Cambustion AAC

Aerodynamic Aerosol Classifier

Classify aerosol particles by aerodynamic diameter, without charging

The AAC is the ideal instrument for generating a truly aerodynamic monodisperse aerosol from a polydisperse source.

With no charger or neutraliser required, AAC output is unaffected by multiple charging issues or by low charging efficiencies.

Particle transmission efficiency is therefore very high across the AAC's uniquely wide size range spanning from 25 nm to 5 µm aerodynamic diameter.

Capabilities

Wide size range:

25nm to > 5µm aerodynamic diameter

Produce monodisperse aerosol:

as a calibration aerosol
for chemical & physical analysis
to send to other instruments

Measure aerodynamic size distributions:

when combined with a detector such as a CPC

New! Configure as a low-pass separator:

with (reversible) user modification

No need for particle charging:

ideal when radioactive / X-ray sources are inconvenient
classification unaffected by particle charge

Applications

Inhalation and particle deposition studies

Filtration studies

Ambient aerosol measurements:

with a uniquely wide size range from a single technique

Complex or large aerosols:

when charge correction would be problematic

Metrology

Calibration of Optical Particle Counters (OPCs):

with truly monodisperse aerosol

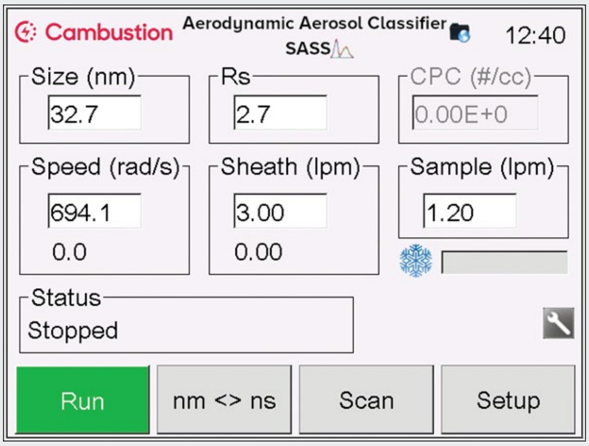
Combine with DMA/CPMA to measure:

mass-mobility, shape factor, effective density

Applications

Production of a monodisperse aerosol

The AAC may be set to select a particular aerodynamic diameter, producing a monodisperse output aerosol from a polydisperse input.



This output does not suffer multiple charging effects, and may be collected for chemical or physical analysis, sent to another instrument as a calibration aerosol, sent to another instrument for further analysis in a tandem experiment, or used as a challenge aerosol.

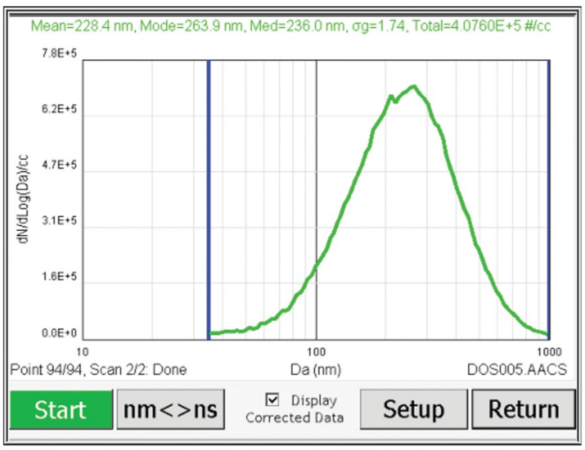
The wide size range of the AAC makes it ideal for calibrating optical particle counters.

Effective density / shape factor

An AAC may be combined with a Centrifugal Particle Mass Analyser (CPMA) or Differential Mobility Analyser (DMA) to allow measurement of fractal shape / effective density of non-spherical aerosol particles.

