

FULLY AUTOMATED MODULAR
SYSTEM

ASAP 2460 SURFACE AREA AND
POROSIMETRY ANALYZER



ASAP 2460

ANALYTICAL VERSATILITY WITH SUPERIOR THROUGHPUT

High Performance and High Sample Throughput

The Micromeritics® ASAP® 2460 Surface Area and Porosimetry Analyzer incorporates a unique expandable system designed for high performance and high sample throughput. The base ASAP 2460 is a two-port master control unit. For more throughput, additional two-port auxiliary units can be connected to the master unit expanding the system to either a four-port or six-port analyzer.

Analysis System

- All analysis ports can be operated independently and consecutively, allowing the user to load and unload samples at any time, regardless of the analysis stage. A new analysis can begin as soon as another is finished.
- An analysis of up to 60 hours can be performed without refilling the Dewar. This allows unattended analysis of high-resolution adsorption/desorption isotherms.
- With a master unit and two auxiliary units, BET surface area analyses utilizing six parallel runs can be achieved in as little as 30 minutes.
- Servo pressure control for dosing and evacuation.
- Up to five different nonreactive adsorptives, plus an additional gas for free space, can be attached to the analyzer simultaneously.
- Intuitive MicroActive software combines user-defined reports with the ability to interactively evaluate isotherm data. User-selectable data ranges through the graphic interface allow direct modeling for BET, t-Plot, Langmuir, DFT interpretation, and new advanced NLDFT methods.
- An innovative dashboard monitors and provides convenient access to real-time instrument performance indicators and maintenance scheduling.

Low Surface Area Measurement (Krypton) and Dedicated Micropore Options

In addition to the standard 2460, low surface area krypton and micropore models are available.

Low surface area (krypton) model includes the addition of a 10 mmHg transducer and permits accurate measurement of very low surface area materials.

The micropore model includes the addition of a 1 mmHg transducer which extends the low pressure measurement capabilities and allows enhanced performance for characterizing microporous materials. The transducer also increases pressure resolution in the range necessary for micropore analysis.

ASAP 2460 Advantages

- Fully automated modular system optimized for walk-up sample screening
- High throughput with two, four, or six independent analysis stations
- BET surface area measurements in as little as 30 minutes
- Dosing options of maximum volume increment or dosing over specified pressure ranges
- Analysis temperature can be entered or calculated
- Equilibration option allows user to specify equilibration times for different parts of the isotherm
- Low surface area and micropore options
- Innovative MicroActive software with advanced NLDFT modeling
- State-of-the-art engineering ensures excellent accuracy, repeatability, and reproducibility from all ports, from the master control unit through one or two auxiliary analysis units.



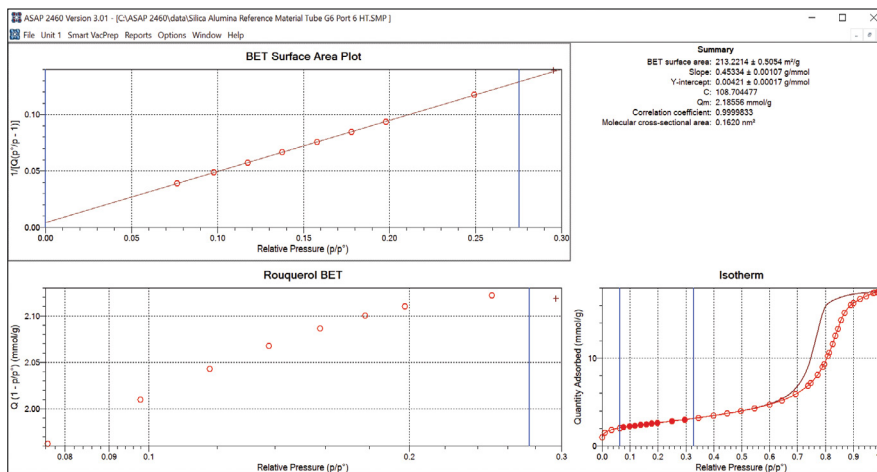
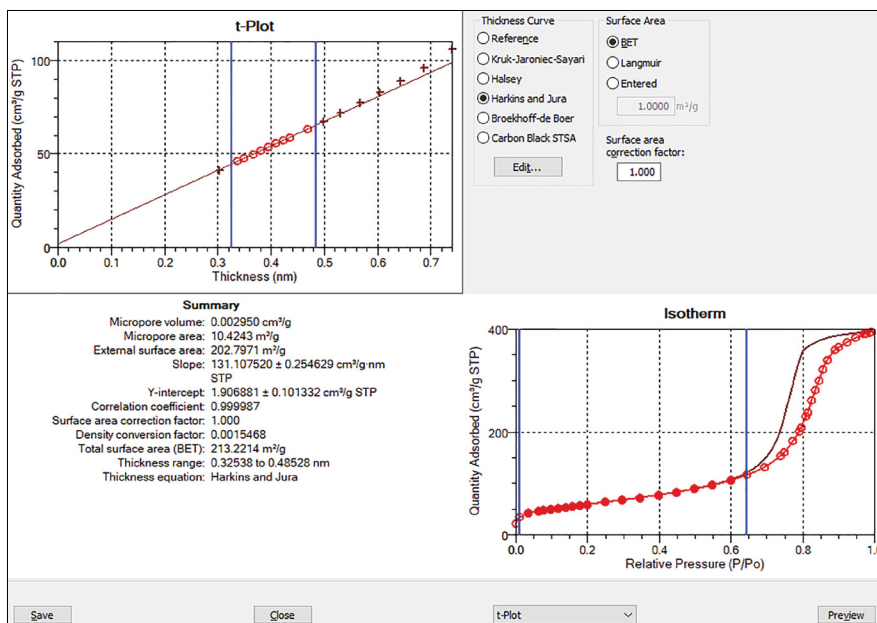
SUPERIOR DATA PRESENTATION CAPABILITY

