

The World's only Simultaneous 5X Parallel Gravimetric Dynamic Vapor Sorption Analyzer



Capabilities:

- 5 balance simultaneous parallel sorption analysis for high throughput/high fidelity data
- Real-time mass measurement kinetics
- Isolated individual sample chambers
- Water vapor and organic sorption kinetics
- Patented Speed of Sound vapor sensor measurement technology
- Co-adsorption with two vapors
- Water vapor sorption isotherms from 10 to 70 °C
- Organic vapor sorption isotherms from 10 to 70 °C
- Optional single channel 200x color video microscopy
- True0™ drying at 0.0% RH.

DVS Endeavour



Key Measurement Capabilities

- Real-time simultaneous (5X) parallel mass measurements and sorption kinetics for 5 samples
- Individual sample chamber isolation preventing crossover contamination
- Sample masses from 1 mg to 5000 mg
- Water and organic vapor sorption kinetics and control using patented Speed of Sound vapor sensor measurement technology
- Multiple sorption/desorption, temperature and sample drying or activation cycles

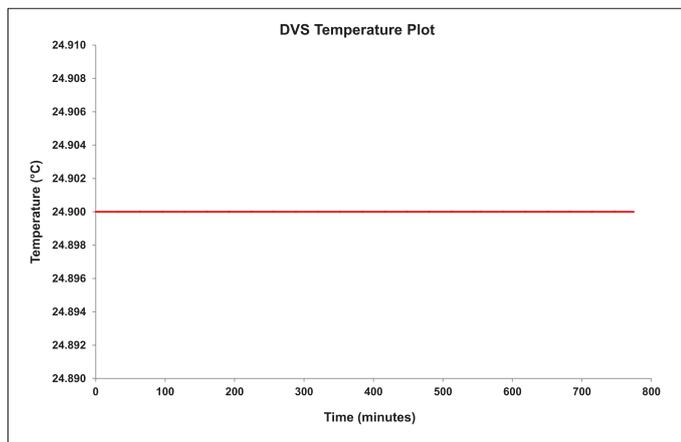
Key Hardware/Software Benefits

- 5 Individual balances operating in parallel
- Patented Speed of Sound vapor sensor measurement technology
- Open stainless steel stand design allows easy access to sample pans while minimizing static electric charging
- Broad temperature range (10-70 °C) from a single uniform and accurate temperature enclosure
- Next generation control and analysis software for the most advanced experimental design and data evaluation

Why Surface Measurement Systems?

- We invented the DVS technology and continue to innovate in our world leading sorption instruments
- Our industry leading sorption scientists stand behind every instrument
- Our service team provides uncompromising support to our customers and partners

DVS Endeavour - Outstanding Performance

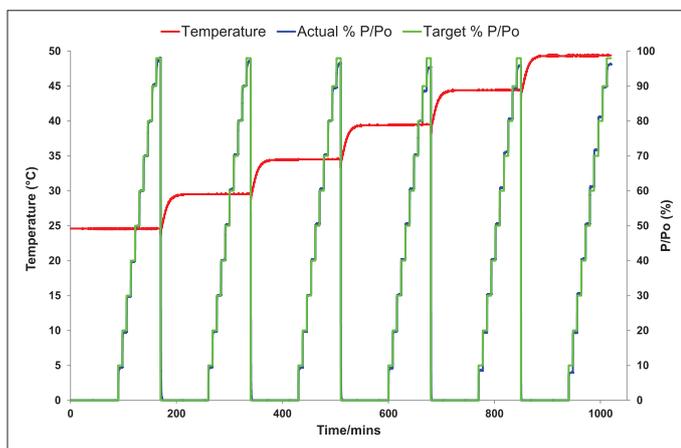
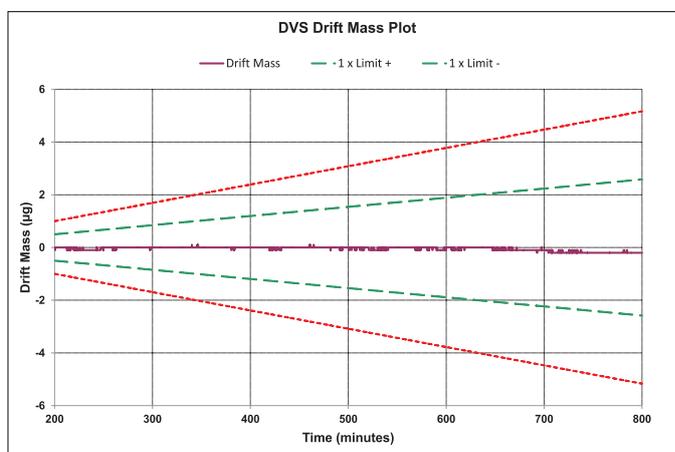