Size distribution measurement

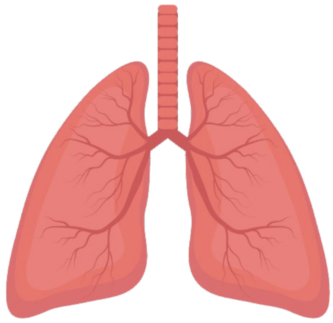
Integrated software allows the pairing of an AAC with a detector such as a Condensation Particle Counter (CPC). The software can scan the setpoint of the AAC (either stepping or continuously) across its size range and measure a size distribution. Size distributions are displayed on the integrated touchscreen and recorded to a USB drive, and may be automatically corrected for particle losses. In continuous scanning mode, the AAC and a CPC form the Scanning Aerodynamic Size Spectrometer, or SASS (the equivalent of an SMPS™.)



A wide range of CPCs from different manufacturers are already supported in addition to the new Cambustion 5210 CPC, which offers measurements between 5nm and 10µm and is ideally matched to the AAC.

The native aerodynamic diameter output may be automatically converted to mobility diameter, using a user entered factor either of known constant density, or using a known mass-mobility relationship to accommodate an aerosol with a size varying density (such as soot).

With an assumed density, conversion to mass spectral density ($dN/dlogm_p/cc$) and mass weighted size spectral density ($dM/dlogD_a/m^3$) is also automatic.



Use when you need Aerodynamic Diameter

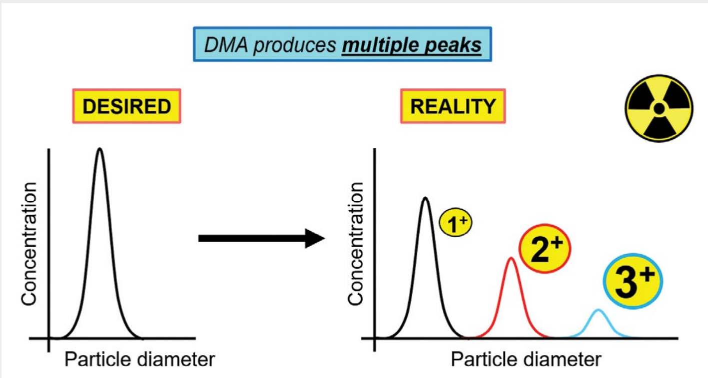
In many areas of aerosol science, Aerodynamic Diameter is the metric of choice, for example in inhalation studies and the filtration of large particles. The AAC allows for the first time selection of aerosol by aerodynamic size over a finite size range. Whilst impactors provide a large particle cut-off, and virtual impactors a small particle cut-off, only the AAC allows selection of particles by aerodynamic diameter over a finite range with selectable, very high, resolution.

Advantages

No particle charging

The AAC is ideal for use in experiments or environments where radioactive sources are either inconvenient or disallowed.

The AAC output does not have multiple charging artefacts, such as encountered with the DMA.

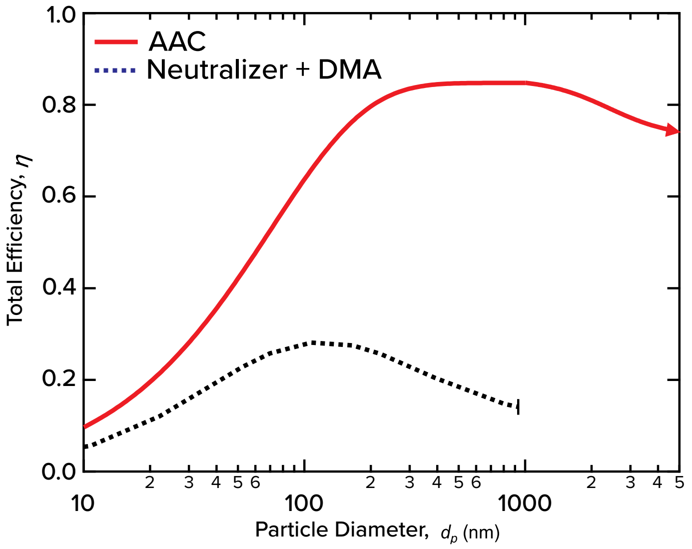


The AAC offers significantly improved transmission compared with the DMA, since the DMA is affected by poor charging efficiency, meaning that only a small fraction of the target particles receive a single charge and make it through the classifier.

