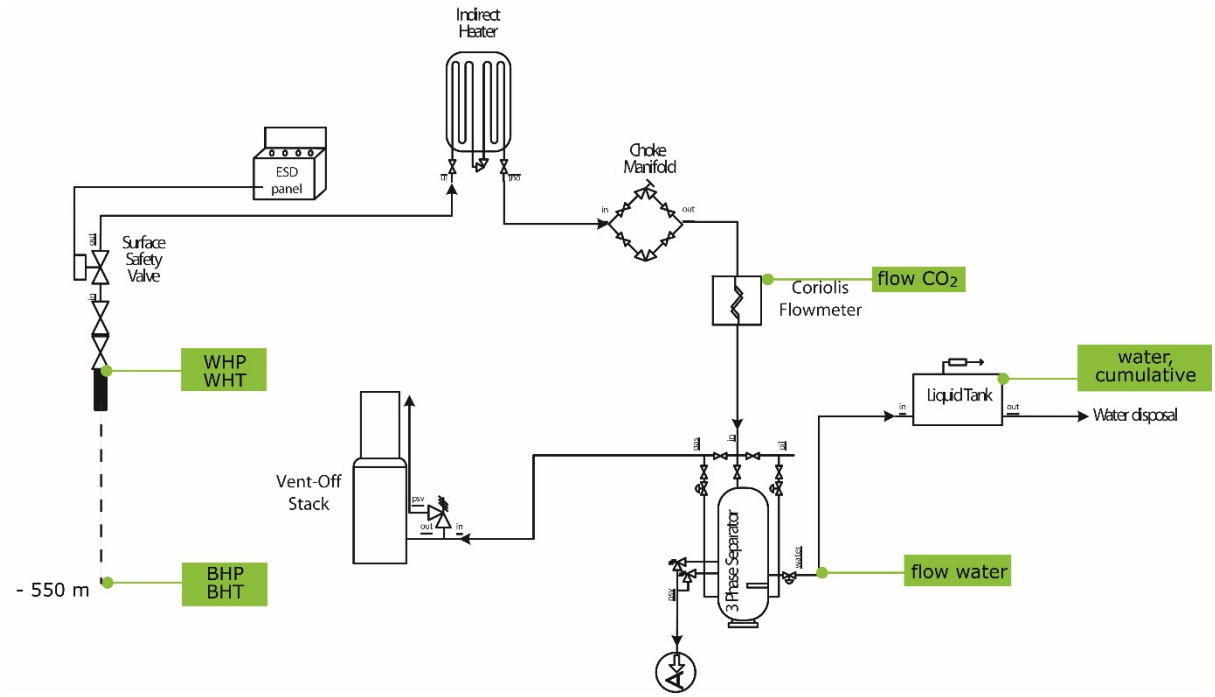


Figure 3: Piping and instrumentation flowchart for the $CO_2$ back-production test

# 4. Data acquisition and correction

All data published in this contribution have been acquired via a Supervisory Control and Data Acquisition (SCADA) system at intervals of 5 minutes.

## 4.1. Definition

Data point in this publication means the evaluated signal from a sensor (e.g. “Ktzi 201 WHP” with a certain value - e.g. “48.28 bar”)

## 4.2. Description of the data points

The following data points are published (reference to Figure 3; except Ktzi 203):

### 4.2.1. Ktzi 201 WHP [bar]

Wellhead pressure of the wellbore Ktzi 201, acquired via pressure gauges at the wellhead (Endress und Hauser Cerabar T PMP 131, 0…100 barg, accuracy >= 0.5 % of upper range limit).

### 4.2.2. Ktzi 201 BHP [bar]

Bottom-hole pressure of the wellbore Ktzi 201, acquired via fibre-optical sensor based on Bragg grating technique (Weatherford “Optical Pressure-Temperature Gauge”, 0…690 barg (calibrated with 14.7 PSI as atmospheric pressure) at 550 m depth (~ 80 m above reservoir depth).

#### 4.2.3. Ktzi 201 WHT [°C]

Wellhead temperature of the wellbore Ktzi 201, acquired via a temperature gauge.

#### 4.2.4. Ktzi 201 BHT [°C]

Bottom-hole temperature of the wellbore Ktzi 201, acquired via fibre-optical sensor based on Bragg grating technique (Weatherford “Optical Pressure-Temperature Gauge”, 25 °C … 150 °C +/- 0.1 °C.) at 550 m depth (~ 80 m above reservoir depth).

#### 4.2.5. Ktzi 203 P [bar]

Pressure (P) values at 305 m and 610 m inside the wellbore Ktzi 203, acquired via fibre-optical sensors based on Bragg grating technique (Weatherford “Optical Pressure-Temperature Gauge”, 0…690 barg (calibrated with 14.7 PSI as atmospheric pressure)).

#### 4.2.6. Ktzi 203 T [°C]

Temperature (T) values at 305 m and 610 m inside the wellbore Ktzi 203, acquired via fibre-optical sensors based on Bragg grating technique (Weatherford “Optical Pressure-Temperature Gauge”, 25 °C … 150 °C +/- 0.1 °C.).

#### 4.2.7. Produced $CO_2$ mass flow [kg/h] and cumulated mass [kg]

Measured $CO_2$ mass flow [kg/h] and cumulated mass [kg] of the produced $CO_2$. Acquired via a coriolis flowmeter (Emerson Micro Motion F 100, max. gas flow rate: 5,452 kg/h, accuracy +- 0.5 % of measured value).

#### 4.2.8. Produced water as cumulated volume [l]

Measured cumulated volume [l] of the produced formation water.

The cumulated volume has been determined manually (discontinuous records) via adding up the determined tank filling level with a sight glass and ruler attached to the (“gauge”) tank.

#### 4.2.9. $CO_2$ flow (setpoint) [kg/h]

Set point value for the $CO_2$ mass flow through the back-production facility into the atmosphere.

### 4.3. Data correction

The data for the Ktzi 201 bottom-hole pressure (BHP) and temperature (BHT) show periodic drops. Usually these occur once a day during the night. This was caused by automated restarts of the data acquisition system. Thus this data is invalid for the short reboot time and needed to be marked as “NV#” (error value; or “no value”).

## 5. Acknowledgements

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