Dynamic Investigation on the Adsorption of *n*-Alkanes on Polymer-based Activated Carbons

R. Eschrich[1], A. Möller[1], C. Reichenbach[1], D. Klank[1], D. Richter[2], B. Böhringer[2],

[1] Quantachrome GmbH, Odelzhausen/D

[2] Blücher GmbH, Erkrath/D

Introduction

The separation of higher hydrocarbons from natural gas is a necessary step to reduce the dew point. For this purpose, adsorptive separation processes can be applied. For the design of industrial adsorbers, a comprehensive analysis of the adsorption behavior of the adsorbents to be used under process-near conditions is necessary.

Here, both Co-adsorption effects as well as different sorption kinetics play an important role. In general, experimental data are available only to a very limited extent since, in most cases, only sorption equilibrium data, *i.e.* which are not sufficient for a comprehensive understanding of the overall process.

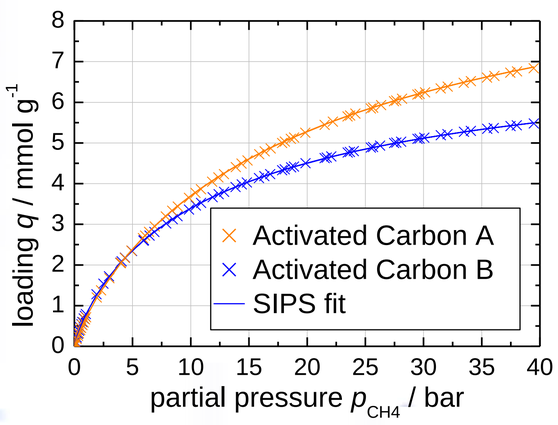
Characterisation of Activated Carbons

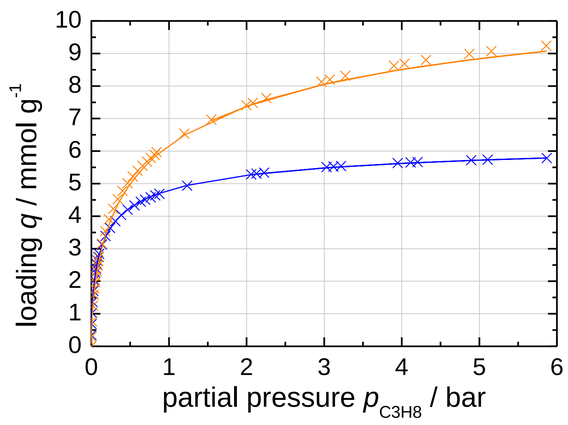
- Model system: mixture of adsorptives propane and methane
- Adsorbents: two fully synthetic microporous activated carbons from Blücher® GmbH
- Measurement of the methane (CH_4) and propane (C_3H_8) isotherms at 40 °C
- Fitting procedure with the SIPS isotherm model

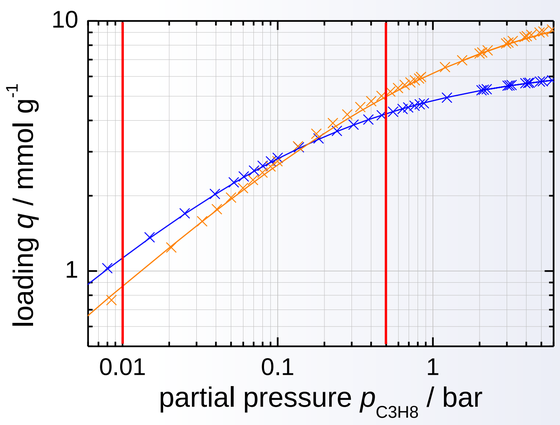
Activated Carbon A A_{BET} = 1843 $m^2\ g^{-1}$

Activated Carbon B A_{BET} = 1305 $m^2\ g^{-1}$

iSorb HP1







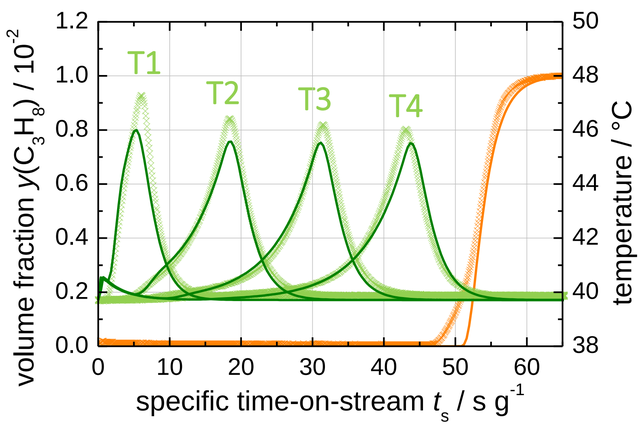
Propane-Isotherms intersect at **0.15 bar**

→ Higher Propane loadings for Activated Carbon B at p < 0.15 bar and for Activated Carbon A at p > 0.15