Wide size range

The AAC offers a uniquely wide size range with a single measurement technique, simplifying data processing and offering genuine measurement of a single physical metric.

As the relationship between aerodynamic and mobility diameters is density dependent, by using dense test aerosols (for example, silver, gold, CsCl), it is possible to reach small (<10 nm) mobility equivalent diameters (Symonds 2018).



Traceable calibration

Every AAC undergoes a traceable calibration process at Cambustion; relevant parameters such as rotation speed, temperatures, pressures and flow rates are calibrated against traceable references, and a certificate is provided.

Different carrier gases

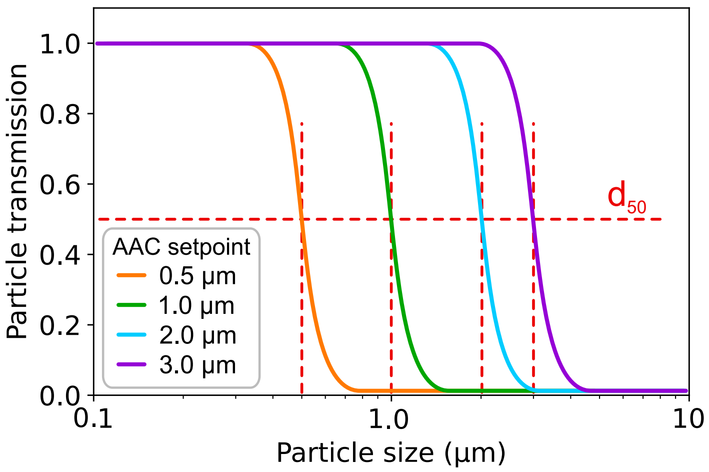
The AAC can be calibrated during testing for a variety of different carrier gases, including air, argon, nitrogen & carbon dioxide.

Classifier temperature control

Air friction on the outside of the classifier would heat the aerosol, and the natural temperature differential across the classifier would cause convection cells to form, preventing the classifier working. Active cooling of the classifier avoids this, with the benefit of minimising any temperature rise in the aerosol.

Low pass separator configuration

In a modification of the standard AAC, the particles smaller than the setpoint which would normally be lost in the sheath flow and internal filters may be intercepted and used for further experiment, rather like a “variable impactor”.



This modification is reversible and can be safely carried out by the user, as it does not interfere with the instrument calibration or with its safety systems.

The cut-off diameter can be freely specified within the standard operating range of the AAC and the steepness of the roll-off can be adjusted by changing the resolution.

Easy operation

With steady development since 2016, the AAC is intuitive to use and at home in any aerosol lab. A built in touchscreen allows operation and data recording with no requirement for an external PC.

Flexible interfaces

The AAC offers users a variety of interfacing options, including a remote Ethernet client, a Windows application, and a DLL library.

Remote control is possible via USB, RS232 and Ethernet.

Three configurable analogue inputs and outputs are also available.

Aerosol flowmeter accessories

Knowledge of the sample flow is required in the AAC to set the resolution. The flow may be entered manually by the user, or real-time measurement is possible.

The AAC is compatible with the new AF10 standalone aerosol flowmeter (shown below) – see separate brochure.

A more limited aerosol flowmeter is available for use only with the AAC and CPMA.

Either of these options allows the AAC to automatically adjust the sheath flow to maintain constant resolution when the sample flow is varying. They also provide a means to monitor performance of other connected equipment.

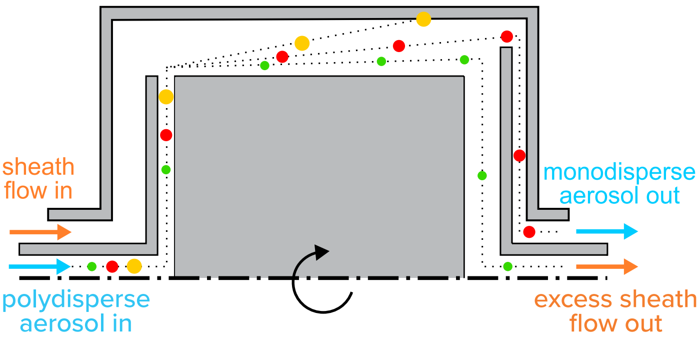
Measurement principle

Classification

The AAC selects aerosol particles of a specified aerodynamic diameter, without requiring particle charging.

