DVS ENDEAVOUR

Surface Measurement Systems
World Leader in Sorption Science

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 and organic vapor 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

www.SurfaceMeasurementSystems.com

DVS Endeavour



Key Measurement Capabilities

- Real-time simultaneous parallel mass measurements and sorption kinetics for up to 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

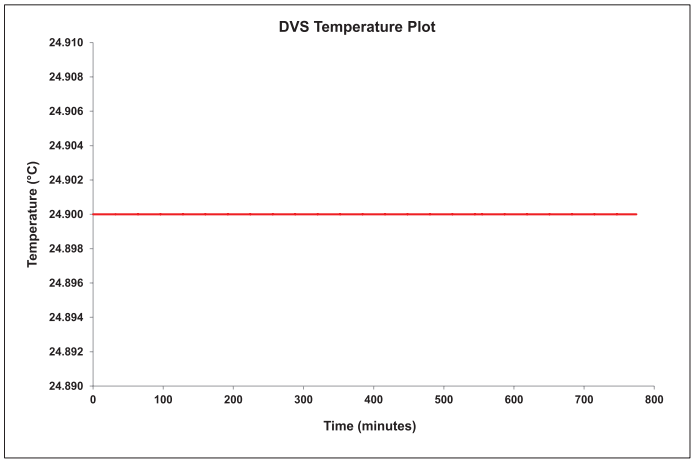
Key Hardware/Software Benefits

- 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

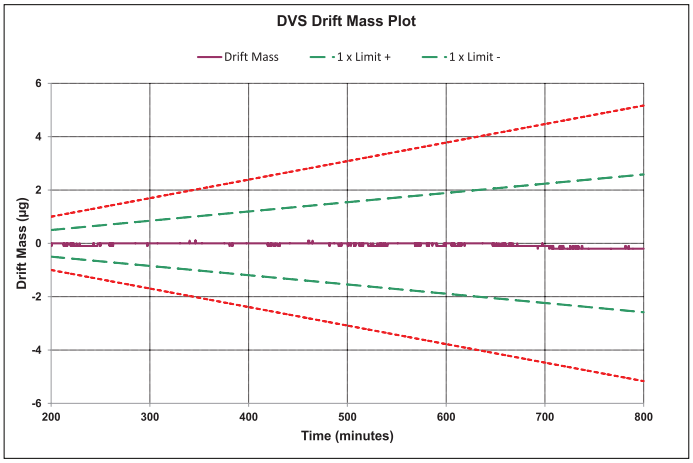


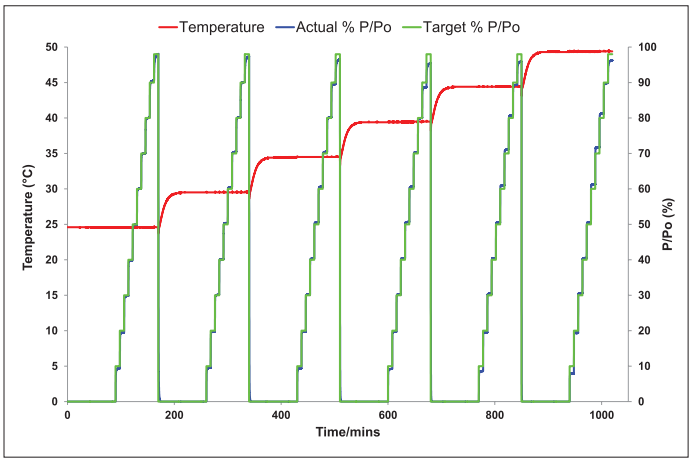
Long Term Temperature Stability

- 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 grams



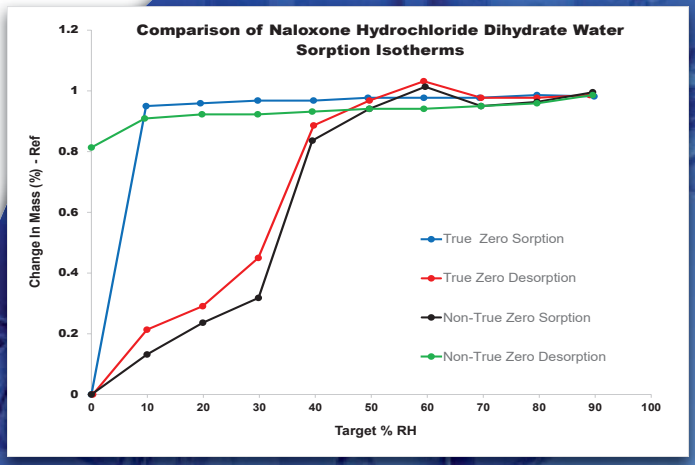


Humidity Performance

- 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

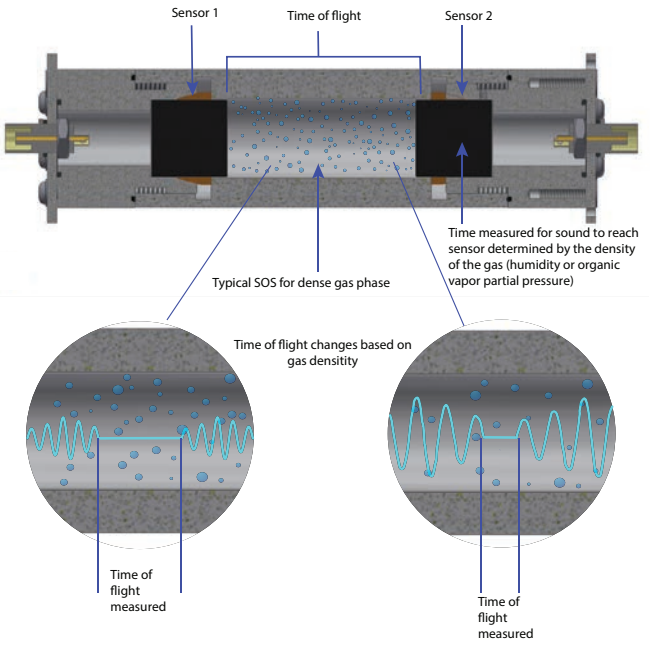
- Only DVS instrument offering True0™ RH
