Dynamic Sorption **Breakthrough** Analyzer

- Breakthrough Curves
- Technical Adsorbents
- Material Research
- Chemical Engineering
- Energy Storage
- Gas Storage
- Separation Technologies
- Environmental

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INTRODUCTION
Technical adsorbents such as active carbons, zeolites and silica gels are widely used in adsorptive separation processes on a multi-ton scale. The after-treatment of exhaust gasses, the removal of carbon dioxide in biogas plants, purification and fractionation of natural gas, air separation, respiratory protection and separation of isomers are just a few examples where adsorptive separation is employed as the most efficient and economic separation technique. A complete understanding of the complex processes taking place in a fixed bed reactor is the key to achieving the best separation performance.

The dynaSorb BT™ series provides unique capabilities to investigate arbitrarily complex dynamic sorption processes in a uniquely safe and easy-to-use bench-top instrument. Technical adsorbents can be investigated under authentic process conditions in a broad temperature and pressure range with adjustable gas flow rates and well-defined gas compositions.

ADSORBER
The stainless-steel adsorber can accommodate representative sample amounts (up to 100 ml) to simulate an authentic fixed bed adsorber with realistic gas flow conditions. Four temperature sensors along the adsorber axis monitor the release/consumption and propagation of heat within the fixed bed due to adsorption/desorption of gas molecules. The direction of gas flow through the adsorber can be switched between up- and down-stream to allow investigation of bed regeneration, adsorption-desorption cycles, and long-term stability of the adsorbent. Sample preparation can be performed in-situ using either inert gas flux or vacuum at temperatures up to 400 °C. Tempering of the inlet gas and the adsorber allows for uncompromised temperature control throughout the measurement. High precision mass flow controllers are used for quick and stable gas mixing and flow rate control. The adsorber pressure is regulated automatically up to 10 bar and a differential pressure detector monitors the pressure drop between adsorber inlet and outlet.

- Determination of breakthrough curves
- Investigation of kinetic performance of adsorbents
- Investigation of co-adsorption and displacement phenomena
- Determination of sorption selectivity
- Reasonable downscaling of technical separation processes
- Dynamic adsorption and desorption experiments
- Determination of single- and multi-component adsorption data
- Investigation of heat profiles along the adsorber bed
SAFETY
A robust adsorber design, protective doors, an illuminated working area, and a clearly structured PC-control interface assure a safe and convenient instrument operation. The adsorber pressure is continuously measured and displayed on the front of the instrument, even if the instrument is turned off. Signal lights turn on when the heating mantle temperature exceeds 80°C, indicating an elevated temperature in the work area. Safety guard sensors for the detection of flammable gasses are standard in all dynaSorb BT™ instruments. In the event of a gas leakage the instrument is brought to an idle state and shut off automatically.

SIGNAL DETECTION
The adsorber outlet gas composition is measured with a built-in TCD situated in a thermostatted environment for most precise and stable signal detection. The TCD is pre-calibrated by the manufacturer for 13 common gas mixtures. You are working with a different system? No problem! Due to fully automated bypass calibration, almost any binary mixture can be detected.

The additional mass spectrometer control capability allows for the quick and easy interfacing of an optional mass spectrometer.

FEATURES
- Easy and intuitive PC-control
- Automated processing of sequential adsorption and desorption experiments
- In-situ sample preparation
- Countercurrent gas flow capability
- Automated regulation of the adsorber pressure up to 10 bar
- Up to 4 high precision mass flow controllers
- Automated built-in gas mixing
- Measurement of inlet and outlet gas composition
- Pre-tempering of inlet gas and tempering of adsorber
- Determination of heat profiles within the adsorber bed with four temperature sensors
- Monitoring of pressure drop along the adsorber
- Built-in thermal conductivity detector (TCD)
- Optional gas analysis via interfaced Mass Spectrometer
- Safety guard sensor for flammable gases for automatic shut down
- Enhanced Safety by intelligent illuminated workspace
BENEFITS

Large Flow Range
Investigation of mixture equilibrium and kinetics, downscaling of technical processes.

Tempered Inlet Gas and Adsorber
For uncompromised temperature control during the measurement.

Built-in Sample Preparation Up to 400°C
Investigation of hydrophilic materials (i.e., Zeolites and silica gels).

Linear Heating Rates Up to 10 K/min
Slow and controlled heating of sensitive materials.

Automated Gas Mixing
No need of multiple pre-mixing gas tanks, increasing of flexibility of measurement conditions.

Automated Counter Current Operation
Downscaling technical PSA-processes.

PC Control and Data Acquisitions
Completely programmable for operator-free analysis

Four Temperature Sensors In Column
Monitoring of heating profiles during adsorption and desorption processes.

Differential Pressure Sensor
Observation of pressure drop in the column.

Built-in Thermal Conductivity Detector (TCD)
Automated time-resolved measurement of outlet gas composition.

Bypass Connection
Measurement of inlet gas composition before analysis.

Automated Pressure Regulation
Completely programmable for operator-free performing of pressure steps.

Optional Gas Analysis Via Interfaced MS
Investigation of ternary and more complex systems.

Battery-Backed Pressure Display
Monitoring of column pressure, also in powered-off state.

Safety Guard Sensor
Automatic shut down and warning in PC software after reaching 1% CxHy in manifold (i.e., caused by leaks).

Switching Illumination
Light in working area switched from white to red, if the column temperature above 80°C (preventing of accidents by hot surfaces).

