

# POROMETER type AP4

The AP4 Porometer measures the rate of water vapour diffusion through leaf surfaces and calculates stomatal conductance. This is a major determinant of water loss from plant leaves and CO<sub>2</sub> uptake in photosynthesis. It is an important indicator of the physiological condition of plants, and gives an insight into their reaction to environmental factors, pollutants, and other stresses.

The AP4 Porometer features:-

- ▶ Direct readout of conductance or resistance
- ▶ Simple and rapid calibration, in the field
- ▶ Minimises leaf stress during measurement
- ▶ Combines outstanding value and ease of use

## APPLICATIONS

In plant-water studies, loss of water vapour through plant leaf stomata is one of the critical factors linking transpiration with ambient temperature, pressure, humidity and wind speed. The stomata are sensitive to light, relative humidity (RH), carbon dioxide (CO<sub>2</sub>), water stress, pathogens and pollutants. Employing the cycling diffusion principle, the AP4 Porometer makes accurate, repeatable and convenient field measurements of stomatal conductance. In combination with leaf area and leaf temperature measurement, the instrument allows water loss from a whole plant or crop canopy to be estimated. The AP4 is thus an invaluable tool for quantifying the effect of various influences on stomatal behaviour. It also has an important role to play in comparing the performance of different crop varieties in response to environmental variations and stresses.

**Practical Experience** The theory behind cycling porometer is well understood. The key to its success has been the rapid repetition of the RH transit time measurement until it stabilises. Over 1000 Delta-T porometers have been used worldwide since the first was devised by Dr J L Monteith in 1974.

### Easy and convenient use

The innovative design of the AP4 provides users with logical, convenient operation, and a comprehensive range of features and functions. In particular, the AP4 offers an automated, rapid cycle that gives temperature-compensated readings, and straightforward calibration that avoids the need to plot calibration curves.

New users can quickly make effective use of the AP4, without a deep knowledge of all the options available to the more experienced user. A HELP button provides operating assistance, especially useful for field work, while a SET button conveniently recalls operating setting stored previously.

In use, the AP4 is carried on a shoulder strap in its own protective carrying case, with the keyboard, control buttons and LCD at a convenient working level. The sensor head, on a flexible cable, is simply clamped on to the leaf to be measured. Once the instrument has been initialised, a READ button on the head allows single-handed operation. Successive readings can be taken, evaluated and stored – just by pressing this one button. Stable readings are audibly indicated by a double 'beep'.

Step-through procedures from menus displayed on the LCD guide the user through the processes of calibration, taking readings, and the review and output of stored data.

## DATA HANDLING

The AP4 can store up to 1500 readings, with a notes facility. Data is read out to a computer, printer or pocket terminal through the RS232 link. Data formats are suitable for direct entry to popular analysis software such as spreadsheets. A complete set of data comprises the reading, reading levels, time, light level, temperature and relative humidity. Up to 30 characters of notes for each reading can be added from the keypad.

## DIRECT CALIBRATION

The direct calibration technique used in the AP4 gives much greater confidence in the absolute accuracy of its readings than is possible in practice with other systems.

The AP4 is supplied with a moulded polypropylene calibration plate with six groups of holes; the rate of diffusion of water vapour through these holes has been carefully verified. Water vapour is provided by backing the plate with dampened paper. The sensor head is clipped onto the calibration plate, and readings are stored from each of the six standard calibration positions.

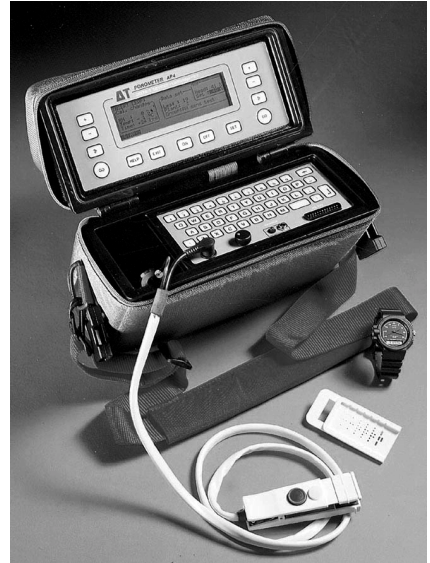
Calibration is a simple process, and easily undertaken in the field. It should be carried out at the start of a measurement session, and when necessitated by a change in temperature, by moving to a new RH cycling level, or by use of the alternative cup on the sensor head.

## COMPACT SENSOR HEAD

The lightweight, compact AP4 sensor head enables reliable and quick measurements even in small or dense canopies, with minimum stress on the leaf.

Made from low water absorption polypropylene, the head contains two cups (cuvettes): one slotted, the other circular, to suit different leaf shapes. A shuttered cover lets the user check leaf alignment. A silicone rubber seal presses gently onto the leaf surface, defining the sample area.

The head contains fast response sensors to measure cup and leaf temperatures, allowing automatic temperature compensation to be applied. Reflective, insulating materials reduce cup heating by bright sunlight, while a PAR photodiode sensor (Photosynthetically Active Radiation) measures light incident on the leaf.



## DYNAMIC DIFFUSION AND STEADY STATE POROMETERS COMPARED POROMETRY

Porometry is the study of gas diffusion through pores, particularly through leaf stomata. Since plant transpiration is mainly controlled by the opening and closing of stomata, the use of porometers is vital to many areas of plant research.

Most field measurements are made using either dynamic or steady state measurement principles. Dynamic diffusion porometers (AP4) are characterised by simplicity, unstirred leaf chambers, and the need for frequent but easy calibration using plates with known diffusion resistances. Steady state porometers, (eg Licor), are comparatively complex, require a vigorously stirred lead chamber, and their recalibration, while infrequent, can be difficult.

## RELATIVE STRENGTHS

**Accuracy:** Under laboratory conditions, the two systems are comparable, though the steady state can be significantly more accurate at higher diffusion conductances when carefully calibrated. Under field conditions, the situation changes. The accuracy of the AP4 can be maintained by simply recalibrating in the field whenever appropriate. In the steady state system, accuracy depends on the absolute accuracy of the RH measurement: an error of more than ±18% in the diffusion reading can be caused by a ±3%RH error. When taking measurements in the field on leaves, the possibility of contamination will usually limit confidence in the absolute RH measurement to ±4%, even with careful and frequent laboratory recalibration.

Conditions within a porometer chamber can occasionally cause the stomata to close before a reading is taken. These are more likely to be present in a chamber where the leaf is stressed by the increased water loss associated with vigorously stirred steady state systems.

**Resolution:** Dynamic and steady state porometry systems offer similar resolution: approx 0.05 s cm<sup>1</sup>.

**Speed:** Both systems enable a reading to be taken within about 15 seconds for a highly conductive leaf, and within about 60 seconds for a highly resistive leaf.

**Convenience:** With the introduction of direct readout and data storage, the AP4 has overtaken existing steady state systems in convenience of use.

**Sampling area:** Because the chamber in a dynamic system is unstirred, it is not practical to use large sampling areas in conjunction with a small RH sensor. However, users' experience suggests that this is a very minor inconvenience, only occasionally requiring more samples to be taken.

**Price:** Generally, dynamic porometers are less expensive because they do not require such elaborate leaf chambers or expensive gas flow meters.