Innovative MicroActive Software

Micromeritics' innovative MicroActive software allows users to interactively evaluate isotherm data. Users can easily include or exclude data, fitting the desired range of experimentally acquired data points using interactive, movable calculation bars. Isotherms can be viewed on either a linear or logarithmic scale.

Data Reduction Benefits

- Interaction with adsorption data is direct. By simply moving the calculation bars, the user is immediately updated with new textual properties.
- Interactive data manipulation minimizes the use of dialog boxes and tunneling of dialogs to specify calculation parameters.
- Ability to overlay files (up to 25) including mercury intrusion data with a file add-and-subtract feature.
- User-selectable data ranges through the graphic interface allow direct modeling for BET, t-Plot, Langmuir, DFT interpretation, and much more.
- Report Options editor allows the user to define reports with on-screen previews. Information from each report can be included in a concise summary, as well as in a tabular and graphical information pane.

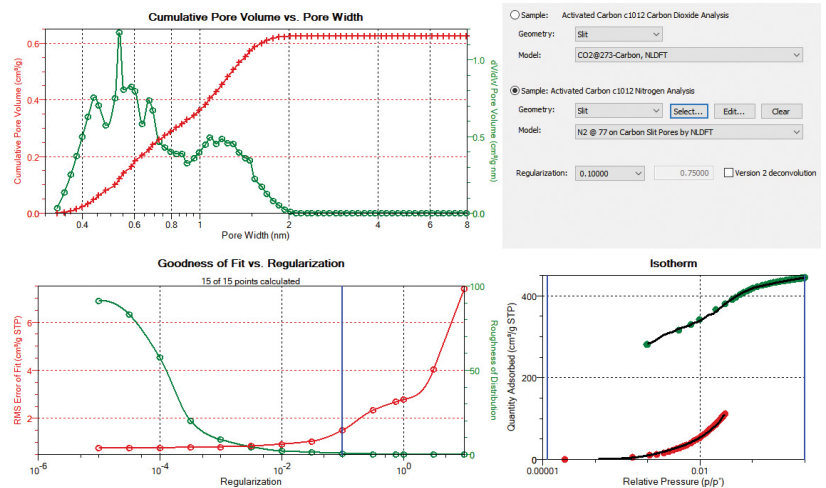


ASAP 2460 Interactive Reports include (when appropriate to the analysis performed):

- Isotherm
- BET Surface Area
- Langmuir Surface Area
- t-Plot
- Alpha-S Method
- BJH Adsorption and Desorption
- Dollimore-Heal Adsorption and Desorption
- Horvath-Kawazoe
- MP-Method
- DFT Pore Size and Surface Energy
- Dubinin-Radushkevich
- Dubinin-Astakhov
- User-Defined Reports

