

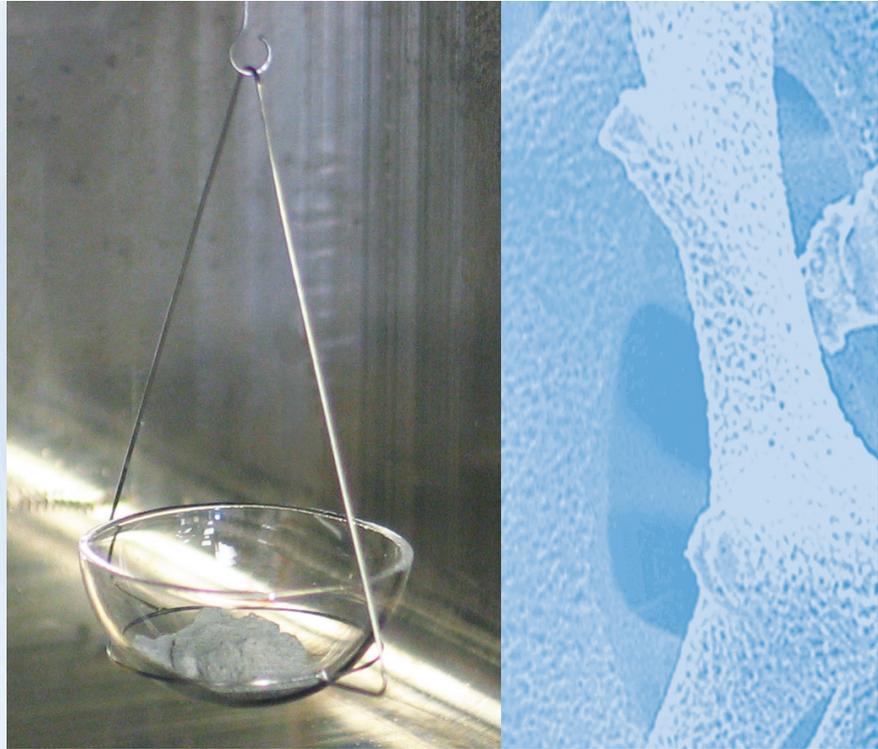
Aquadyne DVS

automated, gravimetric, water sorption analyzers

Fuel Cell Research

Papers

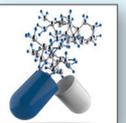
Advanced Materials



DVS-1/DVS-2/DVS-2HT



Pharmaceuticals



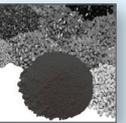
Foods



Archaeological Ceramics



Carbons



Construction Materials



Instrument Features DVS-1/DVS-2HT

Aquadyne DVS-1 has one balance
Aquadyne DVS-2HT has two balances



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-2HT 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 90° C (DVS-2HT) in a flow of dry gas. A version of the software which fully supports 21 CFR Part 11 is available to ensure and document the integrity of the data. The software runs under Windows 7 or higher.

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.

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Applications/Results DVS-1/DVS-2HT

Deliquescence:

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

Equilibrium 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/phility:

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

Micropore investigations:

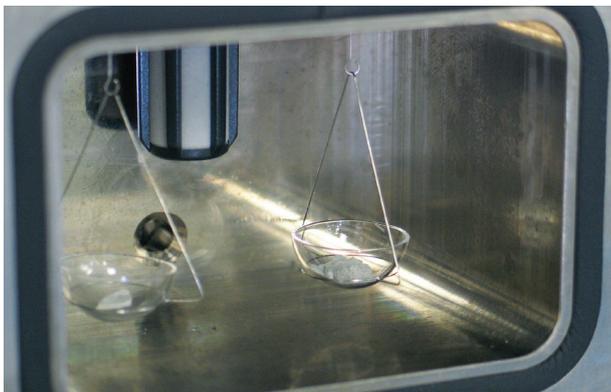
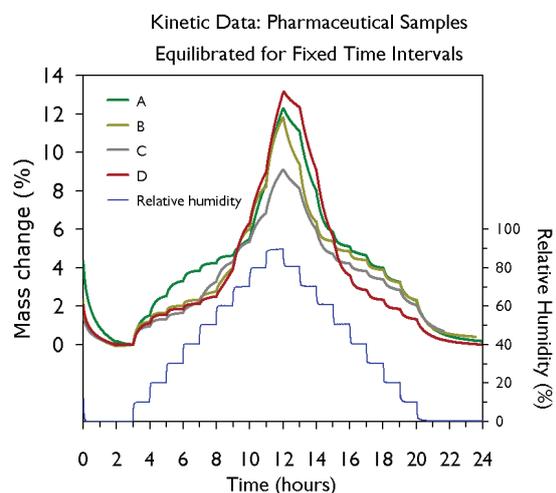
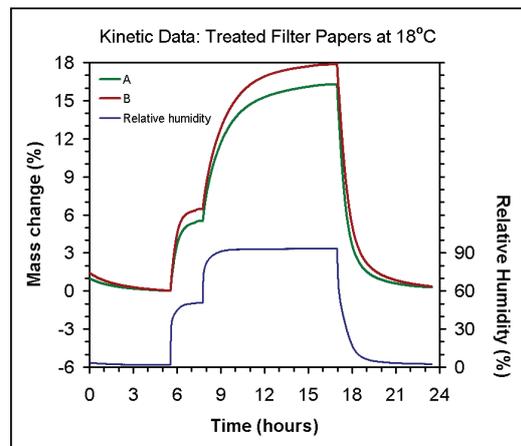
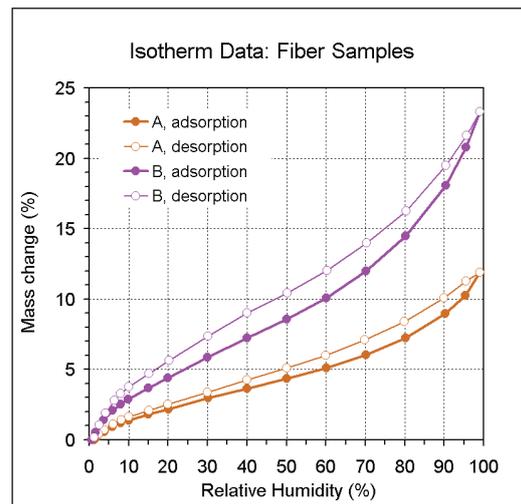
Even hydrophobic materials can take up moisture if their pores are small enough.

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.

Software / Accessories DVS-1/DVS-2HT

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 (non-21 CFR Part 11 version).

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.

Step No.	RH (%)	Chamber T (oC)	Min Time (min)	Max Time (min)	Cut off A (%/min)	Cut off B (%/min)	Min Flow (cc/min)
1	0.0	22.0	60	240	0.0008	0.0008	30.0
2	10.0	22.0	45	240	0.0008	0.0008	30.0
3	20.0	22.0	45	240	0.0008	0.0008	30.0
4	30.0	22.0	45	240	0.0008	0.0008	30.0
5	40.0	22.0	45	240	0.0008	0.0008	30.0
6	50.0	22.0	45	240	0.0008	0.0008	30.0
7	60.0	22.0	45	240	0.0008	0.0008	30.0
8	70.0	22.0	45	240	0.0008	0.0008	30.0
9	80.0	22.0	45	240	0.0008	0.0008	30.0
10	90.0	22.0	45	240	0.0008	0.0008	30.0
11	80.0	22.0	45	240	0.0008	0.0008	30.0
12	70.0	22.0	45	240	0.0008	0.0008	30.0
13	60.0	22.0	45	240	0.0008	0.0008	30.0
14	50.0	22.0	45	240	0.0008	0.0008	30.0
15	40.0	22.0	45	240	0.0008	0.0008	30.0
16	30.0	22.0	45	240	0.0008	0.0008	30.0
17	20.0	22.0	45	240	0.0008	0.0008	30.0

PID Values: RH Stab 3 (0.1 - 99.9) % / min Weight Change 0.01 % (0.0001-9.9999) Time Interval 300 sec (5-9999)

Accessories

Regulator assembly

Apart 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

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

21 CFR Part 11 Software

Software to fully support compliance with 21 CFR Part 11 requirements as frequently required in the pharmaceutical industry.

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Specification DVS-1/DVS-2HT

Specifications

<i>DVS-1</i> Balance heads:	1
<i>DVS-2 HT</i> Balance heads:	2
Balances, type:	Ultra-sensitive electronic microbalances
Balance load capacity(each):	5g*
Balance load capacity(combined):	10g (<i>DVS-2HT</i> only)
Dynamic weighing range(each):	-500mg to + 500mg, 0 to +1000mg
Dynamic weighing range(combined):	-1000mg to +1000mg, 0 to + 2000mg (<i>DVS-2HT</i>)
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:	15-60°C (<i>DVS-1</i>), <10 - 85°C (<i>DVS-2HT</i>)
Sample chamber temperature stability:	± 0.1°C
Balance head temperature :	Up to 75°C (<i>DVS-1</i>), 90°C (<i>DVS-2HT</i>)
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

*Actual sample mass limits may be lower depending on sample density, form, and equilibration rates.

