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Aquadyne *DVS*

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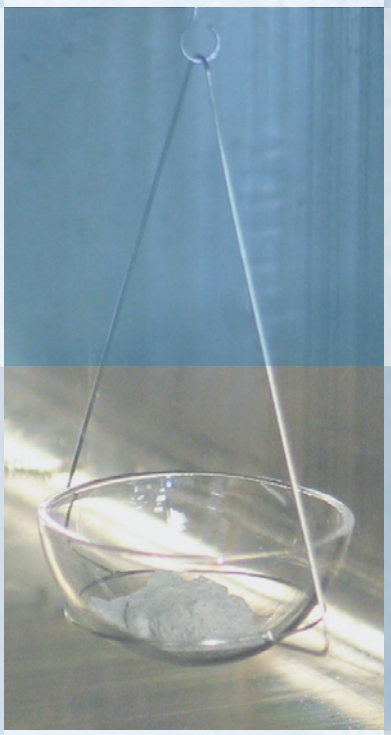
automated, gravimetric, water sorption analyzers

- pharmaceuticals
- food
- construction materials
- fuel cell research
- papers
- carbons
- archaeological ceramics
- advanced materials



DVS-1/DVS-2

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INSTRUMENTS

Aquadyne DVS-1/DVS-2
instrument features

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DVS-1/DVS-2

Water sorption behavior plays an important role in the development and use of many common and advanced materials. Some examples include:

- Stability of pharmaceutical excipients and drug actives
- Drying and storage of grains
- Texture and shelf life of food products
- PEM fuel cell components
- Mortar, grout and other cementitious materials
- Paper and coatings
- Hydrophobic surface treatments
- Microporous and nanostructured carbons
- Archaeological ceramics

The Aquadyne DVS instruments are fully automated, gravimetric, one or two sample water vapor sorption analyzers. They measure adsorption and desorption isotherms of water vapor both accurately and sensitively, including sorption kinetics, with minimal operator involvement. The weight(s) of one or two sample(s) is / are constantly monitored and recorded as the relative humidity is automatically varied by the blending of dry carrier gas with a saturated gas stream using precision mass flow controllers. The dual balance design of the Aquadyne DVS-2 allows increased analysis throughput, side-by-side comparison with known or reference materials, or an extended mass range for a single sample.

The independently temperature controlled balance head environment ensures long term stability. The small sample chamber ensures rapid changes in sample atmosphere conditions when the relative humidity is altered during an analysis. Sample(s) can be pre-dried insitu up to 85° C (DVS-2) in a flow of dry gas. The software is available in a 21 CFR Part-11 compliant version, and runs under Windows® XP, Vista and Windows 7.

Measurement capabilities

Isotherms:
Mass change as a function of changing relative humidity, increasing mass during adsorption (increasing RH%), decreasing mass during subsequent desorption (decreasing RH%).

Kinetics:
Time-dependent studies give the rate of sorption.

Effect of Temperature:
Isotherms and kinetics change as a function of temperature. Can be used to yield sorption enthalpies.

Aquadyne DVS-1/DVS-2
applications/results

Deliquescence:
Certain salts exhibit the property of dissolving in self-adsorbed water.

Equilbrium moisture content:
Quantitatively the amount of water associated (adsorbed/ absorbed) with the material under given atmospheric conditions of temperature and relative humidity (organic materials may be subject to molding according to atmospheric humidity, for example).