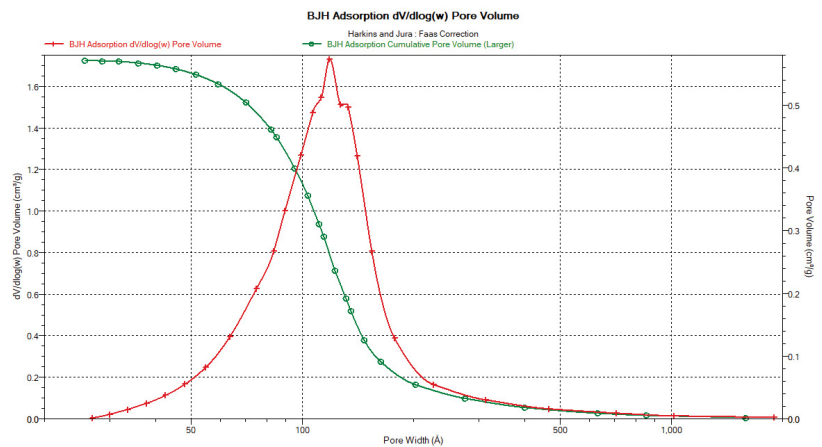
NLDFT Modeling

The NLDFT Advanced PSD, Dual DFT modeling allows the user to combine the information gathered from nitrogen and carbon dioxide isotherms to deliver a full pore size distribution on materials (such as carbon slit pores) where pores of molecular sizes are present. The range of pore size analysis in this method is extended to smaller pore sizes compared to the standard nitrogen analysis. This is due to the fact that CO₂ can access some very small micropores that are not accessible to N₂ at cryogenic temperatures.



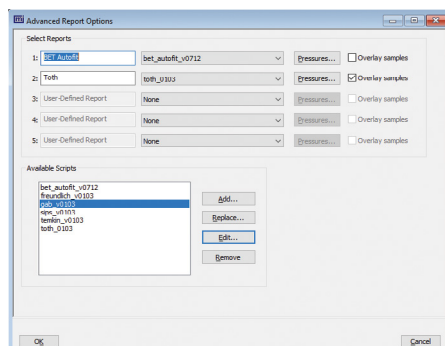
Mercury Porosimetry and Gas Adsorption Overlay

MicroActive for the ASAP 2460 software also includes a powerful utility that allows the user to overlay a mercury porosimetry pore size distribution with a pore size distribution calculated from gas adsorption isotherms. This new import function allows users to rapidly view micropore, mesopore, and macropore distributions in one easy-to-use application.



Python Programming Language Included

The Python programming language has been incorporated into the ASAP 2460 software. This powerful scripting language allows users to develop extensions to the standard report library available within the ASAP 2460 application.



New Dosing Options

Dosing options added to the pressure table give the user the ability to change the pressure increment, volume dose increment, and equilibration interval time between data points. A detailed isotherm can be collected by specifying that a data point be recorded after a certain amount of gas is dosed, increasing the relative pressure by a small amount, or both.

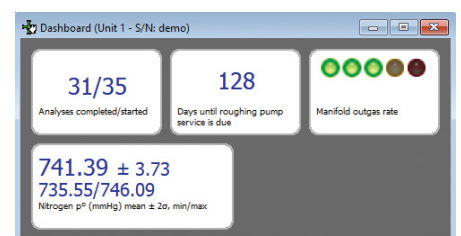
The screenshot shows the Entered Pressures dialog box with a table of dosing options:

| | Starting Pressure (p/p ⁰) | Pressure Increment (p/p ⁰) | Ending Pressure (p/p ⁰) |
|---|---------------------------------------|--|-------------------------------------|
| 1 | 0.0600000000 | 0.0200000000 | 0.2000000000 |
| 2 | 0.2000000000 | 0.0500000000 | 0.8000000000 |
| 3 | 0.8000000000 | 0.0200000000 | 1.0000000000 |
| 4 | 1.0000000000 | 0.0200000000 | 0.8000000000 |
| 5 | 0.8000000000 | 0.0500000000 | 0.2000000000 |

Buttons: Insert, Delete, Clear, Append

Innovative Dashboard

With a single click, the ASAP 2460 provides a powerful suite of information that allows the user to maintain the instrument in peak operating condition with real-time analysis views.



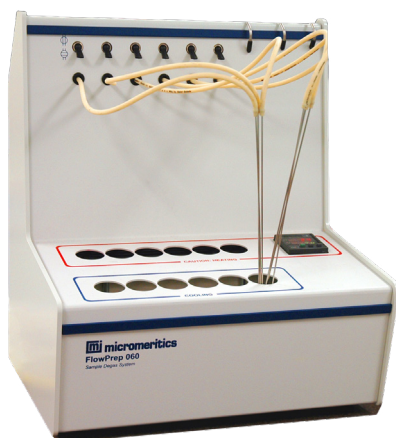
SAMPLE PREPARATION DEVICES

Micromeritics' sample preparation devices prepare batches of samples for surface area and pore volume analysis. They combine flowing gas and/or vacuum with heat to remove atmospheric contaminants, such as water vapor and adsorbed gas, from the surface and pores of the sample.

The Micromeritics® FlowPrep™ O60: Applies both heat and a stream of inert gas to the sample for removal of adsorbed contaminants from the surface and pores. With six degassing stations, this sample preparation unit lets you choose a temperature, the gas, and the flow rate best suited for your sample material and application.

The Micromeritics® VacPrep™ O61: Offers two methods for removing adsorbed contaminants. In addition to flowing gas, this sample preparation unit provides vacuum to prepare samples by heating and evacuation. The VacPrep offers the user a choice of vacuum or gas flow on each of the six degassing stations.

