

The Influence of the binder on the Product and Application Related Properties of Zeolite Molecular Sieves

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and

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Leipzig, 14 May 2019

Ks
Kieselsäuren

Sv
Schwefel-
verbindungen

Ms
Molekularsiebe

Outline

- Introduction
- Manufacturing of zeolite molecular sieves
 - Binder containing zeolite granulates
 - Binderfree zeolite granulates
- Lab-scale tests for determination zeolite properties
 - Behavior under applied stress
 - Breakthrough properties
- Summary

Introduction



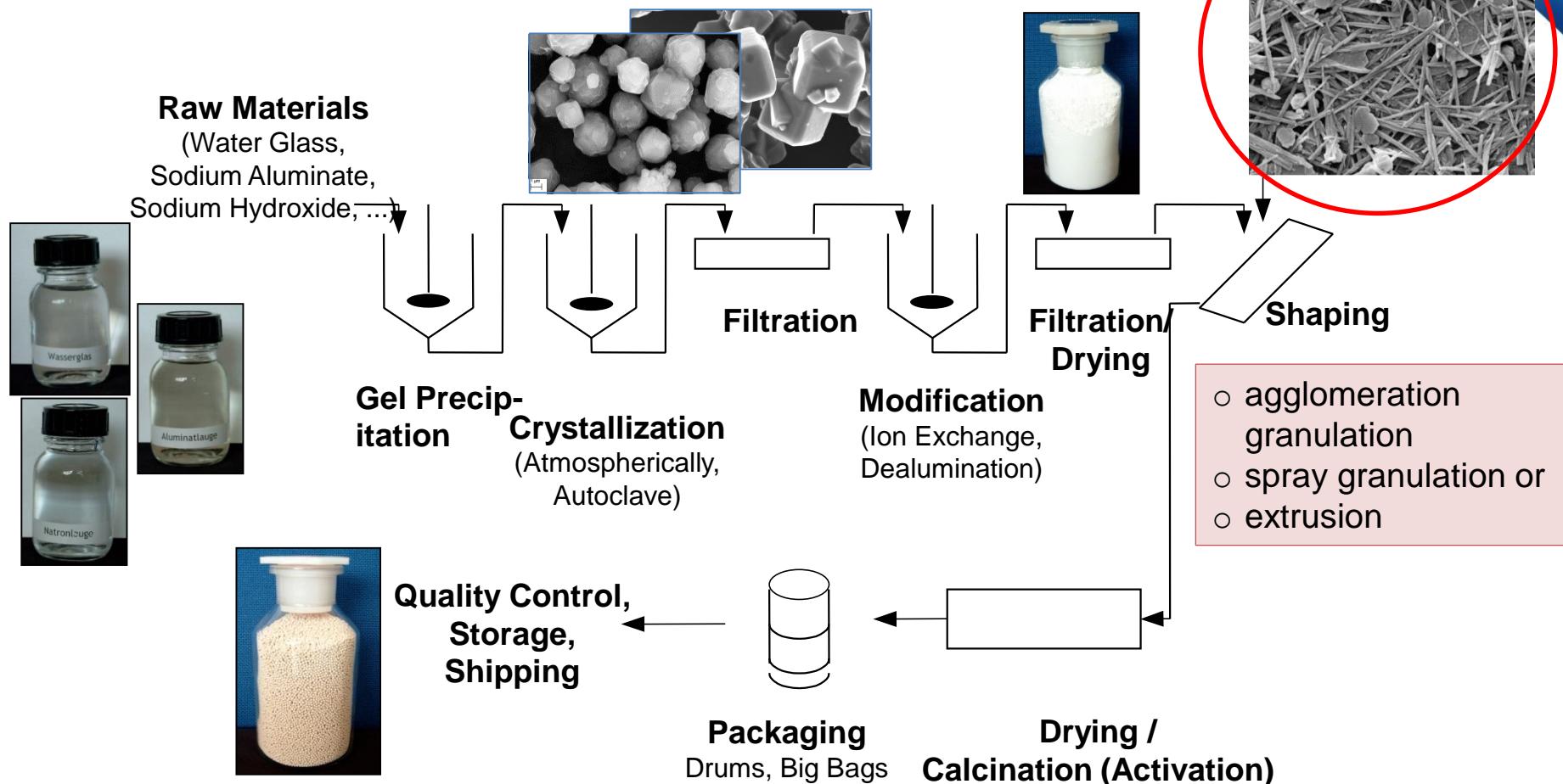
J. Pendergast, DOW Chemicals

Separation techniques: Distillation, Drying, Extraction, Adsorption...

Separation substances are a main task in many industries

During production attention must be paid to defined product characteristics

Manufacturing Process



Binder Material

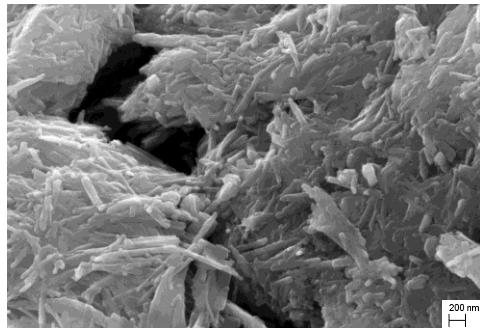
- Mineral binders and/or synthetic binders
- Binder material type and amount influences
 - bulk density
 - strength
 - attrition
 - adsorption kinetics
 - behavior under harsh conditions (temperature/concentration shocks)

Binder Material

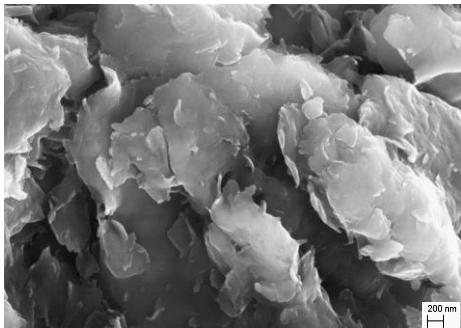
Synthetic Binder Material

- Silica
- Water glass
- ...

