3P Surface Area and Porosity Analyzers

- BET Surface Area
- Pore Size Distribution
- Pore Volume
- Adsorption Capacity
- Chemisorption Parameters
- Vapor Sorption
- Heat of Adsorption
- Research and Development
- Quality Control

STATIC-VOLUMETRIC AND DYNAMIC GAS ADSORPTION ANALYZERS

PARTICLE CHARACTERIZATION

POWDER ANALYSIS

PORE DETERMINATION

3P INSTRUMENTS

Characterization of
particles · powders · pores

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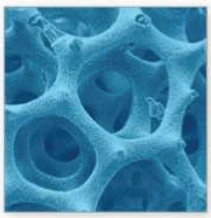
Overview

Contents

Applications

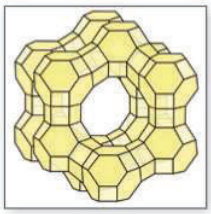
- Research and Development
- Quality Control
- Zeolites, MOFs, active carbon, silica gels, ...
- Determination of BET surface area
- Analysis of Pore Size Distribution and Pore Volume
- Determination of Chemisorption Parameters
- Vapor Sorption Measurements
- Determination of Adsorption Capacity and Heat of Adsorption

Introduction

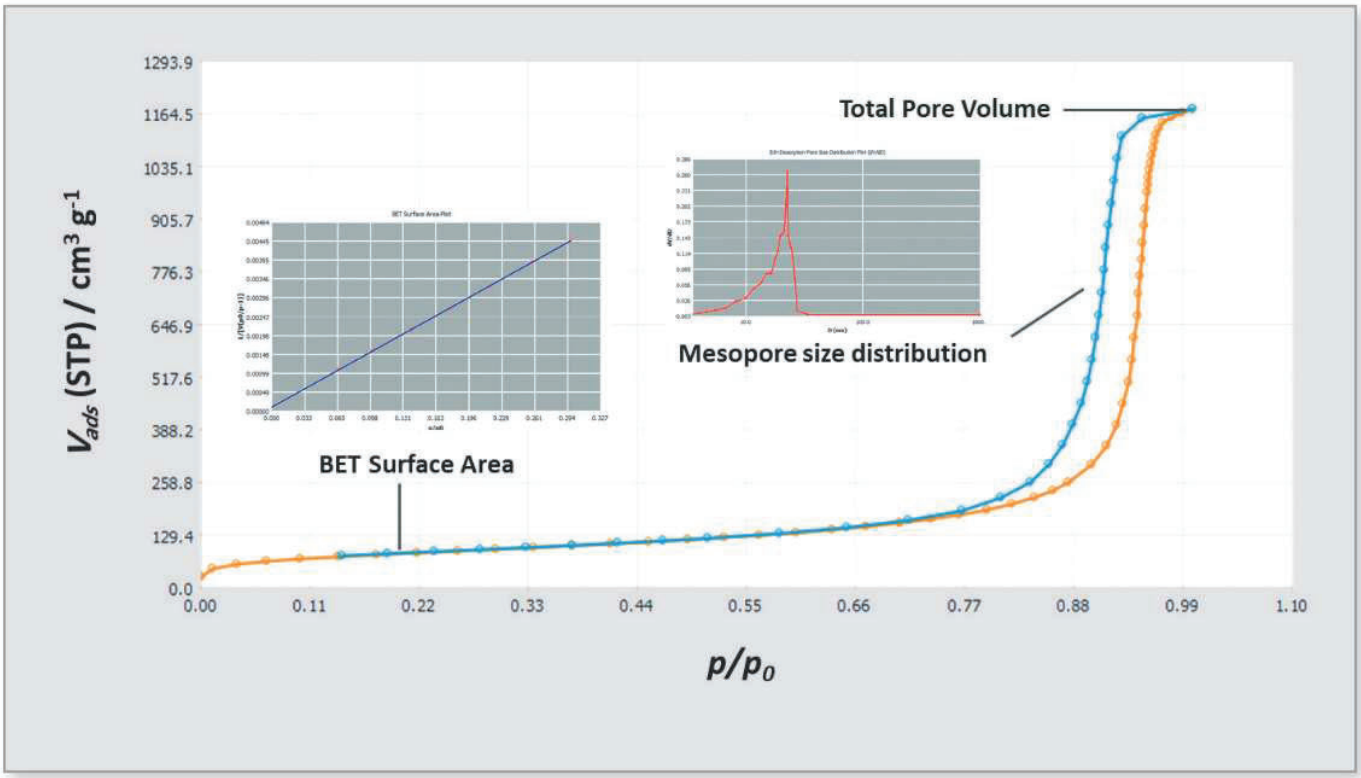


For 30 years, 3P Instruments has been standing for methods of the characterization of particles, powders and porous materials in Europe. The purpose of the department "Surfaces & Pores" is to offer professional consultation