The Micromeritics® SmartPrep™ O65: Applies a stream of flowing gas over the sample at elevated temperatures to remove adsorbed contaminants. Temperature, ramp rates, and soak times of each sample are individually controlled on the six degassing stations by a computer. Up to five ramps and soaks are allowed. All degas information is integrated into the sample data file for future reference.



FlowPrep O60



Smart Prep O65



VacPrep O61

TRANSFER SYSTEM

The Micromeritics® Model O21 LN2 Transfer System is useful for any number of tasks where frequent needs arise for relatively small volumes of liquid nitrogen or argon. The LN2 Transfer System makes it easy to fill Dewars with liquid cryogen for laboratory or general purposes. The system includes a large storage Dewar with a 47 liter capacity that can hold liquid nitrogen or argon up to 30 days allowing convenient and cost-efficient use of your cryogen. The discharge rate is continuously adjustable to a maximum flow of 3 L/min. The discharge line is insulated to prevent frosting and icing during use, and flexible to allow easy positioning for discharge into almost any type of receiving vessel. The system includes a mobile platform that easily adapts to different Dewar dimensions.



Model O21 LN₂ Transfer System

SPECIFICATIONS

Electrical

| | |
|-----------|---|
| Voltage | 100/115/230 VAC (±10%) |
| Frequency | 50 or 60 Hz |
| Power | 800 VA, exclusive of vacuum pumps, which are powered separately |

Environment

| | |
|-------------|---|
| Temperature | 10 to 30 °C, operating -10 to 55 °C, storage or shipping |
| Humidity | Up to 90% (non-condensing) for instrument |

Capacity

| | |
|-----------------|---|
| Analysis System | 2, 4, or 6 sample ports (for krypton analysis, one sample port is used for dosing), each with a constantly monitored saturation pressure port |
|-----------------|---|

Analysis System

| | |
|---|--|
| Manifold Temperature Transducer: | Type: Platinum resistance device (RTD) Accuracy: ±0.10 °C by keyboard entry Stability: ±0.10 °C per month |
| Manifold Pressure Transducers: | Range: 0 to 950 mmHg operating: 1000 mmHg maximum 0 to 10 mmHg added for Krypton option Resolution: 1000-mmHg Transducer: 0.001 mmHg 10-mmHg Transducer ¹ : 0.00001 mmHg 1-mmHg Transducer ² : 0.000001 mmHg Accuracy: 1000-mmHg Transducer: within 0.15% of reading 10-mmHg Transducer ¹ : within 0.15% of reading 1-mmHg Transducer ² : within 0.12% of reading |
| Sample Port Transducers and Po Port Transducers | Range: 0 to 950 mmHg Resolution: 0.001 mmHg Accuracy: ±0.1% Full Scale |
| Vacuum Transducer | Type: Thermocouple Range: 0.001 to 1 mmHg |

Vacuum System

| | |
|--------------------|--|
| Pumps ³ | Nitrogen: Oil-sealed pump Krypton & enhanced micropore option: High-vacuum pump |
|--------------------|--|

Physical

| | |
|--------|----------------|
| Height | 94 cm (37 in.) |
| Width | 38 cm (15 in.) |
| Depth | 59 cm (23 in.) |
| Weight | 54 kg (119 lb) |

Computer Requirements

| |
|--|
| Windows® 7 Professional or higher operating system (64 bit) ^{5,7} USB port ⁶ Ethernet port (10 base T or 100 base T) |
|--|

Includes nonlinearity, hysteresis, and non-repeatability

¹The 10-mmHg transducer is active only when performing krypton analyses

²The 1-mmHg transducer is presented only in the enhanced micropore option

³Oil-free and high vacuum pump: 3.8×10^{-9} mmHg ultimate vacuum⁴

⁴Ultimate vacuum measured by pump manufacturer according to Pneurop Standard 5608

Due to continuous improvements, specifications are subject to change without notice.

⁵For 21 CFR Part 11, Windows 10 Professional or Windows 10 Enterprise or higher is required.

⁶One additional USB port must be available for Instrument.

⁷Not be installed on a network drive with shared access. Multiple users cannot operate the application at the same time.

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HIGH THROUGHPUT ANALYSIS

ASAP 2425 SURFACE AREA AND
POROSIMETRY SYSTEM



ASAP 2425

ANALYTICAL VERSATILITY WITH SUPERIOR THROUGHPUT

Surface area and porosity are important physical properties that influence the quality and utility of many materials and products. Therefore it is critically important that these characteristics be accurately determined and controlled. Likewise, knowledge of surface area and especially porosity often are important properties in understanding the formation, structure, and potential application of many natural materials.