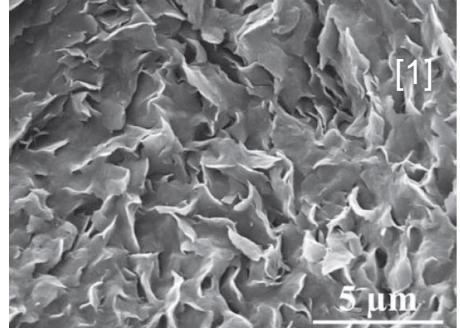
Mineral Binder Material, e.g.



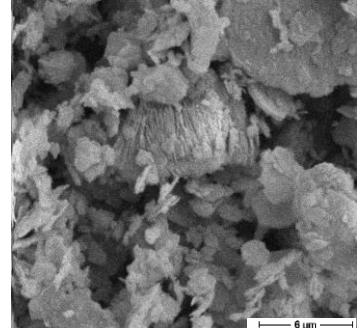
Attapulgite



Sepiolite



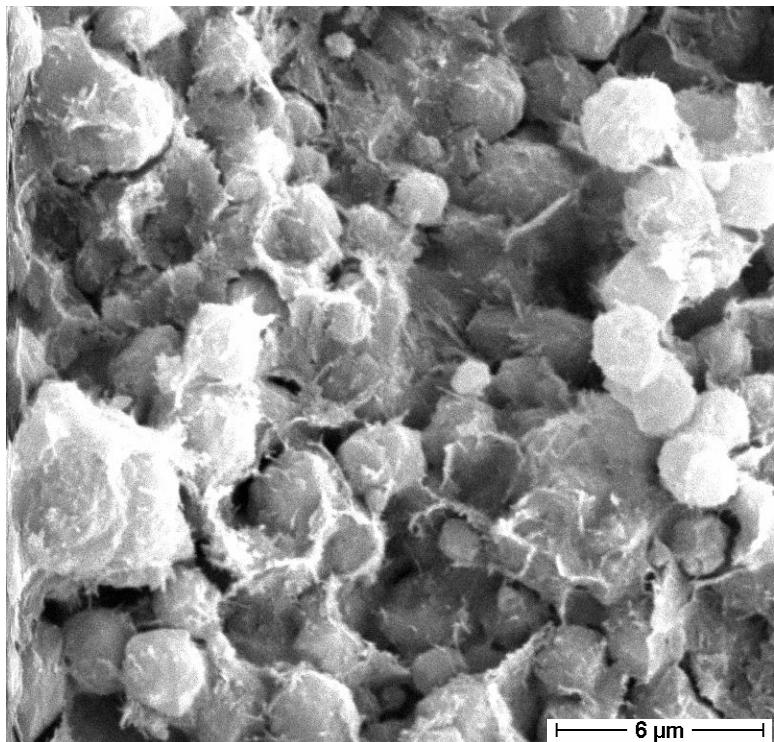
Bentonite



Kaolinite

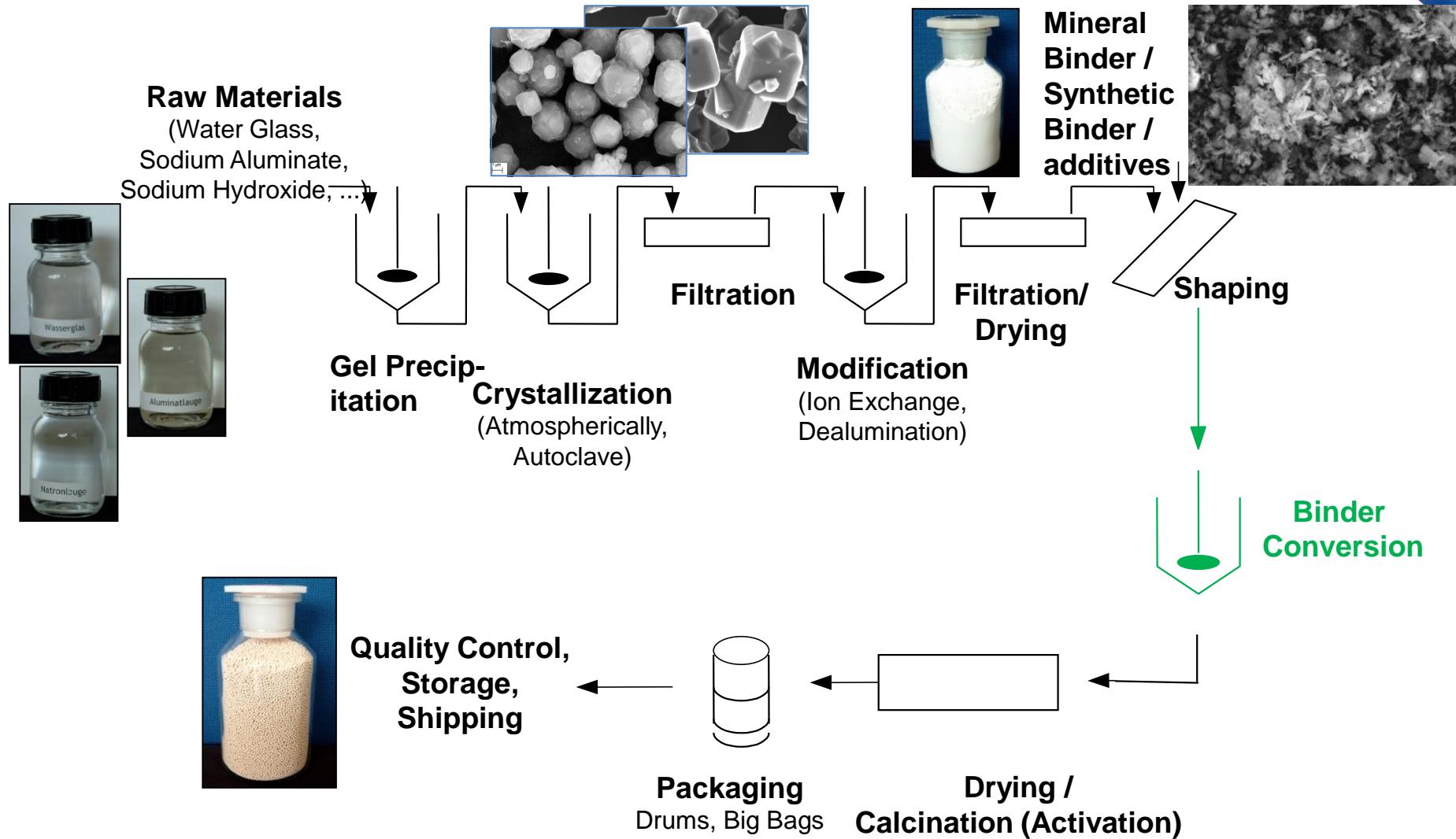
[1] B. Ullrich, M. Dietze, F. Haubrich, Journal of Central European Geology, 56/2, 2010, 115-125