and scientific solutions concerning our analytical instruments and methods to customers in the fields of research, development, or quality control of powders and porous materials. We are mainly focused on the determination and evaluation of characteristics such as the BET surface area, pore size distribution, porosity, pore volume, adsorption capacity, chemisorption parameters, breakthrough analysis, mixed gas adsorption, density, and permeability.

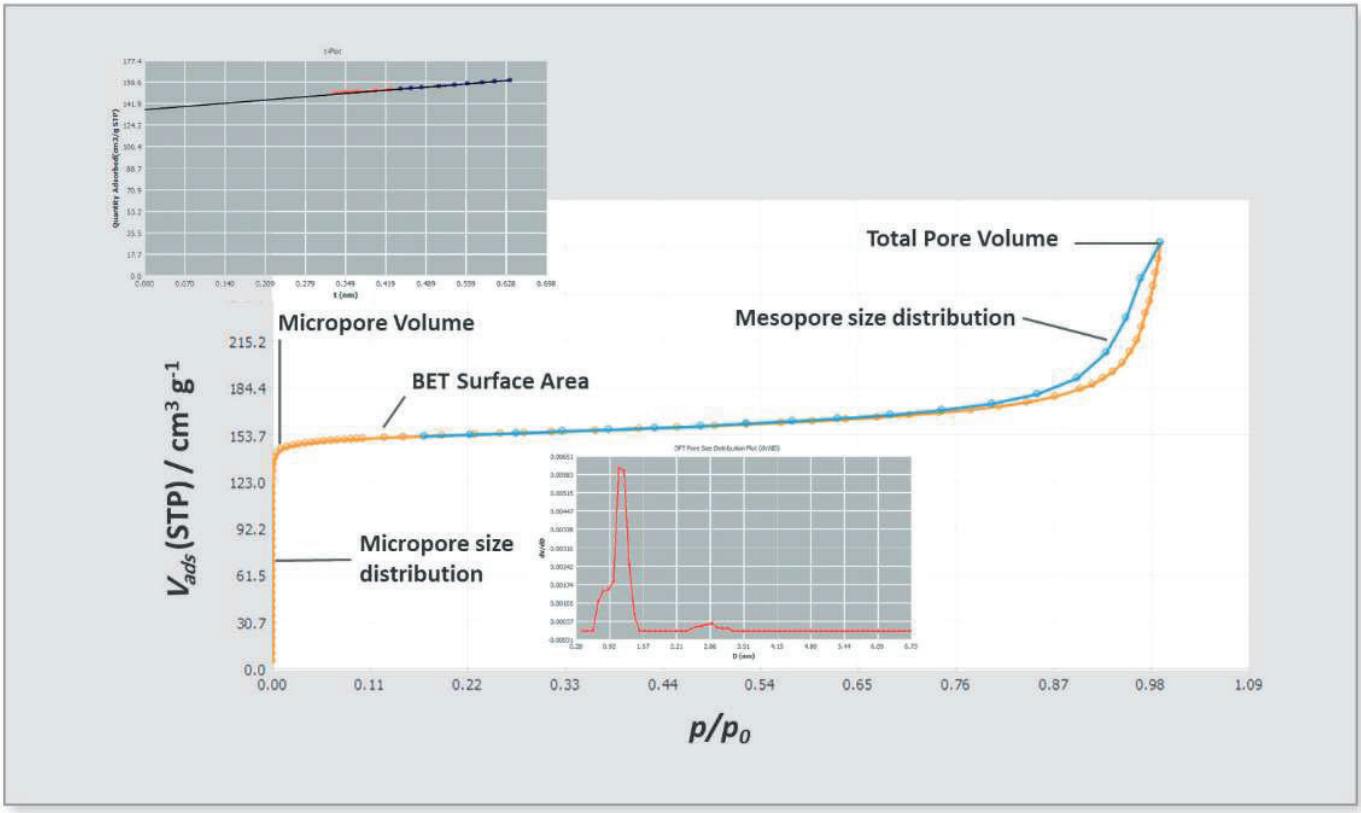
3P Gas Adsorption Analyzer Series



The characterization of surface areas and pores of solid materials are important parameters in many laboratories and are usually determined by gas adsorption equipment. These techniques can be complemented by adsorption of water and other vapors, chemisorption, high-pressure- and breakthrough measurements. 3P Instruments offers a broad range of different surface area and pore size analyzers, perfectly designed to meet your application requirements in terms of analysis parameters, flexibility, desired sample throughput, ease of use and analysis speed. This brochure gives an overview of our instrument models and possible configurations.



