

DYNAMIC SORPTION

Dynamic Sorption Breakthrough Analyzer

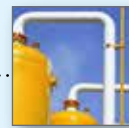
- Breakthrough Curves
- Industrial Adsorbents
- Multi Component Adsorption
- Material Research
- Chemical Engineering
- Energy Storage
- Gas Storage
- Gas Purification
- Separation Technologies
- Environmental



Gas Purification



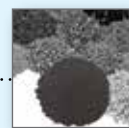
Gas Separation



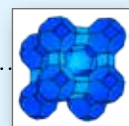
Energy



Carbons



Zeolites



dynaSorb[™] Overview

DYNAMIC SORPTION

INTRODUCTION

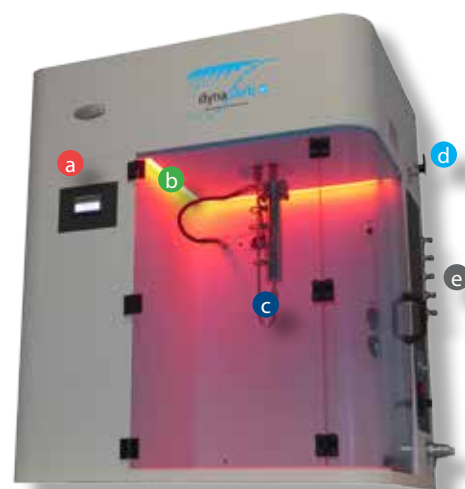
Industrial adsorbents such as active carbons, zeolites and silica gels are widely used in adsorptive separation processes on a multi-ton scale. The after-treatment of exhaust gasses, the removal of carbon dioxide in biogas plants, purification and fractionation of natural gas, air separation, respiratory 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 complex dynamic sorption processes in a uniquely safe and easy-to-use bench-top instrument. Industrial 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.

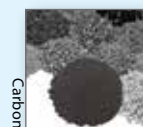
- Determination of breakthrough curves
- Investigation of kinetic performance of adsorbents
- Investigation of co-adsorption and displacement phenomena
- Determination of sorption selectivity
- Reasonable downscaling of industrial separation processes
- Dynamic adsorption and desorption experiments
- Determination of single- and multi-component adsorption data
- Investigation of heat profiles along the adsorber bed
- Measurement of adsorption in the presence of water or others vapors

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. Regulating the temperature 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.



- a** Adsorber pressure
- b** Intelligent lighting
- c** Adsorber with four(4) temperature sensors
- d** TCD bypass valve
- e** Up to four(4) gas input and one(1) vent output



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. Work area illumination changes from white to red 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 Thermal Conductivity Detector (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
- Evaporator option for introduction of water and other vapors
- Measurement of inlet and outlet gas composition
- Temperature control of inlet gas and 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

Characterizing Today's Materials — Discovering Tomorrow's™

DYNAMIC SORPTION



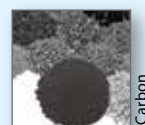
Gas Purification



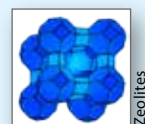
Gas Separation



Energy



Carbon



Zeolites

BENEFITS

Large Flow Range

Investigation of mixture equilibrium and kinetics, downscaling of industrial processes.

Temperature Regulated 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 for multiple pre-mixed gas tanks, increasing flexibility of measurement conditions.

Automated Counter Current Operation

Downscaling industrial PSA-processes.

PC Control and Data Acquisition

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, even when power is off.

Safety Guard Sensor

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

Switching Illumination

Light in working area switched from white to red, if the column temperature is above 80°C (preventing of accidental contact with hot surfaces).