Binder Containing Zeolite Beads

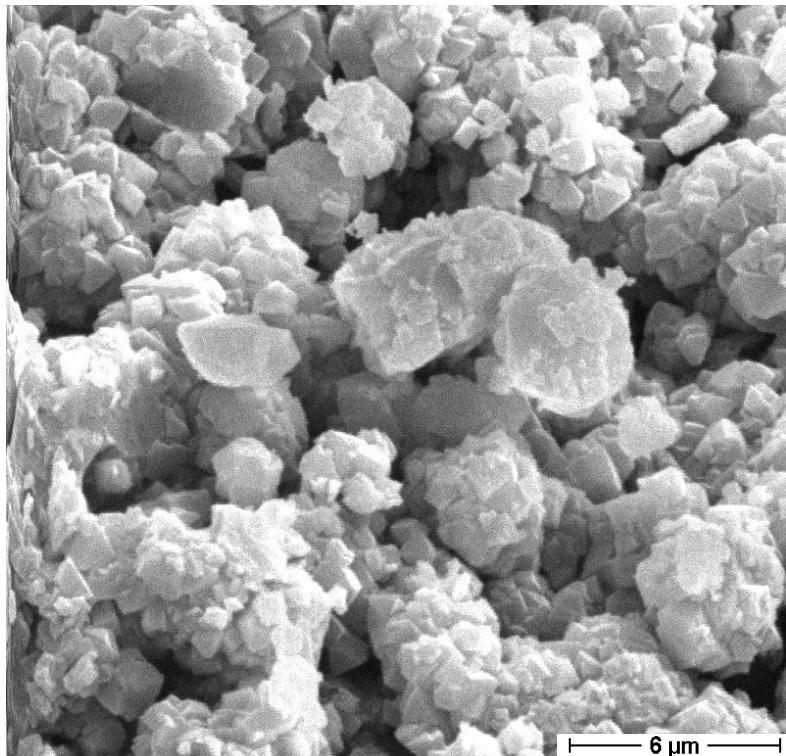


- Binder containing zeolite NaMSX
(zeolite 13X = Si/Al = 1.25 /
zeolite NaMSX = Si/Al ~ 1.17)
- Attapulgite bonded
binder ,net'
Zeolite crystals
- Mechanical stability through embedding
of zeolite crystals into the binder net

Manufacturing Process



Binderfree Zeolite Beads



- Binder-free zeolite NaMSX
- Mechanical stability through intergrowth of zeolite particles
- Adsorption capacity higher than for binder containing zeolites (similar to pure zeolite powder)
- Faster kinetics through better access to the interior of the bead
- BUT: Due to the higher capacity and faster adsorption kinetics larger adsorption heat amount leads to destruction of bead shape (only in case of liquid water)

Lab-scale tests for determination of zeolite properties

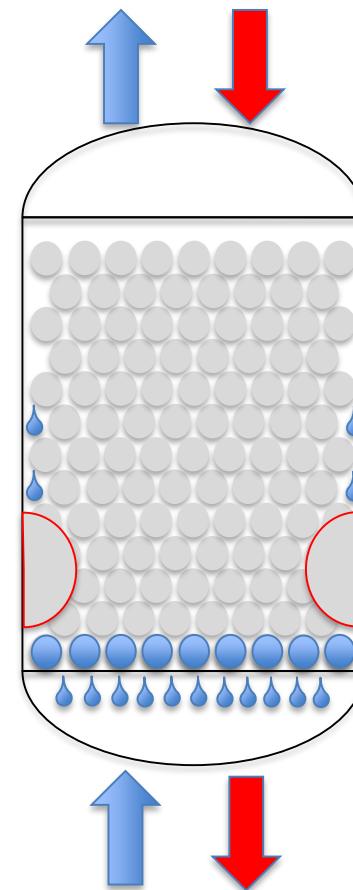
main tasks of an adsorbent:

- selectivity
- high capacity
- good kinetics
- process stability

Lab-scale tests for determination of zeolite properties

process stability:

- thermal stress,
- spill or carry over resistance,
- binder leaching resistance



Lab-scale tests for determination of zeolite properties

Behavior under applied stress:

- Cyclic-Burst-Unit
- Adsorption-Desorption-Test-Device
- Breakthrough-Unit

Lab-scale tests for determination of zeolite properties

Cyclic-Burst-Unit:

- a full cycle contains two steps:
 - Heating out the material at 300 °C,
 - Drop the activated and still hot material into water
- Only applicable for binder containing granules

Lab-scale tests for determination of zeolite properties

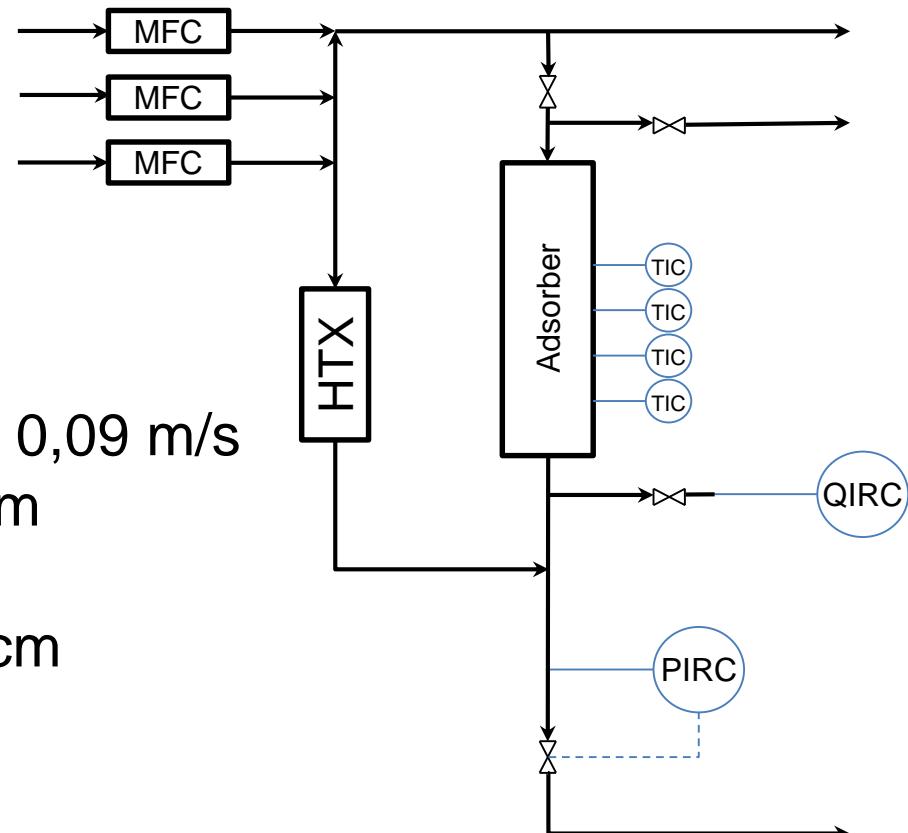
Adsorption-Desorption-Test-Device

Lab-scale tests for determination of zeolite properties

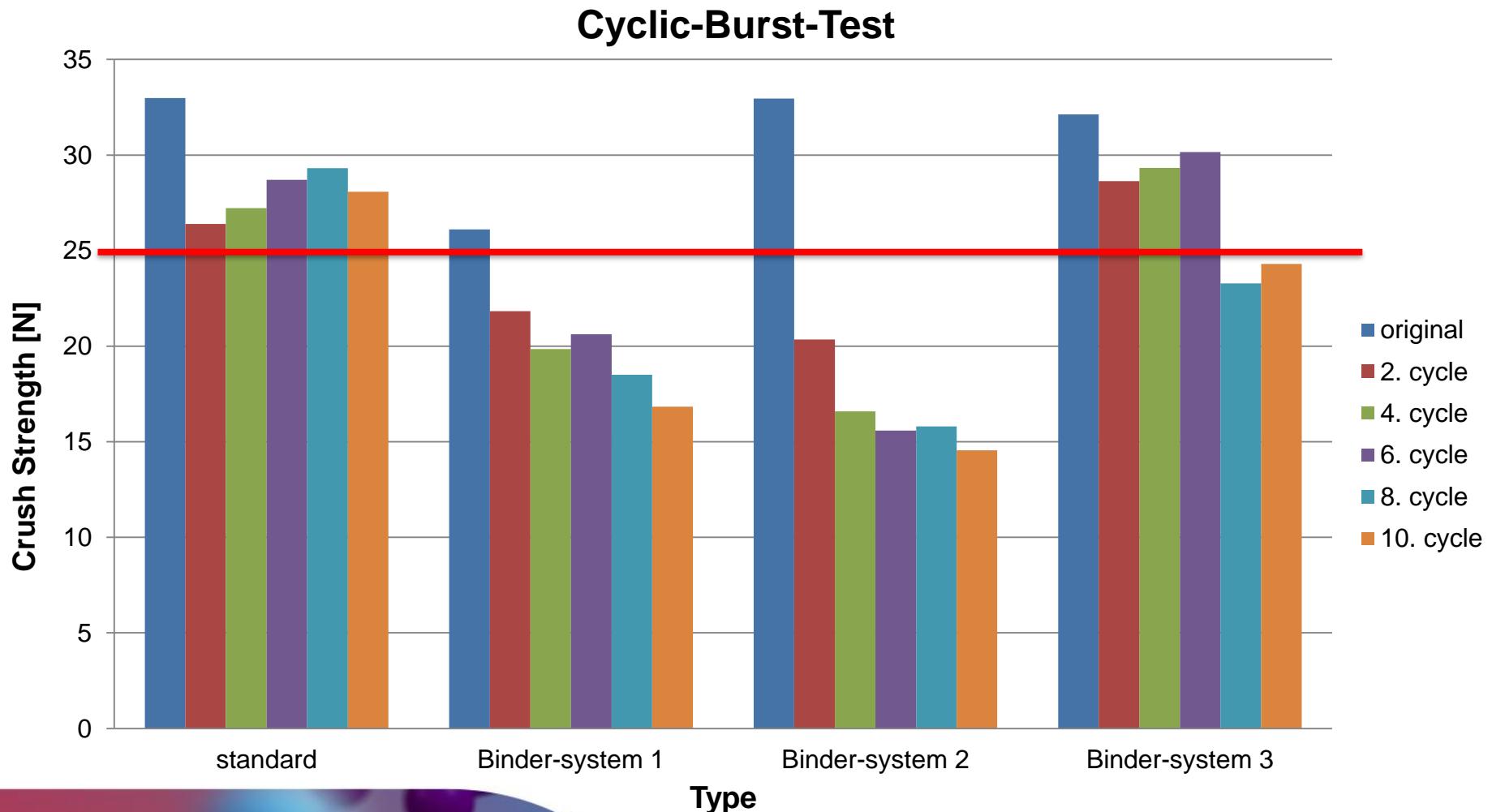
Breakthrough properties

Test-Conditions:

- Temperature: RT
- Pressure: 5 bar a,
- Superficial velocity: approx. 0,09 m/s
- CO₂-Concentration: 445 ppm
- Constant bulk height of 96 cm