Long Term Temperature Stability

- Typical stability at 25 °C of ± 0.02 °C
- Vapor generation and delivery at sample temperature prevents condensation issues found in instruments with multiple temperature zones
- Allows for accurate and stable vapor generation and delivery: a 1 °C temperature variation can alter humidity up to 4% at 25 °C.

Balance Sensitivity and Stability

- Typical balance sensitivity and baseline stability over 10 hours shown at right
- Mass resolution of 0.1 μg
- Root mean square noise of ≤ 0.3 μg
- Samples mass of 1-1000 mg
- Large mass sample option up to 5 gram

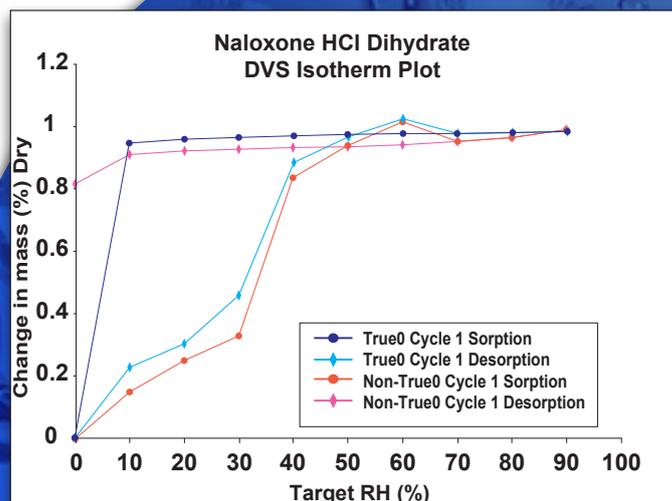


Humidity Performance

- Precision of ± 0.1 % RH of target humidity
- Highest level of humidity precision in any instrument in its class
- RH and Speed of Sound Probe options

True0™ RH

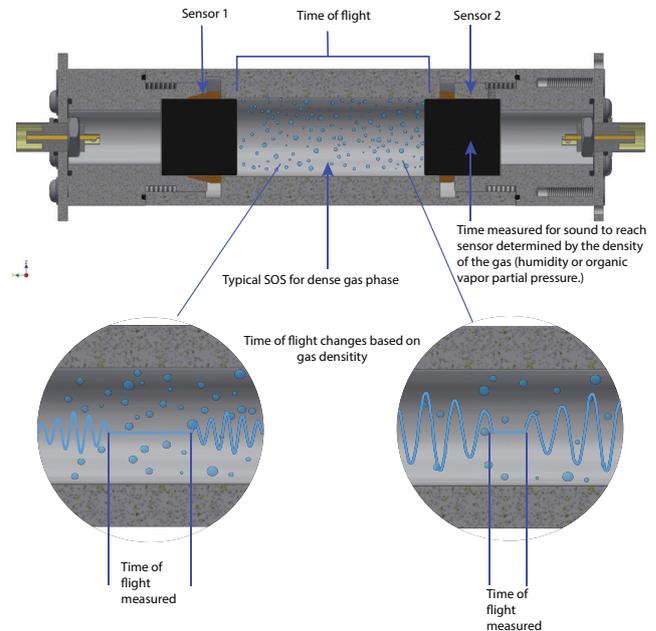
- Only DVS instrument offering True0™ RH
- Achieve partial pressure of water as low as 0.0% RH
- Hydration and dehydration kinetics below 1% RH can be readily studied
- Measurement of sorption/desorption isotherms at low RH or organic vapor concentration



