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 in situ 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.
**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/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.
Aquadyne DVS
automated, gravimetric, water sorption analyzers

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.

<table>
<thead>
<tr>
<th>Step Details</th>
<th>Balances</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
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<td>Chamber T (°C)</td>
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<tr>
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<td>22.0</td>
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<tr>
<td>2</td>
<td>80.0</td>
<td>22.0</td>
</tr>
<tr>
<td>3</td>
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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.
Aquadyne DVS automated, gravimetric, water sorption analyzers

Specification DVS-1/DVS-2HT

Specifications

- **DVS-1** Balance heads: 1
- **DVS-2 HT** Balance heads: 2
- Balances, type: Ultra-sensitive electronic microbalances
- Balance load capacity (each): 5g*
- Balance load capacity (combined): 10g (DVS-2HT only)
- Dynamic weighing range (each): -500mg to +500mg, 0 to +1000mg
- Dynamic weighing range (combined): -1000mg to +1000mg, 0 to +2000mg (DVS-2HT)
- 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 (DVS-1), <10 - 85°C (DVS-2HT)
- Sample chamber temperature stability: ± 0.1°C
- Balance head temperature: Up to 75°C (DVS-1), 90°C (DVS-2HT)
- Gas flow rates: 0 - 200 cm³/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 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 a two-balance Aquadyne DVS close agreement between the two balances. The black and red curves represent the CRM 302 mean adsorbed amount ±2.77\(\sigma\).


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.

Typical CRM 302 data compared to acceptance limits

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<tr>
<th>Data Point</th>
<th>RH% Requested Value</th>
<th>RH% Actual Value</th>
<th>Sample Temp</th>
<th>Min</th>
<th>Actual A</th>
<th>Actual B</th>
<th>Max</th>
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</tbody>
</table>

Aquadyne

DVS-1
DVS-2HT
The quality of Quantachrome’s after sales service support is the reason we are proud to maintain life time relationships with our customers.

Field Service
Our global service staff assure you that Quantachrome Instruments will continue to be the reliable engines of material characterization laboratories. We offer you the flexibility of choosing from service contracts tailored to provide you with the response time, service package, and spare parts discounts that best fit your needs.

Spare Parts
Quantachrome spare parts are certified to work with our instruments. We provide rapid response spare parts orders, and keep large inventories of replacement parts and hardware available.

Application Lab
Our fully equipped, state-of-the-art powder characterization laboratory (email: application.qt@anton-paar.com), provides the option of contracting for expert testing services. Laboratory services are also available to validate the applicability of our products prior to your purchase using your actual samples.

Lifetime Application Support
We view the field support of our instruments as an essential component of our business strategy. Our expert scientists are always available to answer questions on applications, or the use of our instruments. We do this as a standard service regardless of whether you have a service contract with us or not.

Partners in Science
Quantachrome has a scientific research department consisting of world renowned experts in material characterization. Our team conducts collaborative research projects with leading material research labs around the world.

For almost half a century Quantachrome’s scientists and engineers have revolutionized measurement techniques and designed instrumentation to enable the accurate, precise, and reliable characterization of powdered and porous materials. We have an unwavering commitment to providing state of the art technology, along with superior and unparalleled customer service and support.

Our commitment to customers is to support you before, during, and after the sale throughout the lifetime of our instruments. This is a big commitment because our products are so robust and reliable that we regularly find many still in use for decades.

Corporate Headquarters-USA
Quantachrome Instruments
a brand of Anton-Paar
1900 Corporate Drive
Boynton Beach, FL 33426

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