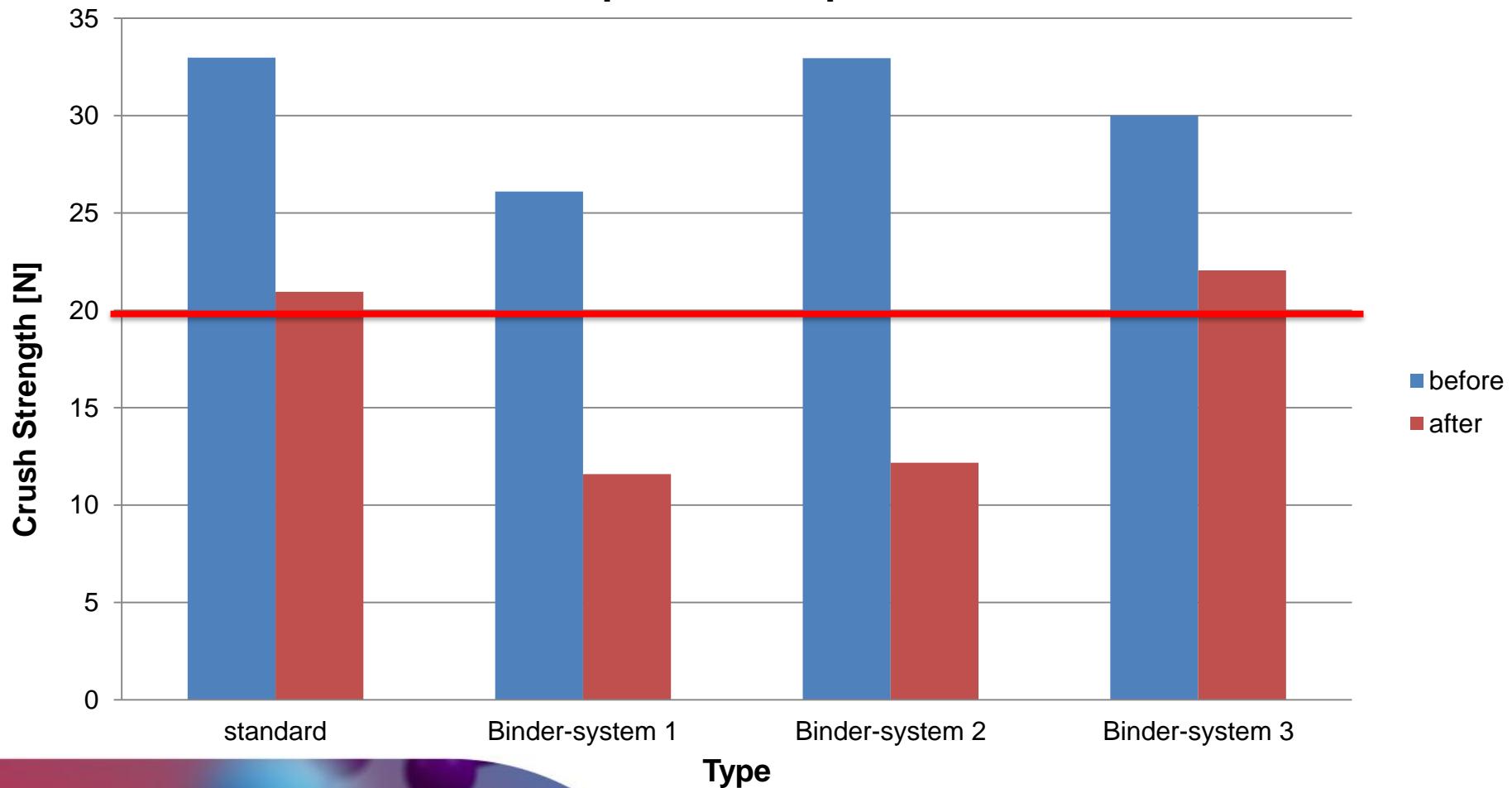


Lab-scale tests for determination of zeolite properties



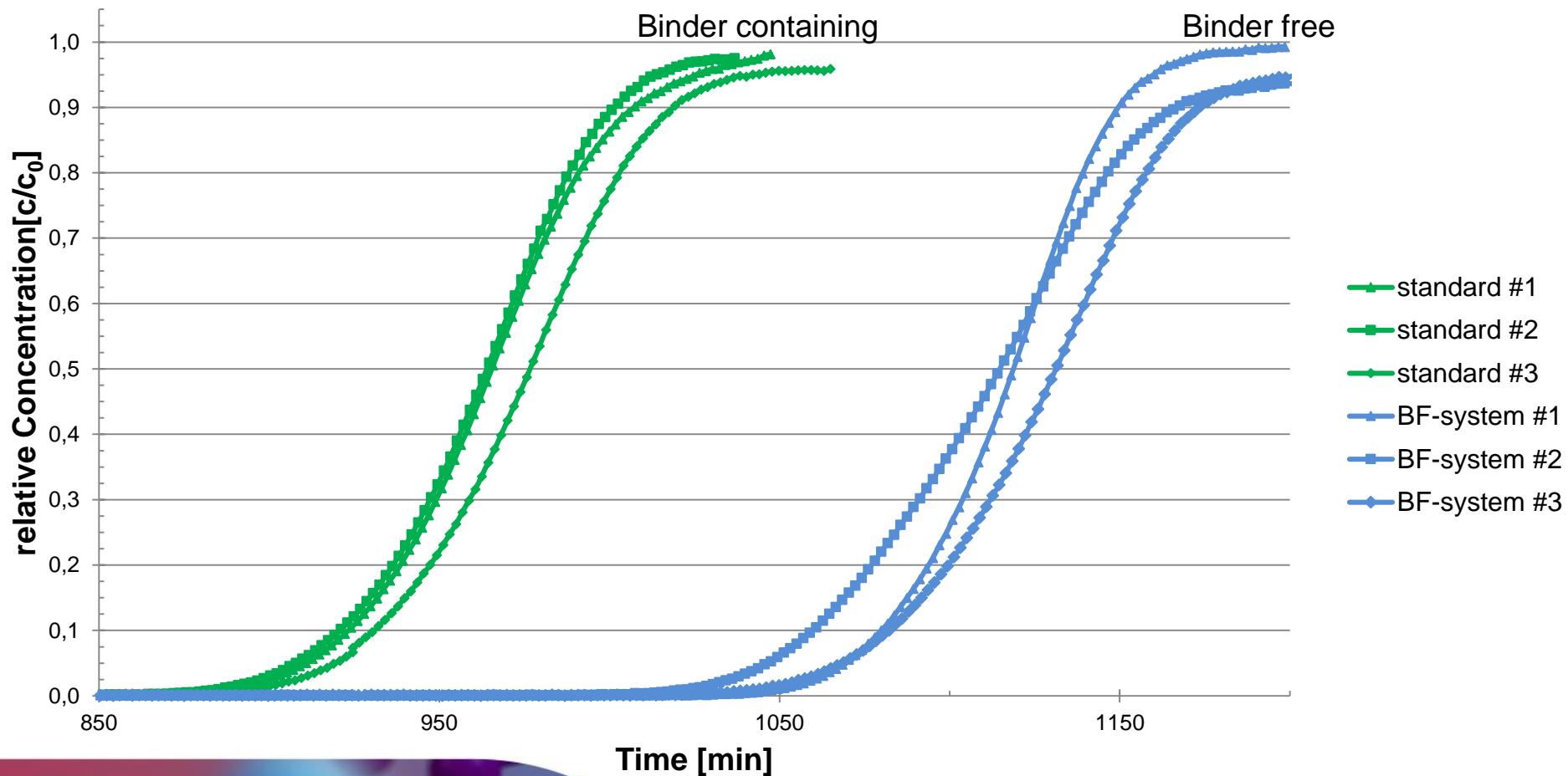
Lab-scale tests for determination of zeolite properties