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adsorber</td>
<td>1</td>
</tr>
<tr>
<td>Number of mass flow controllers¹</td>
<td>2 standard, 3 or 4 optional</td>
</tr>
<tr>
<td>Max. pressure [bar]</td>
<td>10</td>
</tr>
<tr>
<td>Sample preparation</td>
<td>in-situ</td>
</tr>
<tr>
<td>Temperature range heating mantle</td>
<td>ambient to 400 °C</td>
</tr>
<tr>
<td>Temperature range circulator bath</td>
<td>20 °C to 90 °C</td>
</tr>
<tr>
<td>Height</td>
<td>80 cm (31.5 in)</td>
</tr>
<tr>
<td>Width</td>
<td>95 cm (37.5 in)</td>
</tr>
<tr>
<td>Depth</td>
<td>60 cm (23.5 in)</td>
</tr>
<tr>
<td>Weight (approximate)</td>
<td>200kg (440 lbs)</td>
</tr>
</tbody>
</table>

¹Mass flow controllers are available in different ranges (0.1, 0.2, 0.5, 1, 2, 5, 10, 20 L/min) for optimal instrument configuration with respect to customer’s needs.
**dynaWin™**

The user-friendly control software **dynaWin™** provides real-time control and programmable operation of all system functions, such as gas flow rates and gas compositions, flow paths and direction of flow, temperature ramps and dwell times, etc. The Software assists the user in the configuration of complex adsorption and desorption sequences. Analysis sequences can be processed fully automated and unattended. The definition of intelligent start/stop criteria provides unprecedented flexibility and facilitates a most efficient and economic operation (sparing use of gasses). Further software features are:

- Real-time data presentation
- Manual mode control
- Demo mode for operator training and education
- Historical data trending
- System alarm settings
- User account management (hierarchy of user access levels)
- Well-structured log files
- Auto-save function

The status of all sensors and valves, the path and direction of gas flow, and all relevant system information for safe and convenient operation can be viewed at a glance on the controlling PC.

**dynaSim™**

The included simulation software **dynaSim™** provides sophisticated data reduction and simulation capabilities, such as:

- Integration of breakthrough curves
- Comprehensive parameter studies
- Simulation and prediction of breakthrough behavior and heat profiles
- Calculation of single- and multi-component adsorption data
- Determination of selectivity, affinity, and kinetic coefficients

Profound technical calculations or basic research, **dynaSim™** accommodates it all, making it a powerful tool for both industry and academia.

Contact your local representative or call 1.800.989.2476 (in USA/Canada) to request pricing information.
A typical breakthrough curve (red) with the corresponding temperature signal (black) measured at the bottom of the adsorber bed.

Comparison of a measured breakthrough curve (red) with the simulated breakthrough behavior (blue) computed with dynaSim™.

Integration of consecutive adsorption-desorption cycles.

Calculated multi-component sorption equilibria.

Breakthrough curves of a binary gas mixture in helium carrier gas.

Calculated multi-component sorption equilibria showing total loading (yellow) and partial loading (red and blue).
**Customized**

The number and range of mass flow controllers is determined by the customer’s needs. Mass flow controllers are available in different flow ranges 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 L/min). With respect to the application a suitable set of up to four MFC’s can be configured for optimal experimentation. Flexible: The number and range of MFC’s can be changed at any time in field up-grades.

Several options and accessories are available for further customizing dynaSorb BT™ analyzers for individual needs and applications.

**Alternative Adsorber Sizes**

The standard adsorber is 3 cm in diameter and 20 cm in length for the investigation of representative sample amounts of about 100 ml. Four temperature sensors measure the evolution and propagation of heat profiles along the adsorber axis. Alternative adsorber sizes are available to investigate smaller sample amounts.

**Circulator Option**

A single circulating bath can be used for the precise pre-tempering of the inlet gas and the adsorber between -20°C and 90°C.

**Beaker Option**

The Beaker Option gives the user the opportunity to temper the adsorber column isothermally.

**Optional Mass Spectrometer**

With the Mass Spectrometer Option, a Pfeiffer® mass spectrometer (ThermoStar or OmniStar) can be controlled by the dynaWin™ software. Controlling includes turning on/off the filaments and starting/ stopping data acquisition with the Pfeiffer® QUADERA Software.

**Optional Mass Flowmeter**

A Mass Flowmeter can be included in the manifold to measure the mass flow after the adsorber column. Since, especially when using high concentrations, the mass flow that is going inside the column is different from the mass flow that is coming out of the column before 100 % breakthrough, this option is necessary, when you want to determine mixture equilibria with the dynaSorb BT™.

**Vacuum (coming soon)**

With the Vacuum-Option, a vacuum pump can be connected to the instrument. A new software function will be enabled, which allows the activation of the pump to evacuate the manifold and the adsorber column during pretreatments or analyses. In addition to a more effective sample pretreatment, this option will allow the emulation of a VPSA-process (Vacuum-Pressure Swing-Adsorption) with one adsorber column.
The quality of Quantachrome’s after sales service support is the reason we are proud to maintain lifetime relationships with our customers. Our global service staff assure you that Quantachrome Instruments will continue to be the reliable engines of material characterization laboratories. We offer you the flexibility of choosing from service contracts tailored to provide you with the response time, service package, and spare parts discounts that best fit your needs.

Our fully equipped, state-of-the-art powder characterization laboratory, LabQMC (www.labqmc.quantachrome.com, qc.lab@quantachrome.com), provides the option of contracting for expert testing services. Laboratory services are also available to validate the applicability of our products prior to your purchase using your actual samples.

We view the field support of our instruments as an essential component of our business strategy. Our expert scientists are always available to answer questions on applications, or the use of our instruments. We do this as a standard service regardless of whether you have a service contract with us or not.

Quantachrome has a scientific research department consisting of world renowned experts in material characterization. Our staff, led by Dr. Matthias Thommes, conducts collaborative research projects with leading material research labs around the world. They regularly publish articles in leading peer reviewed journals, and speak at technical symposiums around the world.

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