High Performance and High Sample Throughput

The automated Micromeritics® ASAP® 2425 surface area and porosimetry system is designed to help busy laboratories expand their workflow while providing highly accurate and precise surface area and porosimetry data. High performance, versatile analysis, and sample preparation systems are included in the same instrument.



Analysis System

- With six independently operated analysis ports, a new analysis can begin as soon as another is finished. This provides an important advantage over many multiport instruments that require all samples to be prepared or analyzed at the same time.
- Long-duration Dewars and Micromeritics Isothermal Jackets¹ assure a constant thermal profile along the length of both the sample and saturation pressure (P_0) tubes throughout extended analyses. The P_0 value may be entered, or measured either continuously or at selected intervals.
- The high-capacity Dewar also allows unattended analysis of high-resolution adsorption/desorption isotherms that take much longer to complete because the system must equilibrate at each data point.
- BET surface area analyses utilizing six parallel runs can be achieved in as little as 1 hour.
- A low surface area option that uses krypton as an adsorptive to measure total surface areas of 0.5 m^2 or less is available. This option utilizes five of the six available ports. It also features a turbomolecular drag pump, which provides the high vacuum required for krypton analyses, and a 10 mmHg pressure transducer, which allows accurate, repeatable pressure resolution.
- Intuitive Micromeritics MicroActive software combines user-defined reports with the ability to interactively evaluate isotherm data. User-selectable data ranges through the graphic interface allow direct modeling for BET, t-Plot, Langmuir, DFT interpretation, and new advanced NLDFT methods.
- Up to five different nonreactive adsorptives, plus an additional gas for free space, can be attached to the analyzer simultaneously.
- The servo pressure control regulates dosing and evacuation during analysis to reduce analysis time.

Sample Preparation System

- The ASAP 2425 system includes twelve automatically controlled sample preparation ports that operate independently. Samples may be added or removed from degas ports without disturbing the treatment of other samples undergoing preparation.
- The sample preparation system is fully automated with controlled heating time profiles. Temperature and ramp rate can be set and monitored individually and controlled from a few degrees above ambient to 450°C . The temperature hold period may extend past the point when evacuation is completed.
- A programmable pressure threshold can suspend the temperature ramp if the outgassing pressure exceeds the limit specified, preventing destructive steaming or other undesired reactions with residual gasses and vapors.

Low Surface Area Measurement (Krypton) and Micropore Options

In addition to the standard ASAP 2425, low surface area krypton and micropore models are available.

Low surface area (krypton) model includes the addition of a 10 mmHg transducer and permits accurate measurement of very low surface area materials ($< 1 \text{ m}^2/\text{g}$).

The micropore model includes the addition of a 1 mmHg transducer which extends the low pressure measurement capabilities and allows enhanced performance for characterizing microporous materials. The transducer also increases pressure resolution in the range necessary for micropore analysis.

¹ Micromeritics invented and patented the Isothermal Jacket in 1986

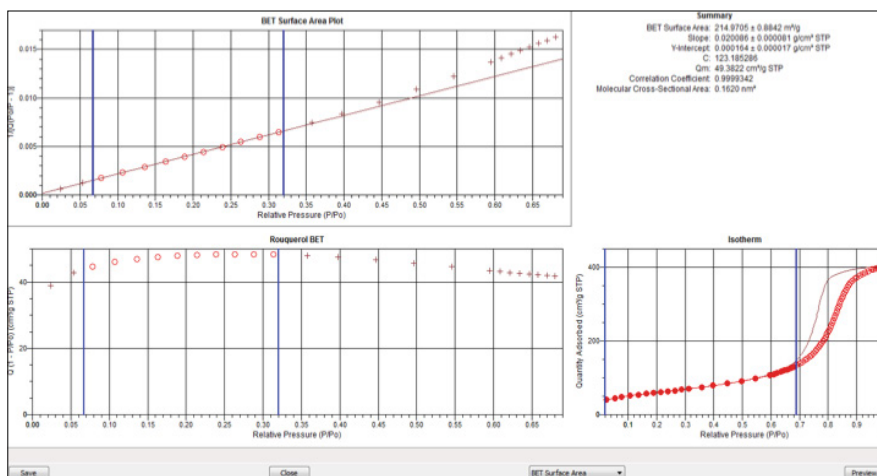
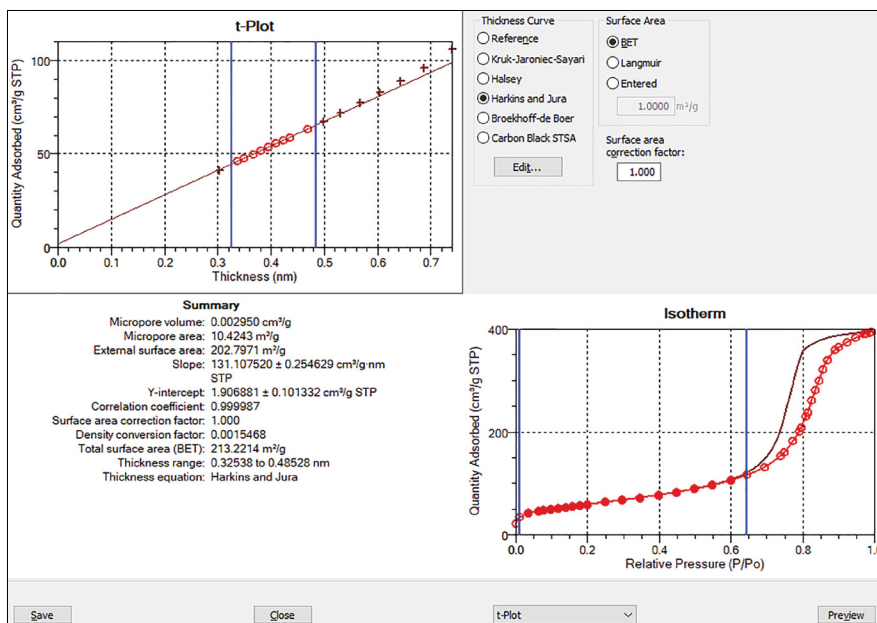
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Micromeritics' innovative MicroActive software allows users to interactively evaluate isotherm data. Users can easily include or exclude data, fitting the desired range of experimentally acquired data points using interactive, movable calculation bars. Isotherms can be viewed on either a linear or logarithmic scale.