- Achieve partial pressure of water as low as 0.0% RH
- Hydration and dehydration kinetics below 1% RH can be readily studied
- Measurement of sorption/desorption isotherms at low RH or organic vapor concentration



The Only Technique to Directly Measure Solvent Concentration

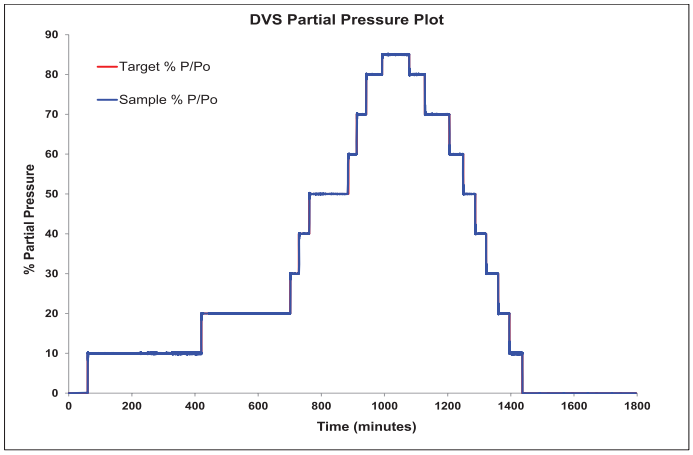
New Speed of Sound Vapor Sensor Measurement Technology

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/Po control



The Only Method to Directly Measure Solvent Concentration

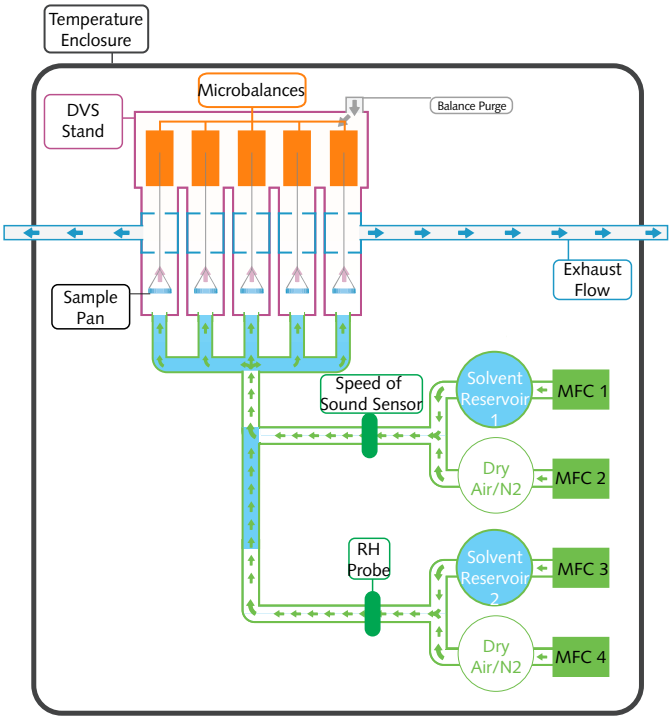
- Speed of sound is an intrinsic property of the vapor or gas measured. Calculates solvent concentration based on the speed of sound travelling through a fixed and known path length of solvent vapor or gas at a known temperature
- Dual Speed of Sound sensors available for complex organic solvent control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