Utilities

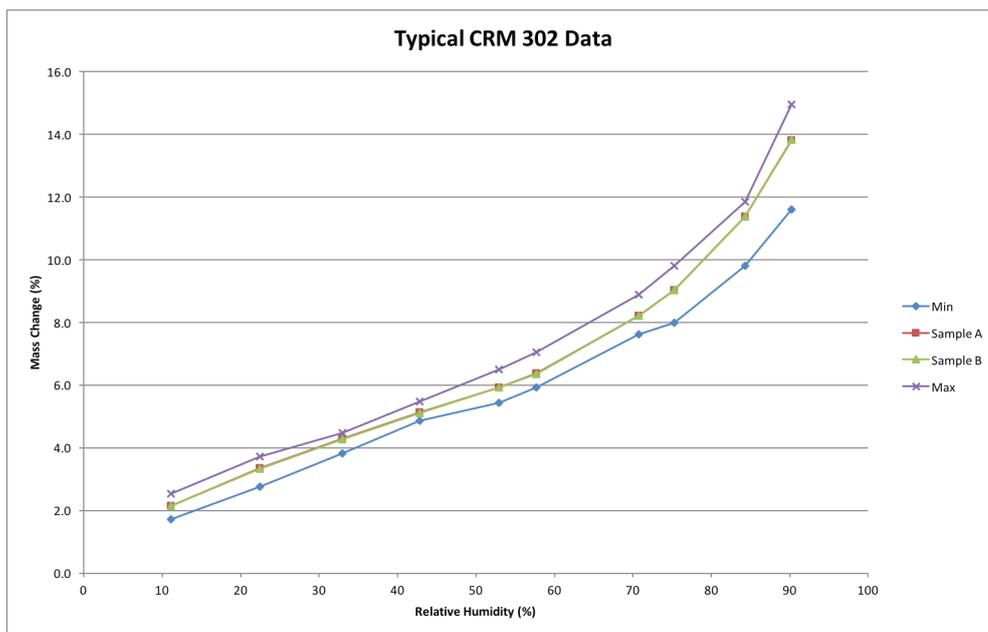
Dimensions (W x D x H):	42cm x 56.5cm x 55.25cm (16.5" x 22.25" x 21.75")
Weight:	60kg(132 lbs.)
Electrical:	100-230 V~, 50/60Hz - single phase
Compressed gas:	Dry air or nitrogen regulated to 100 to 150 kPa (15–22 psig)
PC:	Windows 7 or higher operating system with RS232 communications port and 9-pin D-sub connector or USB to RS232 adapter.

Cost 90 Project

In an effort to standardize the determination of water activity in foods, the European COST 90 project¹ 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 labs². 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 a two-balance Aquadyne DVS close agreement between the two balances. The black and red curves represent the CRM 302 mean adsorbed amount $\pm 2.77\sigma$.

¹Spieß 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.

²Jowitt, 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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Aquadyne DVS Performance

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

Typical CRM 302 data compared to acceptance limits

Data Point	RH% Requested Value	RH% Actual Value	Sample Temp	Min	Actual A	Actual B	Max
1	11.05%	11.10%	25.00	1.717963	2.204611	2.160297	2.542038
2	22.45%	22.50%	25.00	2.763976	3.339607	3.316478	3.716025
3	33.00%	33.0%	25.10	3.825633	4.28819	4.302511	4.474367
4	42.76%	42.80%	25.10	4.85627	5.157592	5.208977	5.463731
5	52.86%	52.90%	25.00	5.440653	6.015004	6.059714	6.499347
6	57.70%	57.70%	25.10	5.922122	6.439637	6.504892	7.037878
7	70.83%	70.80%	25.00	7.610407	8.183871	8.265055	8.889593
8	75.28%	75.30%	25.00	7.993618	9.008932	9.107737	9.806583
9	84.26%	84.20%	25.00	9.794112	11.44249	11.53271	11.83879
10	90.19%	90.20%	25.00	11.60011	13.90907	13.97609	14.93989

Aquadyne

DVS-1
DVS-2HT





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