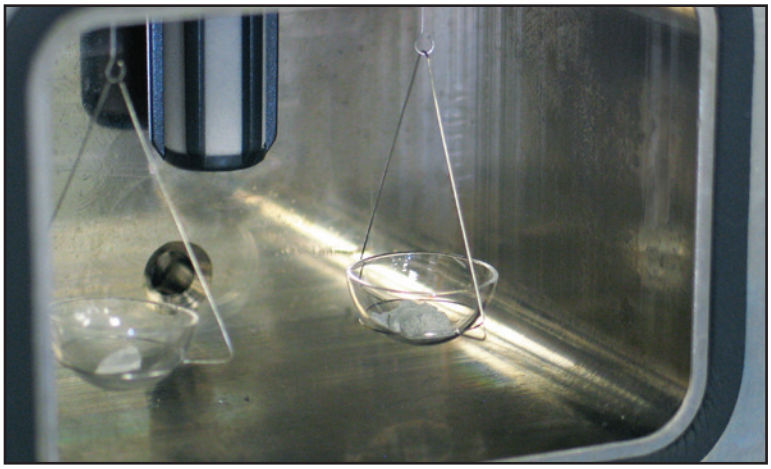
Hysteresis working range:
Adsorption and desorption usually differ by hysteresis - this gives a range of stability in which subsequent sorption cycles produce no change in equilibrium moisture content.

Hydrophobicity/philicity:
The shape of the isotherm reveals relative strength of affinity between water and the surface, due to polar or other chemical interactions.

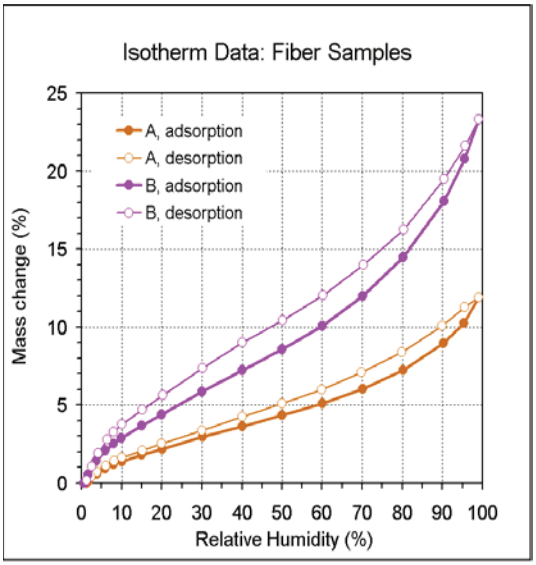
Micropore investigations:
Even hydrophobic materials can take up moisture if their pores are small enough.

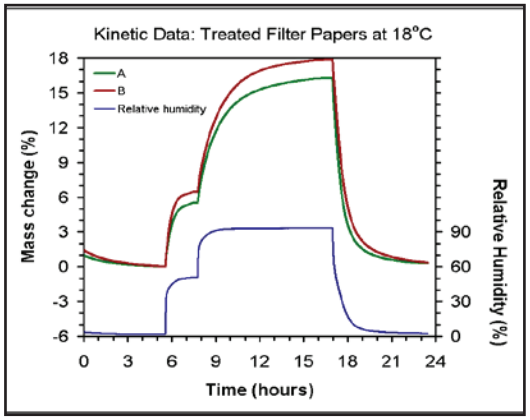
Crystallization phenomena:
Certain amorphous materials will undergo crystallization as a function of water sorption due to, for example, shifts in glass transition points.

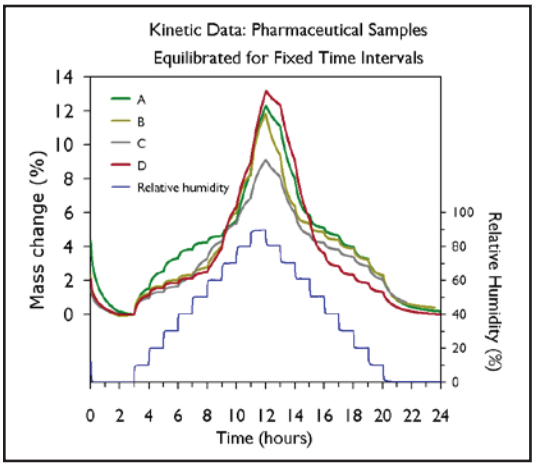
Sample form:
Sorption kinetics can be altered by the physical form of a material - powder, granule, pellet, tablet, monolith etc.