Data Reduction Benefits

- Interaction with adsorption data is direct. By simply moving the calculation bars, the user is immediately updated with new textual properties.
- Interactive data manipulation minimizes the use of dialog boxes and tunneling of dialogs to specify calculation parameters.
- Ability to overlay files (up to 25) including mercury intrusion data with a file add-and-subtract feature.
- User-selectable data ranges through the graphic interface allow direct modeling for BET, t-Plot, Langmuir, DFT interpretation, and much more.
- Report Options editor allows the user to define reports with on-screen previews. Information from each report can be included in a concise summary, as well as in a tabular and graphical information pane.

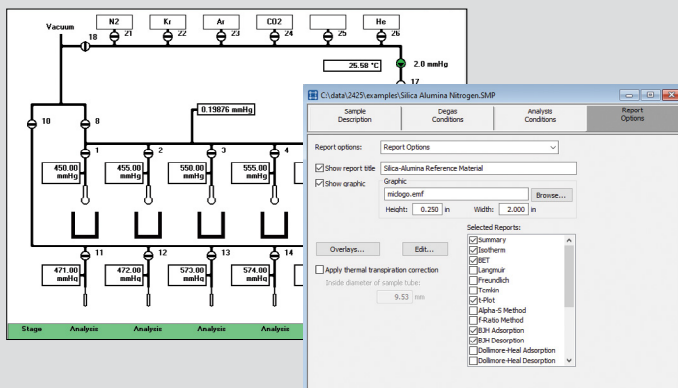


ASAP 2425 Interactive Reports include (when appropriate to the analysis performed):

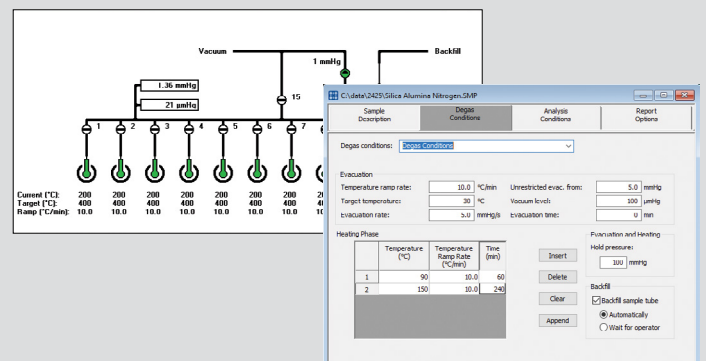
- Isotherm
- BET Surface Area
- Langmuir Surface Area
- t-Plot
- Alpha-S Method
- BJH Adsorption and Desorption
- Dollimore-Heal Adsorption and Desorption
- Horvath-Kawazoe
- Saito-Foley
- Cheng-Yang
- MP-Method
- DFT Pore Size and Surface Energy
- Dubinin-Radushkevich
- Dubinin-Astakhov
- NLDFT Advanced Reports
- User-Defined Reports