Modular Capabilities of DVS Endeavour

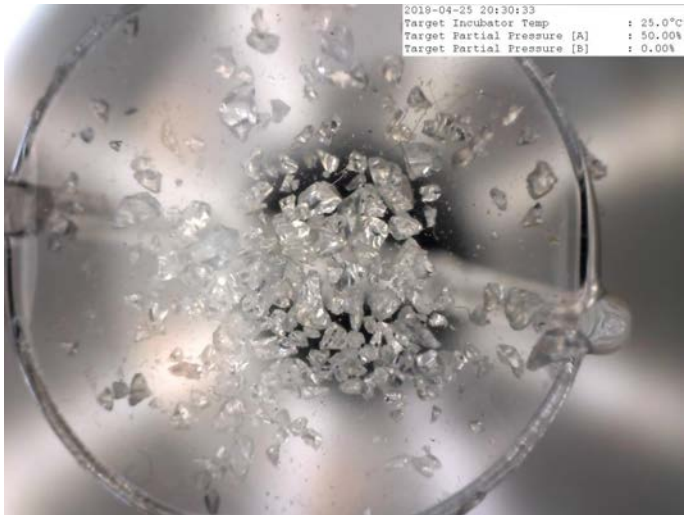
Solvent Delivery Configurations

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

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



DVS Endeavour Schematic



Optional Microscopy and Video

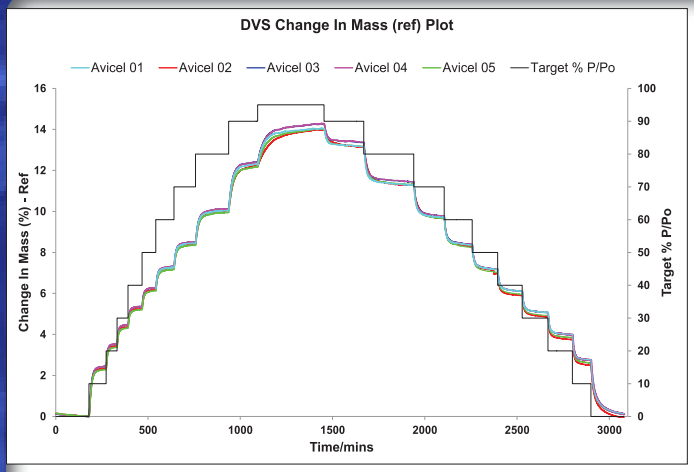
- Optional 1.3 megapixel color camera
- 200x resolution
- Images are time-date-temperature-partial pressure stamped
- Grid overlay and calibration for measuring dimensional change

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



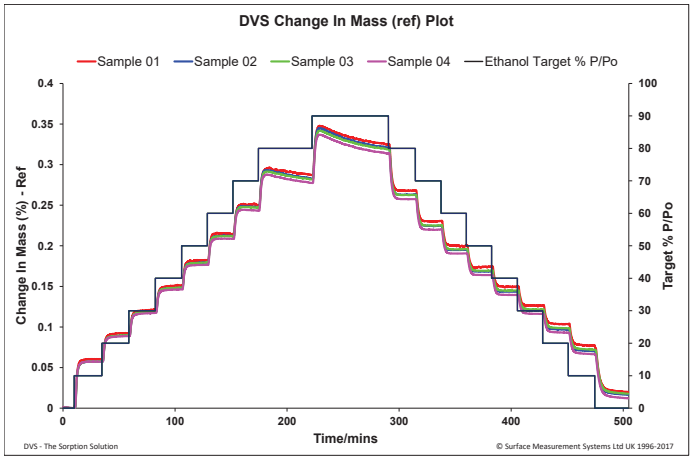
Lot-to-Lot Moisture Sorption/Desorption Variation of Microcrystalline Cellulose