The dual sample capability of the Aquadyne DVS-2 is illustrated above.







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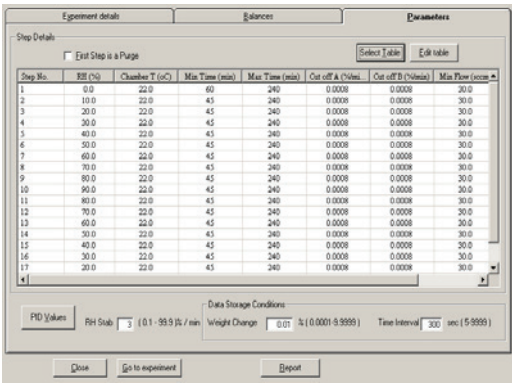
Aquadyne DVS-1/DVS-2
software/specification

Software

The Aquadyne DVS is operated through user-friendly software running under Windows®. Sample analyses are easily and quickly set up in terms of target RH with equilibration criteria based on rate of weight change and/or time. The software automatically records kinetic sorption data and isotherm points at user selectable intervals. During the run, data points yet to be recorded can be deleted, added to, or edited for different values (even sample chamber temperature) for real-time optimization.



Both kinetic and isotherm plots for points acquired can be viewed during the analysis, separately for each balance, or combined in an overlay plot. Once analyzed, results can be viewed in tabular and graphical format, and calculations such as BET surface area and heats of adsorption performed. Data can also be exported in a csv format.

Specifications

DVS-1 Balance heads:	1
DVS-2 Balance heads:	2
Balances, type:	ultrasensitive electronic microbalances
Balance load capacity(each):	5g
Balance load capacity(combined):	10g *(DVS-2* only)
Dynamic weighing range(each):	-500mg to + 500mg, 0 to +1000mg
Dynamic weighing range(combined):	-1000mg to +1000mg, 0 to + 2000mg *(DVS-2* only)
Weighing resolution:	0.1µg
RH range:	<2% - 98% (depending on temperature).
RH resolution:	0.1%
RH accuracy :	± 0.8% RH at 25°C
Sample chamber temperature range:	<10 - 80°C *(DVS-2)*, 15-60°C *(DVS-1)*
Sample chamber temperature stability:	± 0.1°C
Balance head temperature :	Up to 85°C (DVS-2), 75°C (DVS-1)
Gas flow rates:	0 - 200 cm^3/min (mass flow controllers)
Viewing port / sample chamber door:	heated, triple-glazed
Data acquisition rate:	adjustable, up to 12 points per minute
Sample pan material:	silica (other materials can be employed)
Water reservoir capacity:	46 ml

DVS-1/DVS-2

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Utilities

Dimensions(W x D x H):	45cm x 60cm x 55cm (18" x 24" x 22")
Weight:	60kg(132 lbs.)
Electrical:	100-230 V~, 50/60Hz - single phase
Compressed gas:	dry air or nitrogen regulated to 8-15 psig
PC:	Windows 2000 or higher operating system with RS232 communications port and 9-pin D-sub connector.

Accessories

Regulator assembly, p/n: 01207

A part from electricity, the only utility the Aquadyne DVS requires is dry air or nitrogen regulated to the required pressure. Our two-stage regulator assembly includes CGA580 fitting and isolation valve.