The Only Technique to Directly Measure Solvent Concentration

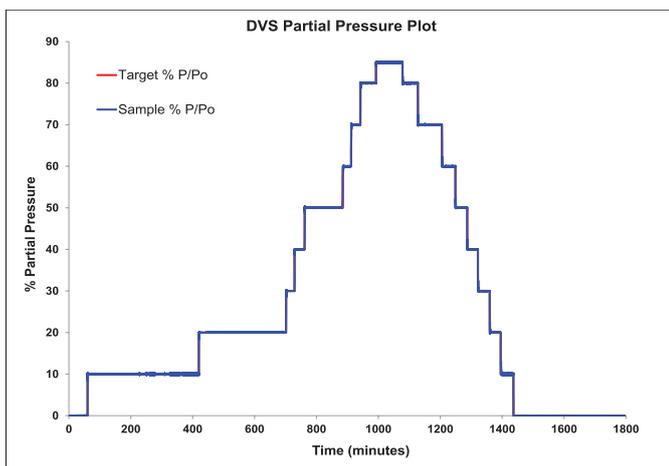
New Speed of Sound Vapor Sensor Measurement Technology

Previous methods for directly measuring solvent concentration have either been non-existent (i.e. predicting the solvent concentration) or in the case of the DVS- Advantage, used a specially configured dew point analyser for the measurement. Increased customer demand for a more universal and accurate measurement technology has resulted in SMS developing a revolutionary new sensor. The patented Speed of Sound vapor sensor measurement technology in the DVS Endeavour measures directly the vapor concentration using the speed of sound (SOS). The SOS is directly related to temperature, the chemical species present, and the absolute vapor concentration of the gas phase species. This technology allows for true closed loop control by adjusting the mass flow controlled vapor delivery to the sample using the real time speed of sound measurement. Not only is the SOS measurement fast (1s), it is reliable and a fundamental gas phase property.



High Precision Organic P/P_o Delivery

- Unrivalled partial pressure concentration precision
- Closed loop experiment P/P_o control



The Only Method to Directly Measure Solvent Concentration

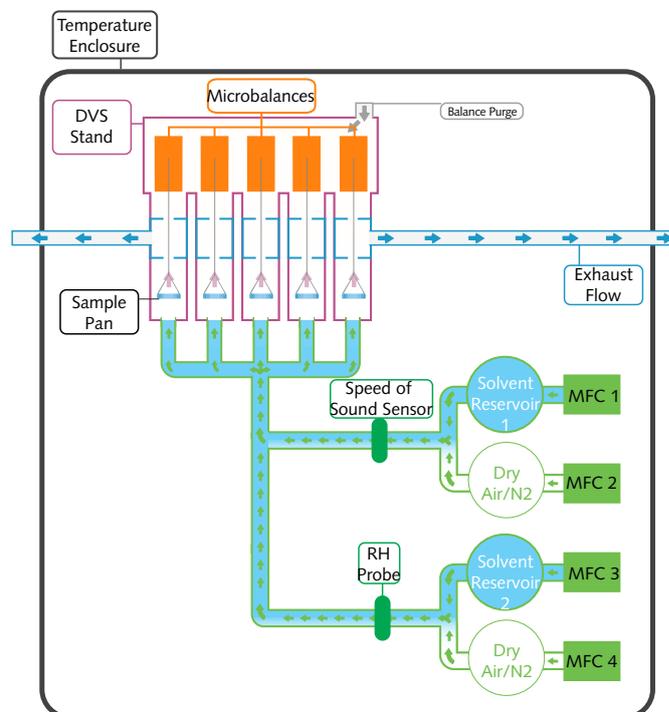
- Speed of sound is an intrinsic property of the vapor or gas measured. Calculates solvent concentration based on the speed of sound travelling through a fixed and known path length of solvent vapor or gas at a known temperature
- Dual Speed of Sound sensors available for complex organic solvent control or solvent co-adsorption measurements
- Automated path-length self-calibration prior to each experiment (1 second calibration time)