DYNAMIC SORPTION



SPECIFICATIONS

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

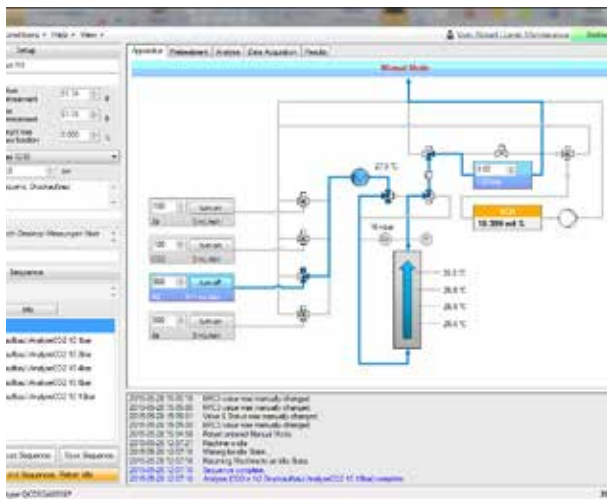
¹Mass flow controllers are available in different ranges (0.1, 0.2, 0.5, 1, 2, 5, 10, 20 L/min) for optimal instrument configuration with respect to customer's needs.

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 (conserving gas usage). 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

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



DYNAMIC SORPTION



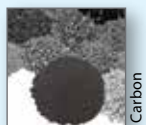
Gas Purification



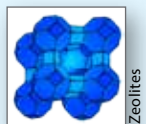
Gas Separation



Energy



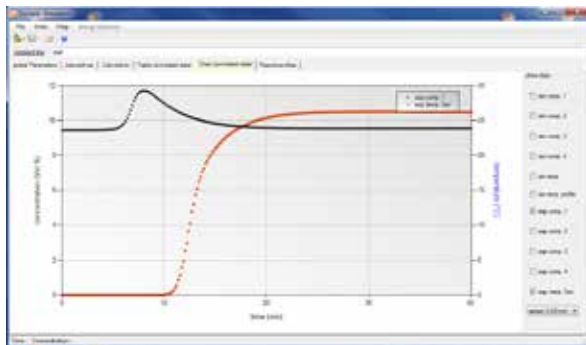
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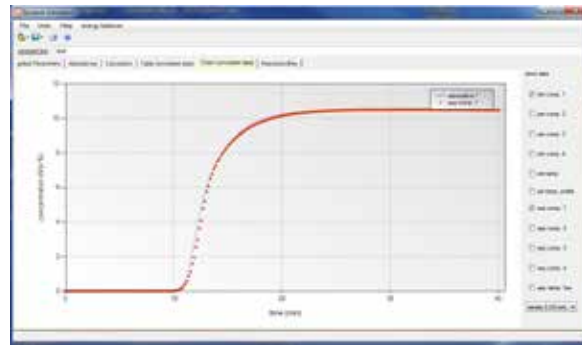
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SOFTWARE

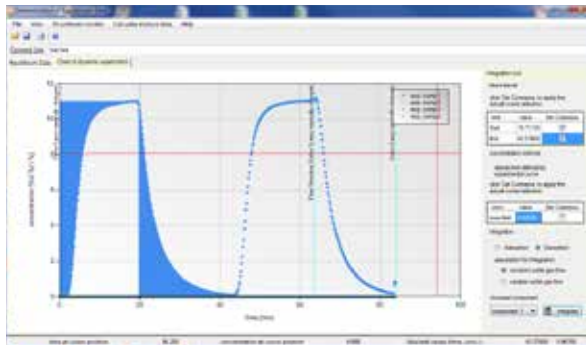
DYNAMIC SORPTION



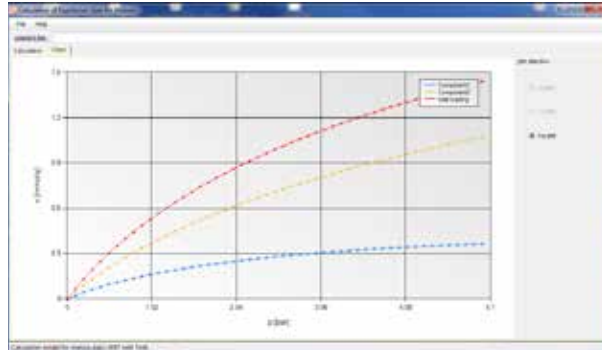
A typical breakthrough curve (red) with the corresponding temperature signal (black) measured at the bottom of the adsorber bed.