Example: Mesopore Analysis



Example: Micropore Analysis

3P surface

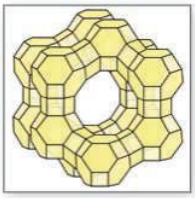
With the 3P surface DX, 3P Instruments offers a fully automated dynamic single- and multi-point sorption analyzer. The dynamic flow method is still in use, especially in areas, e.g., in quality control where fast analysis times and easy handling are the main focus. The dynamic flow method is applicable if the static volumetric method does not supply valid analysis data for a variety of reasons. Pharmaceutical products, raw materials for food or metal hydroxides and materials with crystal water inclusions are examples for the latter. The new 3P surface DX may handle up to four samples and combines the advantages of the dynamic method with a high degree of automation as found in the volumetric method.

Benefits and Features

- Easy and intuitive MS Windows software for operation, calculation and data storage
- Very high reproducibility *(Figure 1)*
- Fully automated with four analysis stations for high throughput flow single and multipoint BET analysis *(Figure 2)*
- Automatic dewar lifting
- Adsorption equilibrium conditions are determined automatically
- Automatical adjustment of zeroing of thermal conductivity detector
- Reference mode for fast surface analysis

Applicable methods and determinable parameters

- Isothermal adsorbed amount
- Single-point BET
- Multi-point BET
- Reference mode (direct comparison with a certified reference)