Modular Capabilities of DVS Endeavour

Solvent Delivery Configurations

Using the Speed of Sound Sensors, the DVS Endeavour measures and controls combinations of:

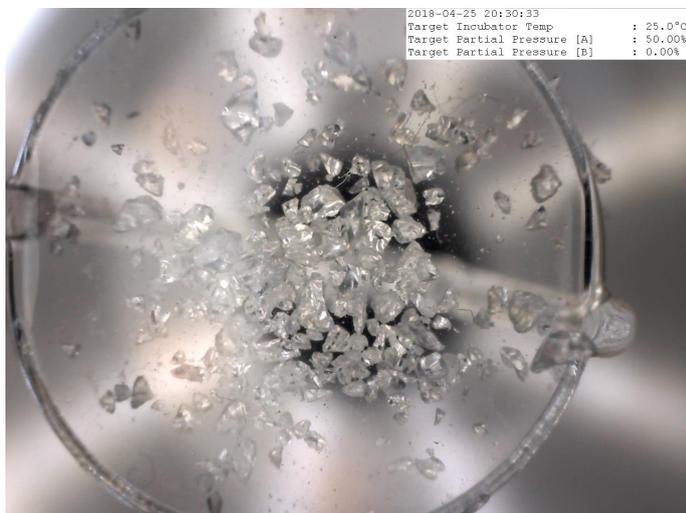
- Humidity
- Organic vapors
- Gases
- Two components systems
- Organic vapor with background humidity



DVS Endeavour Schematic

Optional Microscopy and Video

- Optional 1.3 mega-pixel color camera
- 200x optical zoom
- Images are time-date-temperature-partial pressure stamped
- Grid overlay and calibration for measuring dimensional change

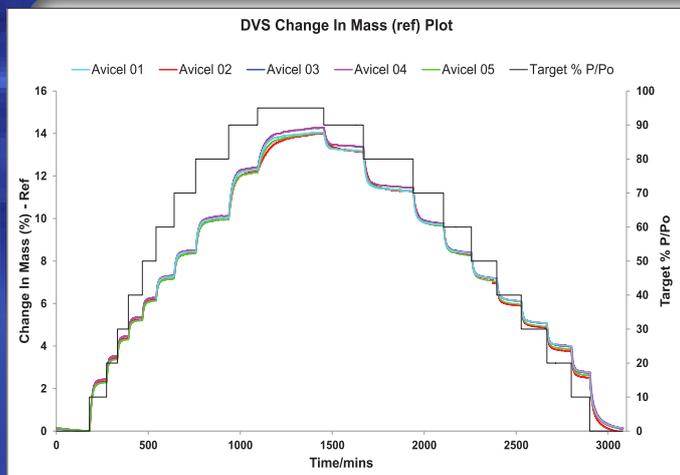


High Temperature Preheater for Drying, Curing and Humidity Generation at Elevated Temperatures

- *In-situ* degassing/activation of samples up to 200 °C
- The temperature is measured by a Pt100 resistance thermometer directly below the sample pan



Applications of DVS Endeavour



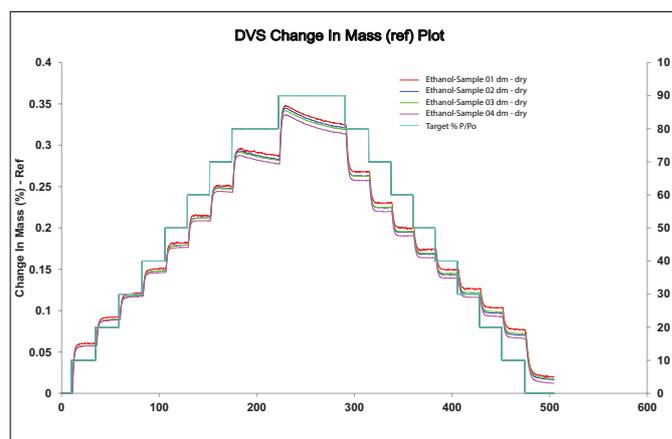
Lot to Lot Moisture Sorption/Desorption Variation of Microcrystalline Cellulose