Adsorption-Desorption-Test



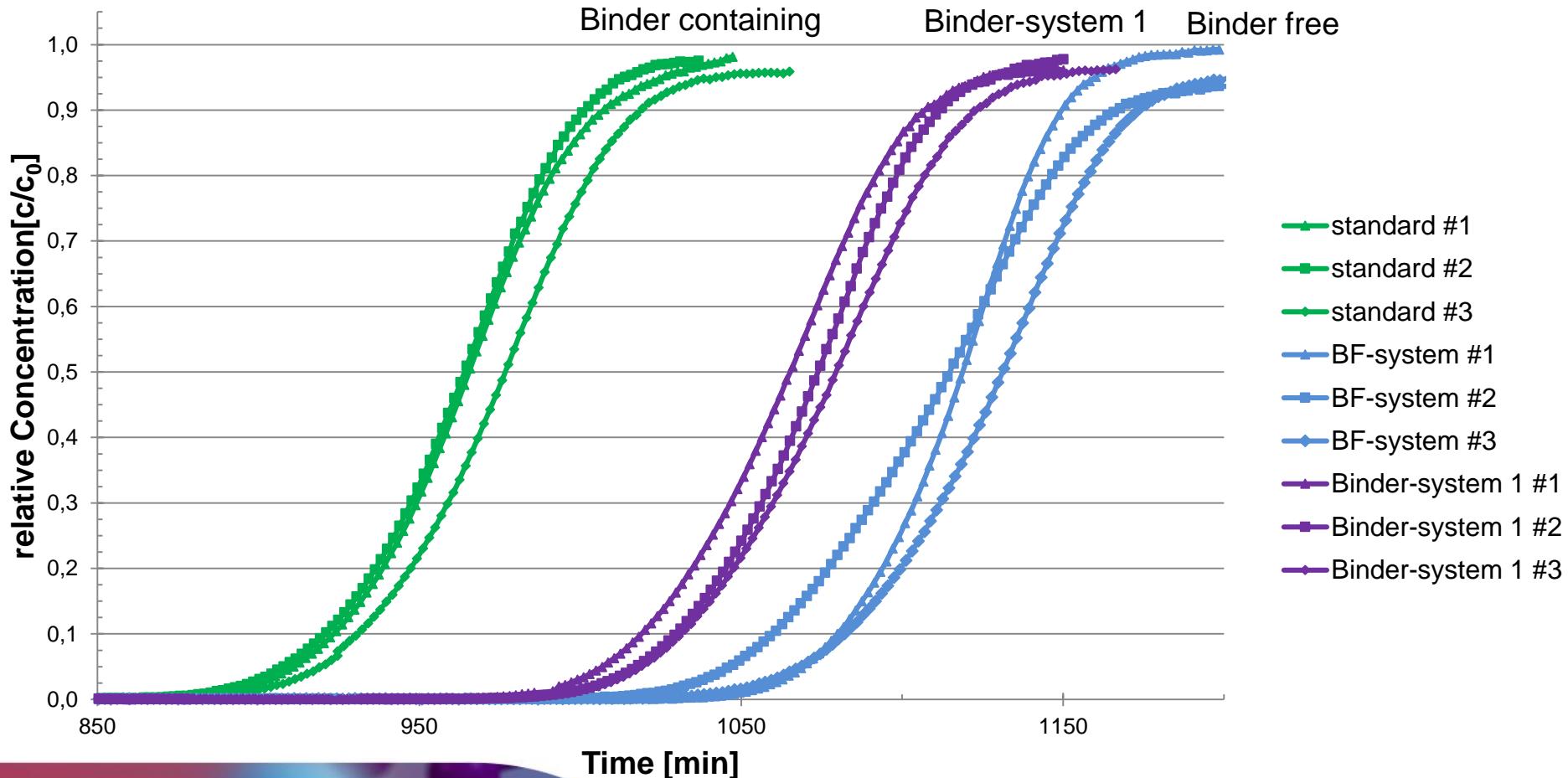
Lab-scale tests for determination of zeolite properties