Granite block, p/n: 90095

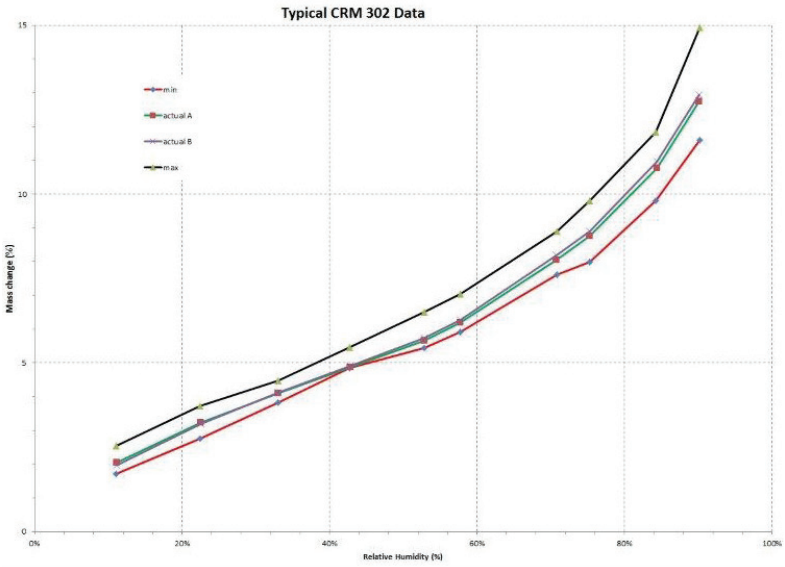
Aquadyne DVS base. Granite slab 46cm x 61cm x 8cm.

Cost 90 Project

In an effort to standardize the determination of water activity in foods, the European COST 90 project[1] made recommendations for the method of measurement of the water adsorption. The method specified using saturated salts to control the relative humidity and weighing the samples dry and after several days of equilibration.

Microcrystalline Cellulose (MCC) was selected as a standard and certified in a round-robin study involving ten independent labs[2]. The mean percent adsorbed was determined and reported. These data form an internationally accepted standard for validation of instrumentation and methods used to measure water sorption.

Although these data were obtained using a static method, well-equilibrated dynamic vapor sorption (DVS) data should be in good agreement with these data.



302 data collected on an Aquadyne DVS-2 showing close agreement between the two balances. The black and red curves represent the CRM 302 mean adsorbed amount ±2.77σ.

Aquadyne DVS Performance

All Aquadyne DVS instruments are tested using the CRM 302 MCC standard and must fall within ±2.77σ of the published mean before shipping. Validating these instruments to this internationally accepted standard ensures the highest quality data in your specific application.

CRM 302 data compared to acceptance limits

Data Point	RH% Requested Value	RH% Actual-Value	Sample Temp	Min	Actual A	Actual B	Max
1	11.1%	11.1%	25.00	1.717963	2.048538	1.976655	2.542038
2	22.5%	22.5%	25.00	2.763976	3.225222	3.193948	3.716025
3	33.0%	33.0%	25.00	3.825633	4.10964	4.114775	4.474367
4	42.8%	42.8%	25.00	4.85627	4.865123	4.910316	5.463731
5	52.9%	52.9%	25.00	5.440653	5.654797	5.729425	6.499347
6	57.7%	57.7%	25.00	5.922122	6.186601	6.261578	7.037878
7	70.8%	70.8%	25.00	7.610407	8.052447	8.17559	8.889593
8	75.3%	75.3%	25.10	7.993618	8.758911	8.902286	9.806583
9	84.3%	84.4%	25.10	9.794112	10.76172	10.97425	11.83879
10	90.2%	90.1%	25.00	11.60011	12.739	12.93684	14.93989

[1]Spiess W.E.L. & Wolf W.R. (**1983**) "*The Results of the COST 90 Project on Water Activity in Physical Properties of Foods (Part I).*" Eds Jowett R., Eschen F., Halström B., Meffort H.F.Th., SPIES W.E.L. & VOS G. Applied Sci. Publishers, London.

[2]Jowitt, R. & Wagstaff, P.J. (**1989**) "*The Certification of the water content of microcrystalline cellulose (MCC) at 10 water activities — CRM 302.*" Office for Official Publications of the European Communities, Luxembourg.

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