- Investigation of batch to batch variation in raw materials and production technical support
- Ingredient compatibility
- Quality control for excipients, actives and formulations
- Stability studies in the selection of new compounds/candidates
- Large scale formulation studies

Moisture Sorption/Desorption Variation Within the Same Lot of Crystalline Material

Only true high-throughput gravimetric dynamic vapor sorption kinetics for 5x samples in parallel. Multiple-method protocols incorporating:

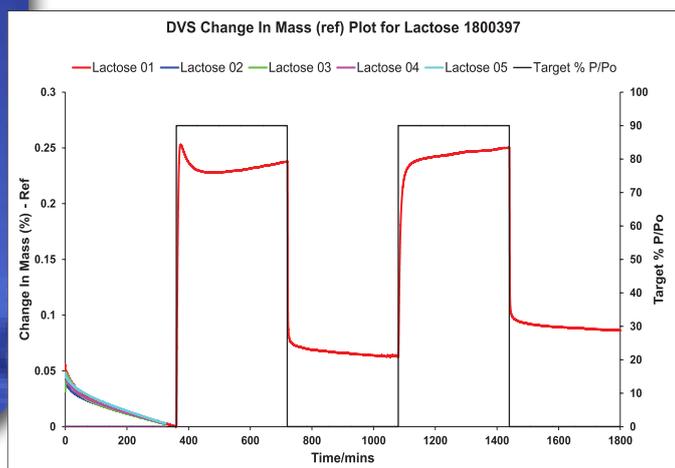
- Isotherms and ramped humidity/organic vapor and experiments
- Vapor sorption, vapor exchange and dual vapor co-adsorption
- Experiments may include half, full or multiple partial pressure or temperature cycles
- Most versatile yet simple experimental control interface
- Small footprint



Processing Variations Affect Amorphous Content and Humidity Sorption/Desorption of Milk Powder

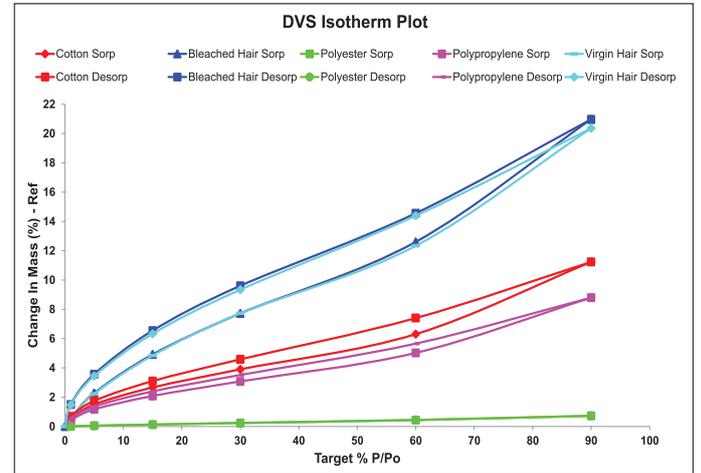
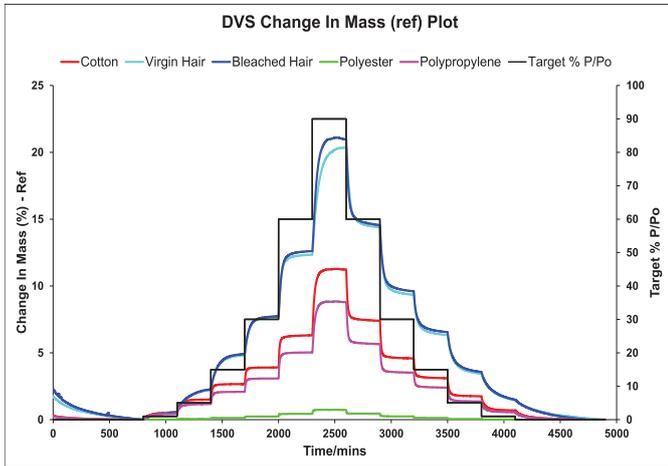
High sensitivity balance, temperature stability, and accurate vapor generation for measurement of rapid and/or small mass changes for process induced surface and bulk properties including:

- Amorphous content
- Hydrate/solvate formation
- Polymorph identification
- Moisture/solvent induced T_g
- Small sample size where only low quantity materials are available

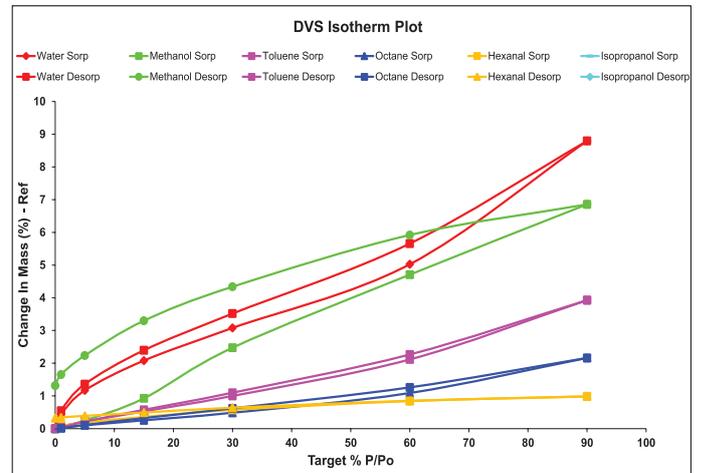
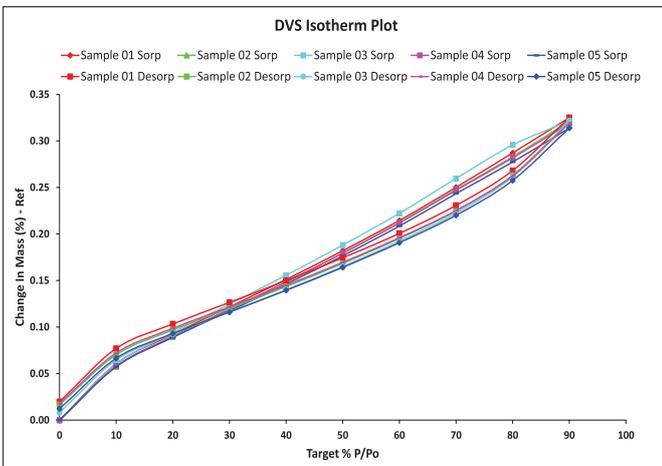


Applications of DVS Endeavour

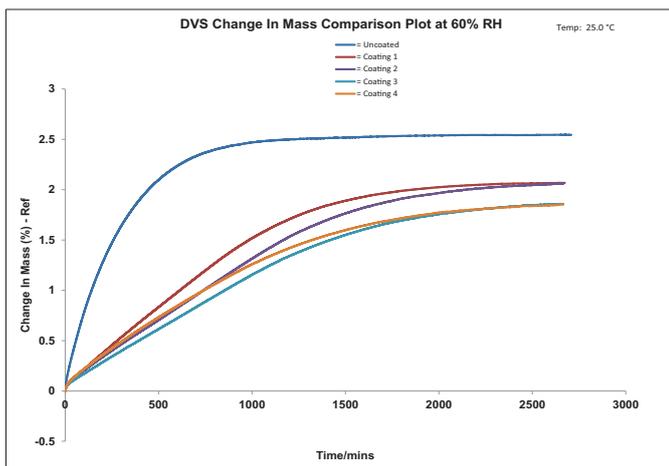
Variation in Fiber Humidity Sorption/Desorption Kinetics and Isotherms