CO₂ - Breakthroughcurves on different CWK-Materials



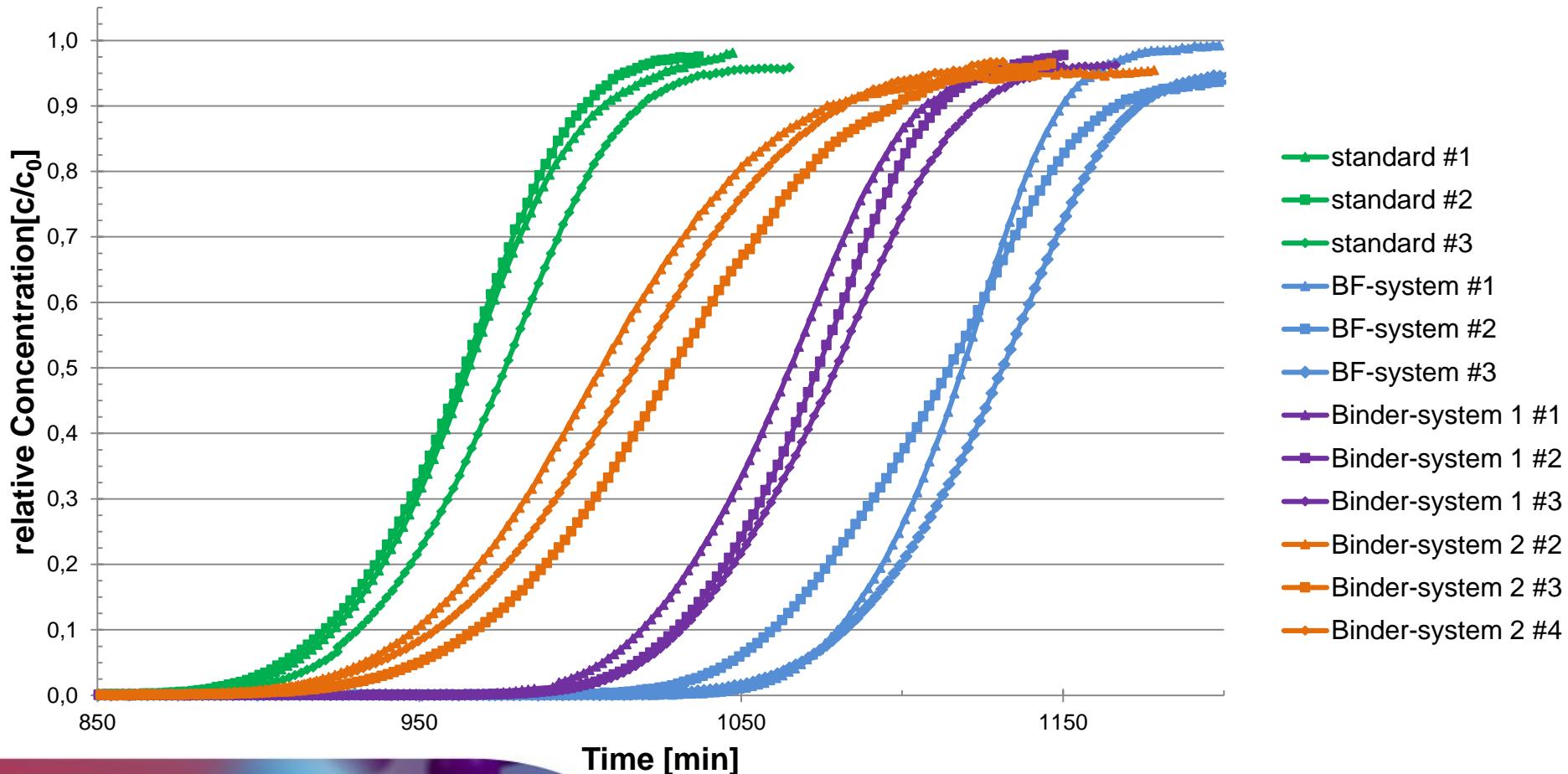
Lab-scale tests for determination of zeolite properties