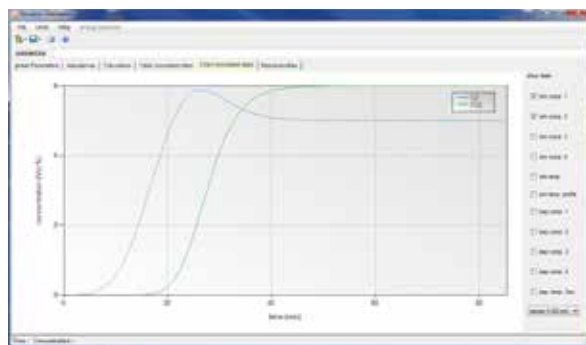
Comparison of a measured breakthrough curve (red) with the simulated breakthrough behavior (blue) computed with **dynaSim™**.



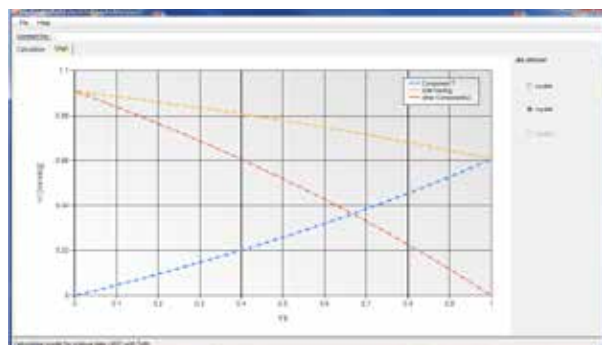
Integration of consecutive adsorption-desorption cycles.



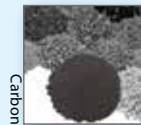
Calculated multi-component sorption equilibria.



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 AND FLEXIBLE

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 18 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 temperature control of the inlet gas and the adsorber between -20°C and 90°C.

Beaker Option

The Beaker Option gives the user the opportunity to regulate the temperature of the adsorber column.

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 the filaments on/off 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, prior to 100% breakthrough the mass flow entering the column can be different from flow coming out, especially in high concentrations, measuring the actual flow allows the software to compensate for the difference.

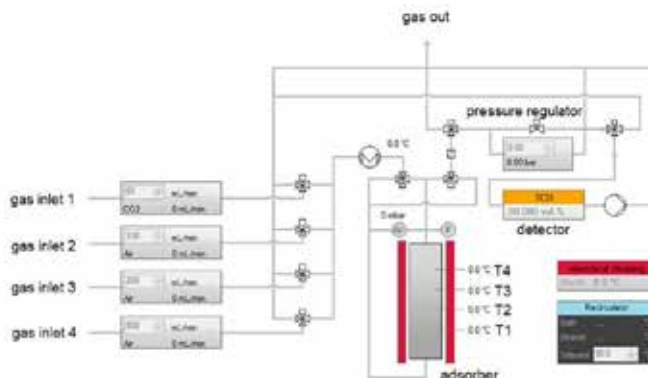
Vacuum Option

With the Vacuum-Option, a vacuum pump can be connected to the instrument. The software 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.

Evaporator Option

This option injects a liquid into a flash evaporator which is then mixed with a carrier gas stream, introducing a vapor at controlled concentration. This allows the evaluation of the adsorption characteristics of an adsorbent in the presence of a vapor (e.g. water) or the separation of the vapor from a gas.

The configuration, installed options, and current status of the system are visible at a glance on the main display.



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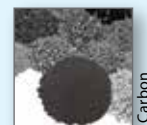
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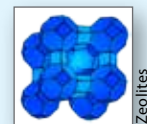
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For almost half a century Quantachrome's scientists and engineers have revolutionized measurement techniques and designed instrumentation to enable the accurate, precise, and reliable characterization of powdered and porous materials. We have an unwavering commitment to providing state of the art technology, along with superior and unparalleled customer service and support. Our commitment to customers is to support you before, during, and after the sale throughout the lifetime of our instruments. This is a big commitment because our products are so robust and reliable that we regularly find many still in use for decades.

Renowned innovator for today's porous materials community.

Quality Function Dependability

The quality of Quantachrome's after sales service support is the reason we are proud to maintain life time relationships with our customers.

Field Service



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.

Spare Parts



Quantachrome spare parts are certified to work with our instruments. We provide rapid response spare parts orders, and keep large inventories of replacement parts and hardware available.

Application Lab



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.

Lifetime Application Support



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.

Partners in Science



Quantachrome has a scientific research department who are world renowned experts in material characterization. Our staff, led by Dr. Matthias Thommes, conduct 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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