Polydisperse particles enter the classifier, and are carried along towards the exit by a clean sheath flow.

View animation at: cambustion.com/aac



Drawing not to scale

With the classifier stationary, all particles follow the sheath flow, and are lost in an internal HEPA filter.

When the classifier is rotated, centrifugal force causes the particles to accelerate outwards through the sheath flow, resisted by their aerodynamic drag.

Particles larger than the setpoint experience a high centrifugal force and are lost to the outer wall.

Particles smaller than the setpoint experience a low centrifugal force and are lost with the exhaust sheath flow.

Particles with an aerodynamic diameter equal to the setpoint (which is controlled by varying the rotation speed) are presented at the outlet slit and passed to the output.

Resolution

The resolution of the AAC is determined by the ratio of sheath to sample flow, as for a DMA. High resolutions similar to a DMA are easily achieved, while users can also detune the AAC for certain applications.

When step scanning, the AAC can be run at constant sheath flow, or at constant size resolution. In the latter case, the sheath flow is automatically adjusted as a function of size. Faster continuous scans are possible at constant sheath flow.

View AAC practical video tutorial:

Cambustion
VIDEO TUTORIAL

Patents:
The Aerodynamic Aerosol Classifier includes technology licensed from the University of Alberta and is protected by the following international patents: US8966958, JP5658244, CA2764522A1, GB2550185B, EP2449359B1.

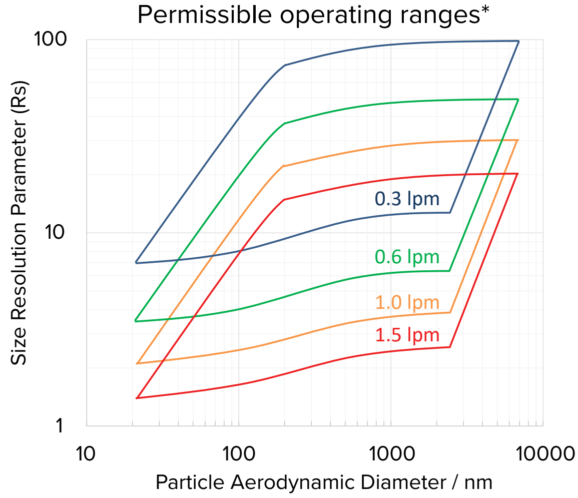
Specifications

Particle size range (see plot below)	25 nm – >5 µm (aerodynamic equivalent diameter)
Sample flow range	0.3 – 1.5 lpm
Sheath flow range	2 – 15 lpm
Ambient conditions	10 – 40˚C ,0 – 95% RH non condensing
User Interface	Built-in touchscreen
Remote control	Ethernet, USB & RS232
CPC communication	RS232 & analogue
Recommended CPC Compatible CPCs (via RS232 serial). Others added by request. Ethernet comms with TSI375x now also supported.	Cambustion 5210 Aerosol Devices MAGIC, Airmodus A20, Brechtel 1720, Grimm 54xx, PALAS UF CPC, TSI 30xx, 375x, 377x, 378x
Analogue inputs and outputs	3 inputs, 3 outputs, 0 – 10 V (software configurable)
Electrical supply	100 – 240 VAC, 50/60 Hz 1,000W
Dimensions / Weight	57 (w) x 52 (d) x 48 (h) cms 61 kg
All specifications subject to review and change without notice	

Operating size range

This is dependent upon the resolution (R_S) required, and the sample flow used. R_S is defined as D_{ae} /Δ D_{ae}, Full Width Half Maximum. The resolution is set via the sheath flow: sample flow ratio, see resolution section.

Permissible operating ranges*



* within shown coloured bounds

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