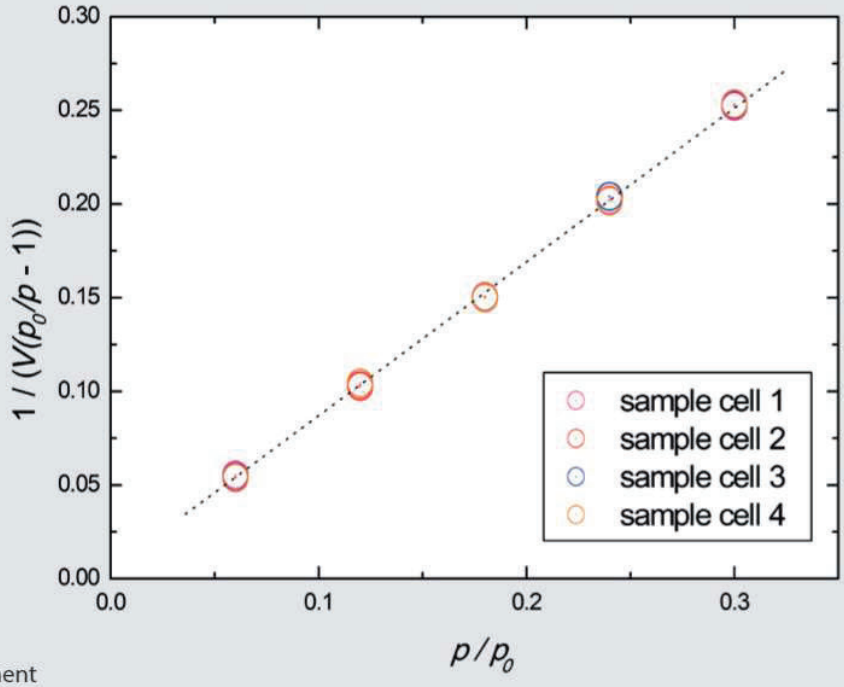


Figure 1
5-point BET measurement carried out with 3P surface DX

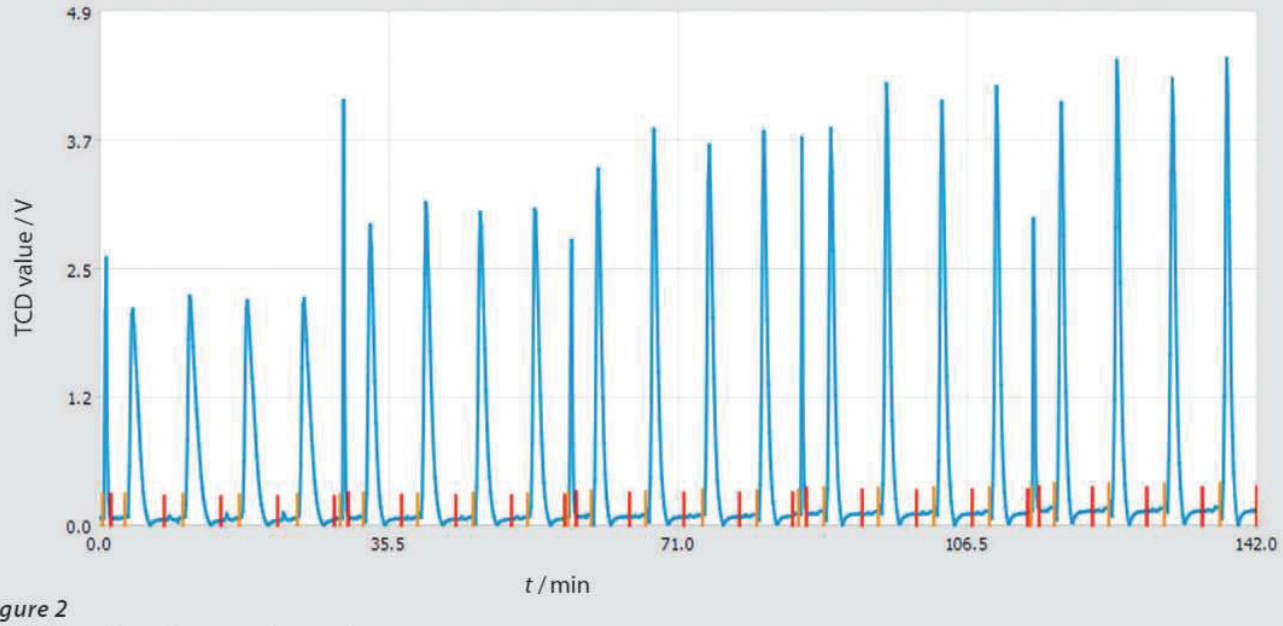


Figure 2
TCD (thermal conductivity detector) value vs. measurement time

Specifications

Measurement range (p/p_0)	0.05 – 0.3
Analysis Stations	4
Reproducibility	± 1 %
Lower Limit	0.01 m^2/g
Upper Limit	No upper limit
Speed single point BET	< 5 min
Speed multipoint BET	< 25 min
Degasser Temperature	400 °C (external)
Humidity	10 % – 90 %
Power requirements	AC 220 V ± 20 V, 50/60 Hz, maximum power 300 W, current 5 A

Optional Accessories and Tools

Optional Accessories and Tools	3P micro	3P meso	3P sync
3P prep J4: Additional sample preparation system with 4 stations and a max. degasser temperature of 400°C. It offers an optional turbo vacuum and temperature ramp control *(Figure 1)*.	■	■	■
Vapor source with heated manifold up to 50 °C *(Figure 2)*.	■		
Tempering Kit for experiments from 0 to 50°C. It is most commonly used for CO_2, n-Butane or vapor experiments *(Figure 3)*.	■	■	■
cryoTune series: Cryostatic accessory/temperature controller for adsorption using various adsorptives at temperatures 77–323 K. It needs only liquid nitrogen for cooling. It allows the characterization of microporous solids according to ISO 9277 and IUPAC 2015 recommendation, but also the determination of BET surface of other materials by Ar/Kr instead of N_2 adsorption. It operates noiseless and has a very low energy consumption *(Figure 4)*.	■	■	■
cryoCooler: Can be used for cryogen free temperature control for measurement temperatures < 20–320 K *(Figure 5)*.	■		
Simulation software 3P sim to predict the performance of dynamic experiments or mixed gas experiments *(Figure 6, right page)*.	■	■	■