ASAP 2425 Advantages

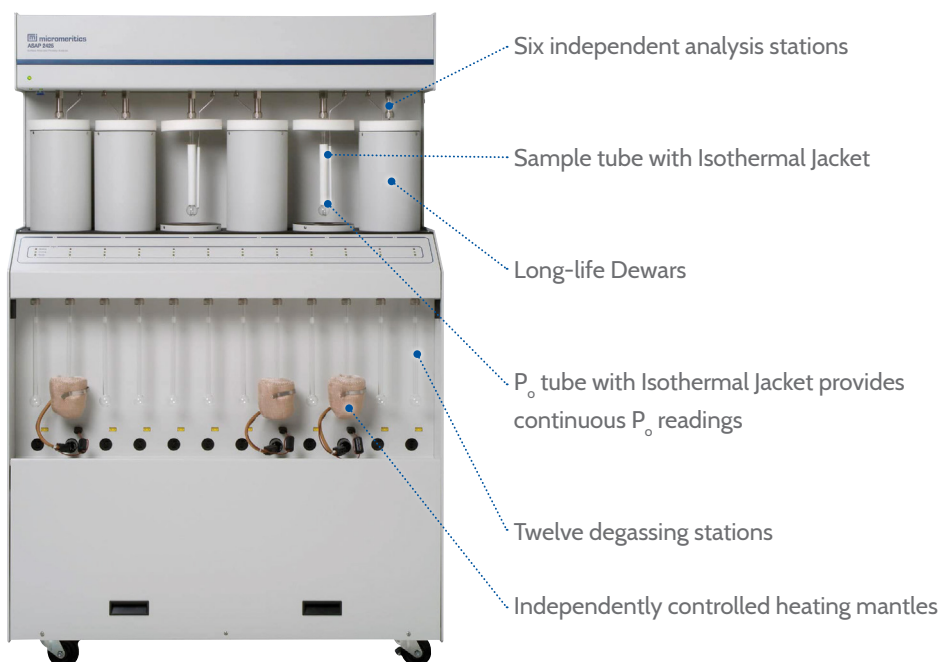
- Fully automated analyses
- High throughput with six independent analysis stations
- Each analysis port has a dedicated analysis and P_o pressure transducer
- Twelve independently controlled degas ports
- Evacuation rate precisely regulated by a servo valve
- BET surface area measurements in as little as 1 hour
- Dosing options of maximum volume increment or dosing over specified pressure ranges
- Entered or calculated analysis temperature
- Equilibration option allows user to specify equilibration times for different parts of the isotherm
- Low surface area option with five independent analysis ports



The ASAP 2425 includes Windows® compatible software. This advanced instrument operation software features a full graphical user interface that displays the instrument operations and a MicroActive reporting system that includes many standard and advanced reports for the characterization of powders and porous materials.



A standard feature of the ASAP 2425 is the integrated twelve-station degas system. Users may prepare up to twelve samples simultaneously. The sample degas procedure is software-controlled and allows easy-to-specify parameters for custom degas and sample preparation. User-defined evacuation rates and temperature ramps are provided to support even the most difficult-to-prepare samples.



TYPICAL ASAP 2425 APPLICATIONS

Pharmaceuticals

Surface area and porosity play major roles in the purification, processing, blending, tableting, and packaging of pharmaceutical products as well as their useful shelf life, dissolution rate, and bioavailability.

Ceramics

Surface area and porosity affect the curing and bonding of greenware and influence strength, texture, appearance, and density of finished goods. The surface area of glazes and glass frits affects shrinkage, crazing, and crawling.

Adsorbents

Knowledge of surface area, total pore volume, and pore size distribution is important for quality control of industrial adsorbents and in the development of separation processes. Surface area and porosity characteristics affect the selectivity of an adsorbent.

Activated Carbons

Surface area and porosity must be optimized within narrow ranges to accomplish gasoline vapor recovery in automobiles, solvent recovery in painting operations, or pollution controls in waste-water management.

Carbon Black

The wear lifetime, traction, and performance of tires are related to the surface area of carbon blacks used in their production.

Catalyst

The active surface area and pore structure of catalysts influence production rates. Limiting the pore size allows only molecules of desired sizes to enter and exit, creating a selective catalyst that will produce primarily the desired product.

Paints and Coatings

The surface area of a pigment or filler influences the gloss, texture, color, color saturation, brightness, solids content, and film adhesion properties. The porosity of a print media coating is important in offset printing where it affects blistering, ink receptivity, and ink holdout.

Projectile Propellant

The burn rate of propellants is a function of surface area. Too high a rate can be dangerous; too low a rate can cause malfunction and inaccuracy.

Medical Implants

Controlling the porosity of artificial bone allows it to imitate real bone that the body will accept and allow tissue to be grown around it.

Electronics

By selecting high surface area material with carefully designed pore networks, manufacturers of super-capacitors can minimize the use of costly raw materials while providing more exposed surface area for storage of charge.