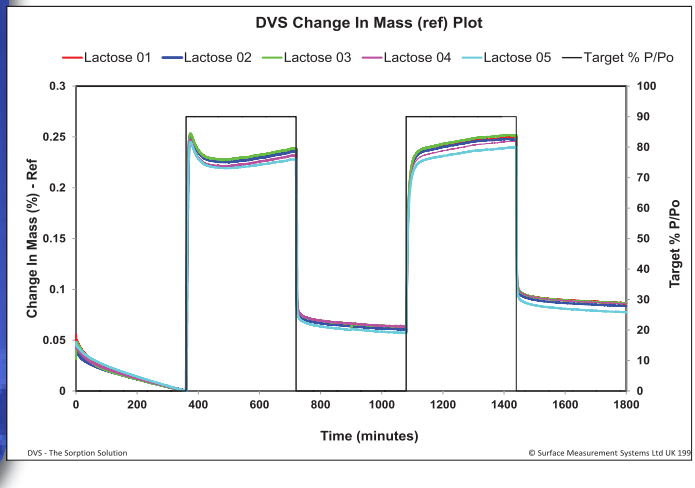
- Investigation of batch-to-batch variation in raw materials and production technical support
- Ingredient compatibility
- Quality control for excipients, actives and formulations
- Stability studies in the selection of new compounds/candidates
- Large scale formulation studies

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





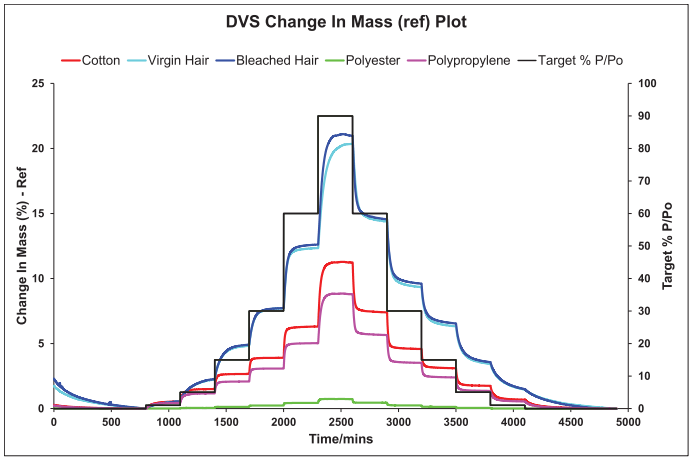
Processing Variations Affect Amorphous Content and Humidity Sorption/Desorption of Milk Powder

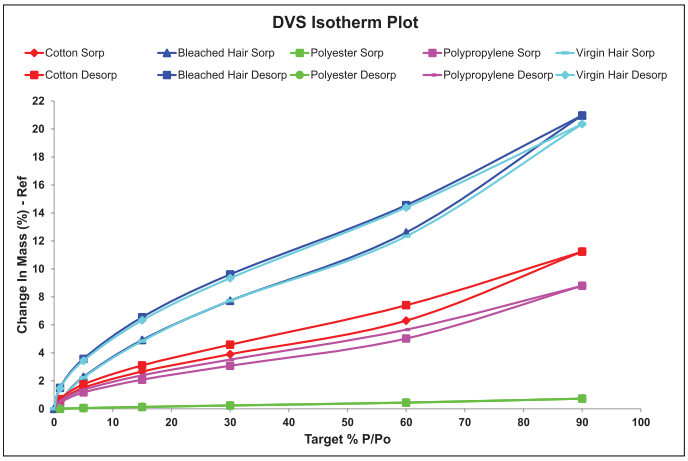
High sensitivity balance, temperature stability, and accurate vapor generation for measurement of rapid and/or small mass changes for process induced surface and bulk properties including:

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

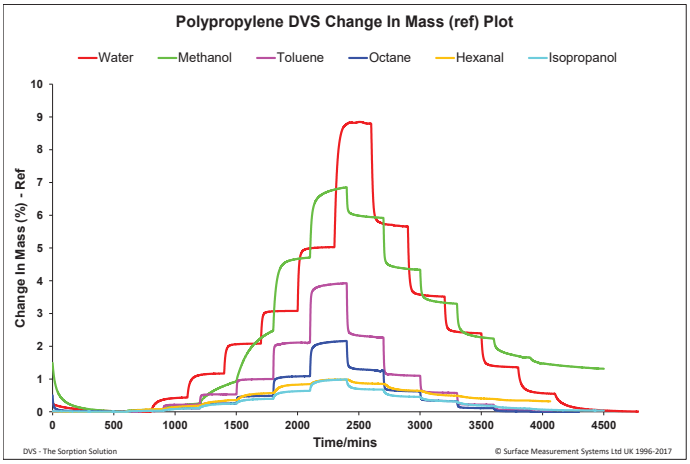
Applications of DVS Endeavour

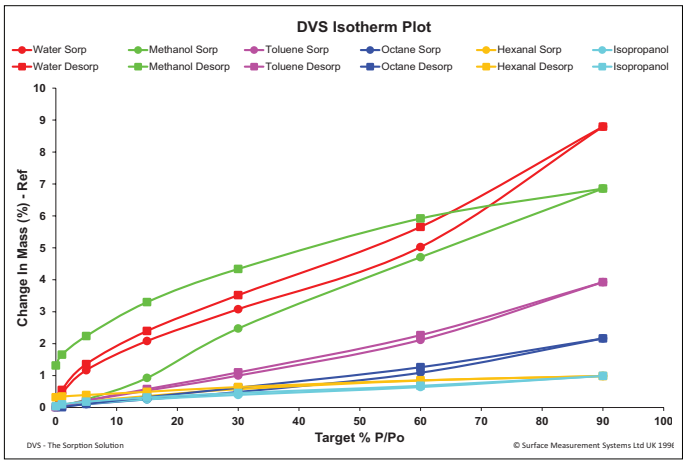
Variation in Fiber Humidity Sorption/Desorption Kinetics and Isotherms



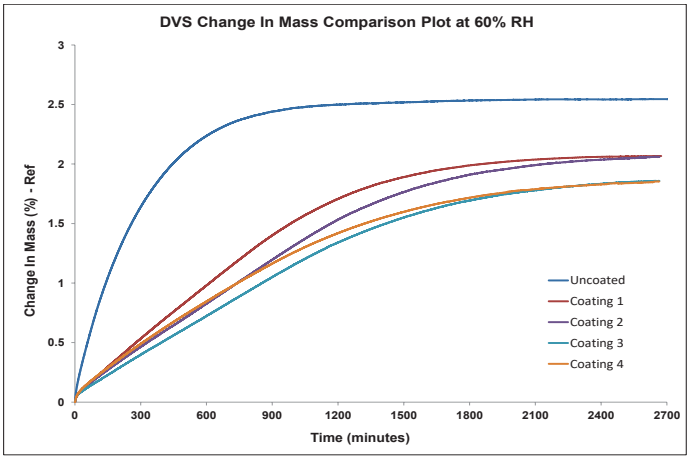


Fiber Sorption Isotherms for Moisture and a Series of Organic Vapors





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	3.63×10^{-10}
Coating 1	0.68	4.30	1.90	33.61	1.14×10^{-10}
Coating 2	0.80	4.37	1.75	27.66	7.02×10^{-11}
Coating 3	0.67	4.34	1.55	33.79	6.50×10^{-11}
Coating 4	0.58	4.31	1.60	38.31	1.22×10^{-10}

Surface Measurement Systems

World Leader in Sorption Science

Temperature

Temperature controlled enclosure

Control range: 10 °C to 70 °C
Regulation precision: ± 0.1 °C
Enclosure also provides anti-condensation protection

High temperature pre-heater for drying samples up to 200 °C

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

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 ±0.5%*
RH range accuracy from 60 - 70 °C ±1%*

Organic Vapor Generation and Measurement Speed of Sound Sensor

Partial pressure range from 0 to 90% ¤ see note
P/P_o range accuracy from 10 - 50 °C ±1% ¤¤ see note

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

Solvents Available include:

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

Instrument Platform

System Software

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

DVS Control Software

Multiple-method protocols incorporating:

- Sample pre-heating
- Vapor sorption
- Vapor exchange
- Dual vapor co-adsorption
- Temperature changes in a single experiment
- 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

DVS Analysis Software

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

Software Options

Standard

- DVS Control Software
- DVS Standard Analysis

Advanced

- DVS Advanced Analysis Suite
- DVS Isotherm Analysis Suite

21CFR Part 11 software solution is available for all DVS software upon request

Mass Measurement

Ultrabalance Low Mass

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*

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

The instrument is factory calibrated at 25°C including salts calibrations. Calibrations at different temperatures including salts available upon request.
Speed of Sound sensor is calibrated for solvents listed in Solvents Available upon request.

Additonal solvent calibrations available upon request.

¤ depending on the solvent selected and temperature of the incubator
¤¤ depending on the solvent selected

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