Fiber Sorption Isotherms for Moisture and a Series of Organic Vapors



Film Diffusion Coefficient for Moisture Barrier Coatings



Sample	Weight Gain 40° C/75% RH	Moisture (%)	Δ in Mass (%)	Average Coating Thickness (μm)	Diffusion Coefficient (cm ² /sec)
Uncoated	0.67	4.56	2.50	37.15	3.63 x 10 ⁻¹⁰
Coating 1	0.68	4.30	1.90	33.61	1.14 x 10 ⁻¹⁰
Coating 2	0.80	4.37	1.75	27.66	7.02 x 10 ⁻¹¹
Coating 3	0.67	4.34	1.55	33.79	6.50 x 10 ⁻¹¹
Coating 4	0.58	4.31	1.60	38.31	1.22 x 10 ⁻¹⁰



Surface Measurement Systems

World Leader in Sorption Science

Temperature

Temperature controlled enclosure

Control range: 10 °C to 70 °C
Regulation precision: ± 0.02 °C
Enclosure also provides anti-condensation protection

High temperature pre-heater for sample drying/activation

200°C (maximum local temperature)
Heating ramp rates: up to 10 °C/min
Sensor: Pt-100 resistance thermometer

Endeavour Stand

Manifold: 316 stainless steel
Seals: Viton
Tubing: 1/4 inch stainless steel

Solvent Reservoirs

Material: Pyrex glass
0.25 and 0.5L as standard
2 Reservoirs included

Relative Humidity Generation and Measurement

Flow control

High accurate digital mass flow controllers

Relative Humidity Sensor

Capacitance probe
Carrier Gas - Dry air or Nitrogen
Relative humidity range from 0 to 98%*
RH range accuracy from 10 - 60 °C $\pm 0.5\%$ *
RH range accuracy from 60 - 70 °C $\pm 1\%$ *

Organic Vapor Generation and Measurement Speed of Sound Sensor

Partial pressure range from 0 to 90%
P/P_o range accuracy from 10 - 70 °C $\pm 1\%$

Speed of Sound sensor for organic vapors
Real time partial pressure measurement and control

Solvents Available include:

Water	Toluene
Pentane	Acetone
Heptane	Chloroform
Hexane	o-Xylene
Octane	m-Xylene
Nonane	p-Xylene
Decane	Benzyl Acetate
Cyclohexane	Ethyl Acetate
Methanol	d-Limonene
Ethanol	Tetrahydrofuran
Phenol	Dioxane

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Instrument Platform

System Software

Next generation purpose built control and evaluation software for the most advanced experimental design and data analysis.

Analysis

- Isotherms
- Permeability and diffusion
- Kinetics information
- Surface area models
- Heat of sorption
- T_g determinations
- A_s morphous content

Control

Multiple-method protocols incorporating:

- Sample pre-heating
- Vapor sorption
- Vapor exchange
- Dual vapor co-adsorption
- Temperature changes in a single experiment, including
- Ramp or step changes in relative humidity
- Automated video image acquisition
- Organic vapor sorption partial pressure
- Temperature stages may be based on fixed-time or user-defined dm/dt criteria
- Complex isotherm experiments
- Experiments may include half, full or multiple partial pressure or temperature cycles

Mass Measurement

Ultrabalance High Sensitivity

Low Mass SMS microbalance
Sample mass: between 1 and 1000 mg
Mass change: ± 150 mg
Resolution (precision): 0.1 μg *
Root mean square balance noise: ≤ 0.3 μg *

Ultrabalance High Mass

High Mass SMS microbalance
Sample mass: between 10 and 5000 mg

Mass change: ± 1000 mg
Resolution (precision): 1 μg *
Root mean square balance noise: ≤ 3 μg *

Software Options

Standard

- Control
- Analysis

Advanced

- Analysis Suite
- Isotherm Analysis Suite

CFR

- Control
- Analysis
- Advanced Analysis Suite
- Isotherm Analysis Suite

*For a current list of calibrated solvents or to request a solvent be calibrated contact sales@surfacemeasurementsystems.com

** Salt calibration is at 25 °C and any other request, please contact your sales advisor

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