CO₂ - Breakthroughcurves on different CWK-Materials



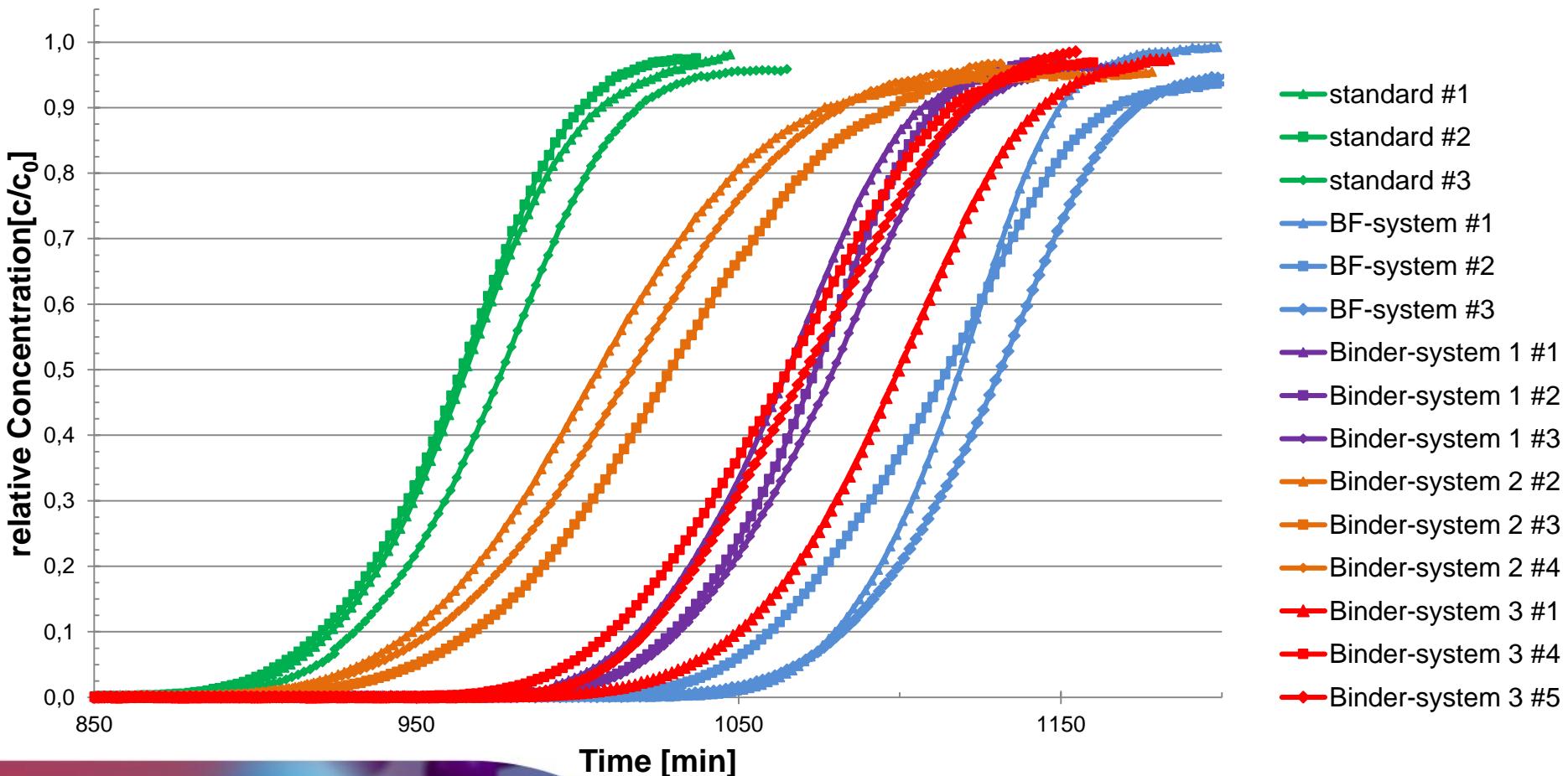
Lab-scale tests for determination of zeolite properties

CO₂ - Breakthroughcurves on different CWK-Materials



Lab-scale tests for determination of zeolite properties

CO₂ - Breakthroughcurves on different CWK-Materials



Summary

Investigated several new binder-systems

Identified a systems that fits well to the well known standard material

- mechanical and application stress tests fulfilled
- further investigations in breakthrough behavior needed

CWK - IHR CHEMIEPARTNER MIT SUBSTANZ

R

Rentabilität

Sc

Schnelligkeit

Tr

Transparenz

K

Kompetenz

Ks

Kieselsäuren

Er

Erfahrung

E

Effizienz

S

Sicherheit

Sv

Schwefel-
verbindungen

Fa

Fairness

P

Partnerschaft

In

Innovation

Ms

Molekularsiebe

14

Si

Silicium

8

O

Sauerstoff

13

Al

Aluminium

16

S

Schwefel

An

Anlagenbau

La

Landwirtschaft

H

Holzindustrie

Rf

Raffinerie

El

Elektronik

Ke

Keramik

L

Lebensmittel

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CKW
Weil die Chemie stimmt.

Specific CO₂-Capacity of different Binder-Systems at the Beginning and the End of a CO₂-Breakthrough