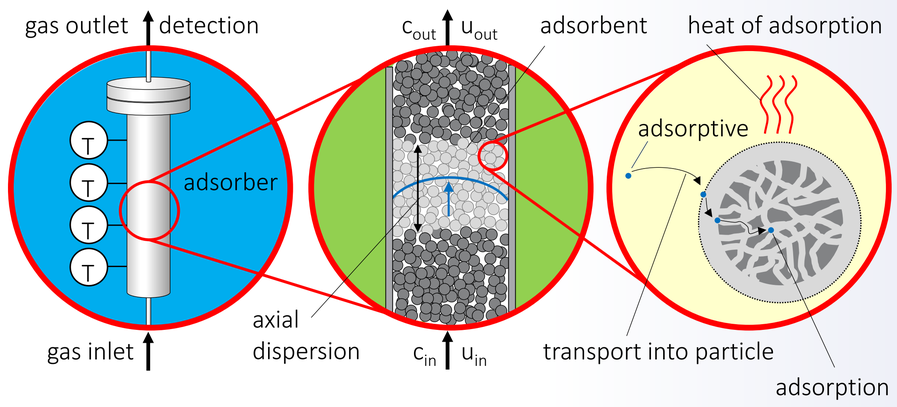
→ Verification with Breakthrough experiments with Propane partial pressures of 0.01 bar and 0.50 bar

Breakthrough Curves: Experiments and Simulation

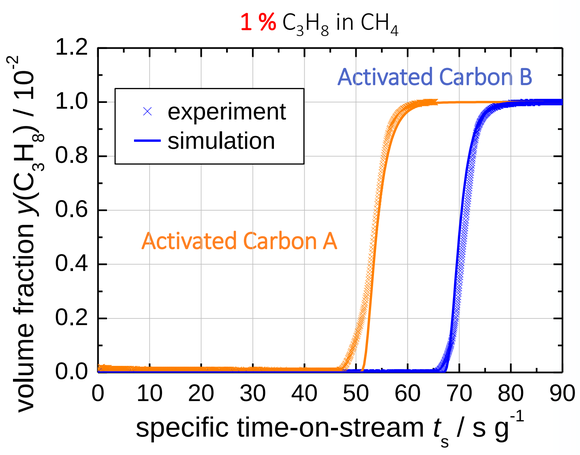
- Measurements at 1 bar, 2 L min^{-1} and 40 °C
- Gas mixtures 1 % C_3H_8 in CH_4 and 50 % C_3H_8 in CH_4
- Measuring the isotherms at 20 °C, 40 °C and 60 °C with the iSorb HP for dynamic simulations → extended Standard Characterization

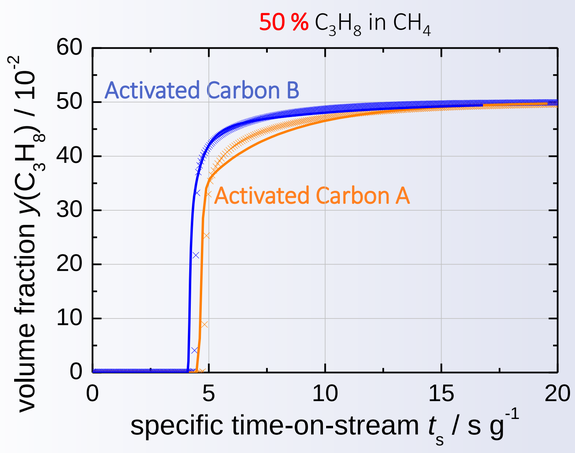


- **Simulation** (straight lines) can describe breakthrough curve as well as course of temperatures well.
- Activated Carbon B shows better separation performance with 1 % C_3H_8 in CH_4 (later breakthrough) and Activated Carbon A a better separation performance with 50 % C_3H_8 in CH_4
  → reverse order of suitability for separation processes
  → This behavior **cannot** be explained with the **BET** surfaces



dynaSorb BT





The optimum adsorbent for different concentrations can be selected using a combination of application-oriented measurements and simulations.

Conclusions

In this study breakthrough curves of the propane / methane model system were measured on two fully synthetic activated carbons of the company Blücher® with different BET surface areas and were evaluated using a simulation model consisting of mass- and energy balances. For these investigations the commercially available dynaSorb BT instrument and the corresponding simulation software dynaSim were used.

By measuring the pure component isotherms it could be estimated that activated carbon A has a higher separation performance at high and activated carbon B a higher separation performance at low propane partial pressures. This was confirmed by simulations and measurement of breakthrough curves. This underlines the versatility of the carbons used as well as the performance of the simulation software and the measurement setup.

www.quantachrome.de

Quantachrome GmbH & Co. KG
Rudolf-Diesel-Straße 12
D-85235 Odelzhausen

Tel. +49 8134 9324 0
Fax. +49 8134 9324 25
info@quantachrome.de