Cosmetics

Surface area is often used by cosmetic manufacturers as a predictor of particle size when agglomeration tendencies of the fine powders make analysis with a particle-sizing instrument difficult.

Aerospace

Surface area and porosity of heat shields and insulating materials affect weight and function.

Geoscience

Porosity is important in groundwater hydrology and petroleum exploration because it relates to the quantity of fluid that a structure can contain as well as how much effort will be required to extract it.

Nanotubes

Nanotube surface area and microporosity are used to predict the capacity of a material to store hydrogen.

Fuel Cells

Fuel cell electrodes require high surface area with controlled porosity to produce optimum power density.

SPECIFICATIONS

Electrical

| | |
|-----------|---|
| Voltage | 100/115/230 VAC ($\pm 10\%$) |
| Frequency | 50 or 60 Hz |
| Power | 800 VA, exclusive of vacuum pumps, which are powered separately |

Environment

| | |
|-------------|---|
| Temperature | 10 to 30 °C operating, -10 to 55 °C storage or shipping |
| Humidity | Up to 90% (non-condensing) for instrument |

Capacity

| | |
|-----------------|---|
| Analysis System | 6 sample ports, each with a constantly monitored saturation pressure port |
| Degas System | 12 degas ports, each with independently controlled heating mantle |

Analysis System

| | |
|--|---|
| Manifold Temperature Transducer | Type: Platinum resistance device (RTD) Accuracy: ± 0.10 °C by keyboard entry Stability: ± 0.10 °C per month |
| Manifold Pressure Transducer | Range: Vacuum to 950 mmHg operating: 1000 mmHg maximum 10 mmHg added for krypton option 1 mmHg for micropore option Resolution: 1000 mmHg Transducer: 0.01 mmHg 10 mmHg Transducer: 0.0001 mm 1 mmHg Transducer: 0.00001 mm Accuracy: 1000 mmHg Transducer: within 0.1% FS 10 mmHg Transducer ¹ : within 0.15% of reading 1 mmHg Transducer ² : within within 0.12% of reading |
| Sample Port Transducer and Po Port Transducers | Range: 0 to 950 mmHg Resolution: 0.01 mmHg Accuracy: $\pm 0.1\%$ Full Scale |
| Vacuum Gauge | Type: Thermocouple Range: 0.001 to 1 mmHg |

Physical

| | |
|--------|-------------------|
| Height | 159 cm (62.5 in.) |
| Width | 103 cm (40.5 in.) |
| Depth | 51 cm (20.2 in.) |
| Weight | 160 kg (350 lb) |

Includes nonlinearity, hysteresis, and non-repeatability.

¹The 10 mmHg transducer is active only when performing krypton analyses.

²The 1 mmHg transducer is present only in the enhanced micropore option.

Vacuum System

| | |
|---------------------------|---|
| Nitrogen System Pumps | 2 oil-based pumps: 1 analysis, 1 degas 4 pumps (optional): 2 oil-free (1 analysis, 1 degas), 2 high vacuum (1 analysis, 1 degas) |
| Krypton & Micropore Pumps | 4 pumps: 2 oil-free (1 analysis, 1 degas), 2 high-vacuum (1 analysis, 1 degas) Oil-based mechanical pump: 5 x 10 ⁻³ mmHg ultimate vacuum Oil-free and high vacuum pump: 3.8 x 10 ⁻⁹ mmHg ultimate vacuum ³ |

Degas System

| | |
|------------------------------|--|
| Capacity | 12 degas ports |
| Vacuum Control | Selectable target pressure controls switchover from restricted to unrestricted evacuation |
| Evacuation | Selectable evacuation rate from 1.0 to 50.0 mmHg/s |
| Manifold Pressure Transducer | Range: 0 to 950 mmHg Resolution: 0.01 mmHg Accuracy: $\pm 0.1\%$ Full Scale |
| Vacuum Transducer | Type: Thermocouple Range: 0.001 to 1 mmHg |
| Titled Backfill Gas | User-selectable at dedicated port, typically nitrogen or helium |
| Temperature Control | Temperature Range: Ambient to 450 °C (Programmable) Temperature Control: 1 ramp during evacuation phase, 5 additional selectable ramps during heating phase Selection: Digitally set, 1 °C increments from computer Accuracy: Deviation less than ± 10 °C of set point at the sensing thermocouple embedded in the heating mantle |

Computer Requirements

Windows® 7 Professional or higher operating system recommended (64 bit)⁴
USB port⁵
Ethernet port (10 base T or 100 base T)

³Ultimate vacuum measured by pump manufacturer according to Pneuop Standard 5608

⁴Not to be installed on a network drive with shared access. Multiple users cannot operate the application at the same time.

⁵One additional USB port must be available for Instrument.

Due to continuous improvements, specifications are subject to change without notice.

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