Figure 1

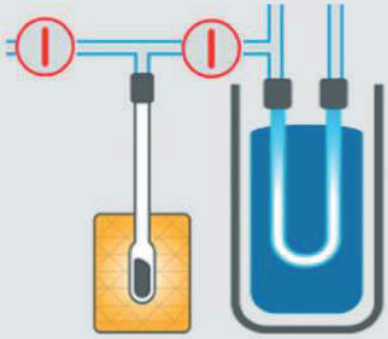


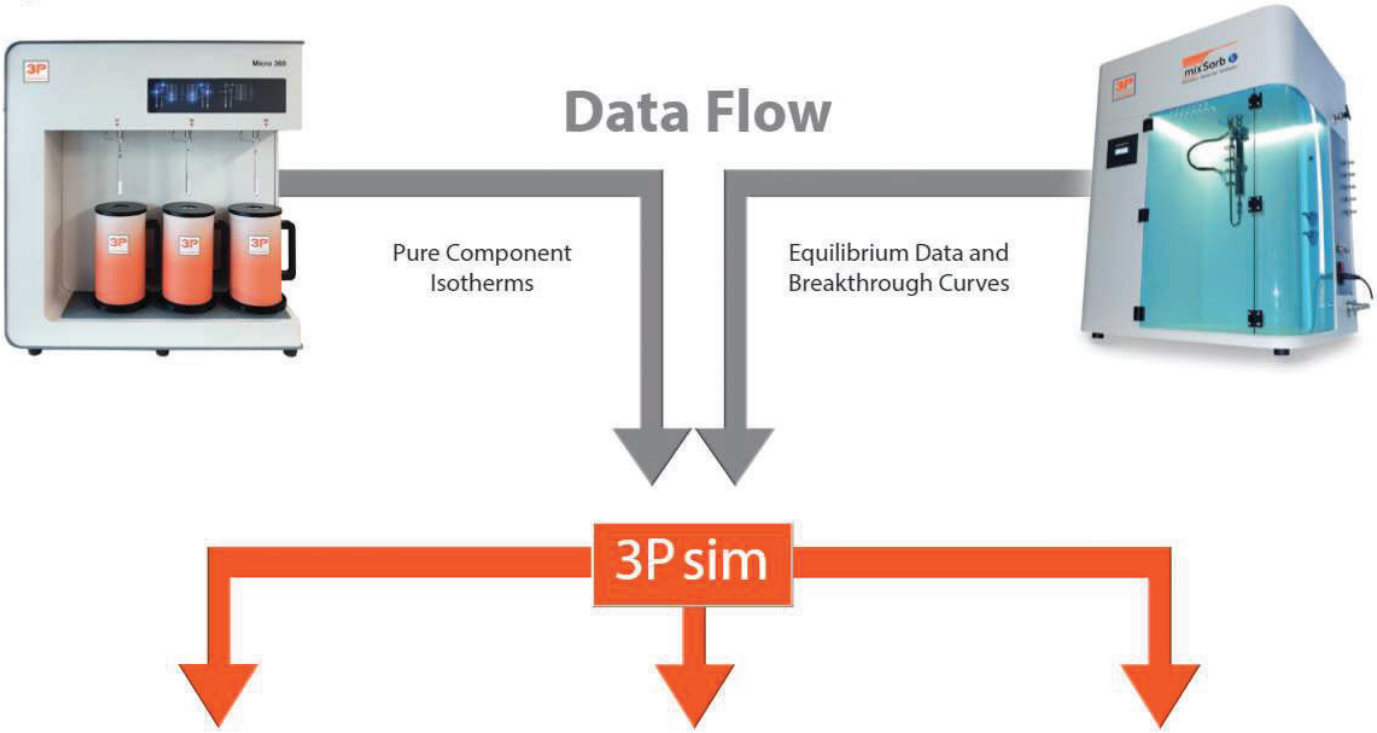
Figure 2

Figure 3

Figure 4

Figure 5

Figure 6



Isotherm Fitting

With **3P sim** measured isotherm data can be fitted with the following mathematical isotherm models:

- HENRY
- LANGMUIR
- TOTH
- SIPS
- FREUNDLICH
- DUALSITE LANGMUIR
- DUALSITE LANGMUIR SIPS

Prediction of Mixture Equilibria

The program allows the calculation of total and partial loadings at given pressures or compositions and supports the following theories:

- IAST* with LANGMUIR
- IAST with TOTH
- IAST with DUALSITE LANGMUIR
- IAST with DUALS. LANGMUIR SIPS
- Multicomponent LANGMUIR
- Multicomponent SIPS

* Ideal Adsorption Solution Theory

Dynamic Simulation

- **3P sim** provides solutions for mass- and energy balances which allow simulations without user precognition or programming skills.
- Technically relevant transport parameters (e.g., LDF* constants) are accessible
- Simulation of breakthrough curves and temperature profiles

* Linear Driving Force