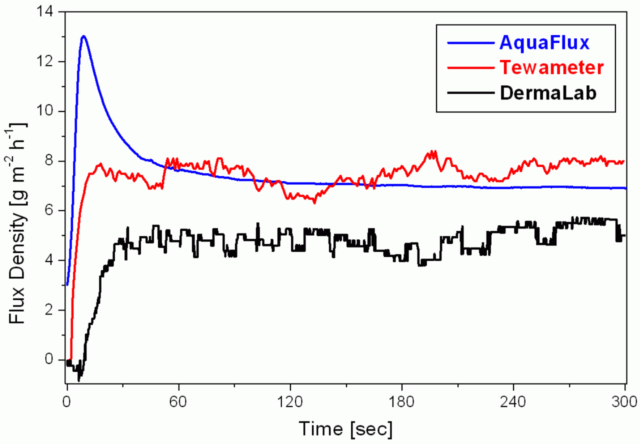
Why the AquaFlux?

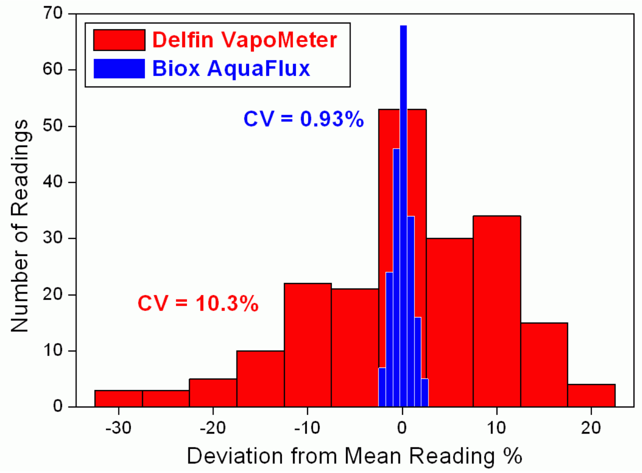
The short answer is performance. The AquaFlux offers unrivalled performance, in-vivo or in-vitro, in climate-controlled conditions or in improvised surroundings. No other instrument can come close in terms of accuracy, sensitivity, repeatability and reproducibility.

By contrast, open-chamber instruments cannot be used reliably without elaborate climate-controlled conditions and perfectly still ambient air. At their best, open-chamber measurements correlate well with condenser-chamber measurements, as shown recently in an SLS patch-test study on 22 volunteers [1]. Over 650 same-site TEWL measurements, ranging from 4 to 83 $gm^{-2}h^{-1}$, were performed with Tewameter TM300 and AquaFlux AF200 instruments. The correlation between their readings was found to be r=0.98.

Open-chamber instruments cannot match the sensitivity of the AquaFlux, see below.



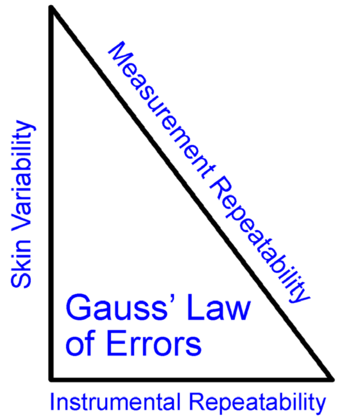
A closed-chamber by itself is no guarantee of performance. Illustrated below is an in-vitro comparison between two different types of closed-chamber instrument. A stable wet-cup flux source was used in this test, with 200 repeat measurements per instrument [2].



These data give a clear comparison of instrumental repeatability under identical conditions. The ~10 times better repeatability of the AquaFlux implies, according to Gaussian statistics, that a single AquaFlux measurement is equivalent to ~100 VapoMeter repeat measurements!

The effect of instrumental repeatability is difficult to assess in practice, because skin is heterogeneous and variable. The

observed scatter of TEWL measurements is then a superposition of instrumental repeatability and skin variability, which combine as variances in Gaussian statistics, as illustrated below.

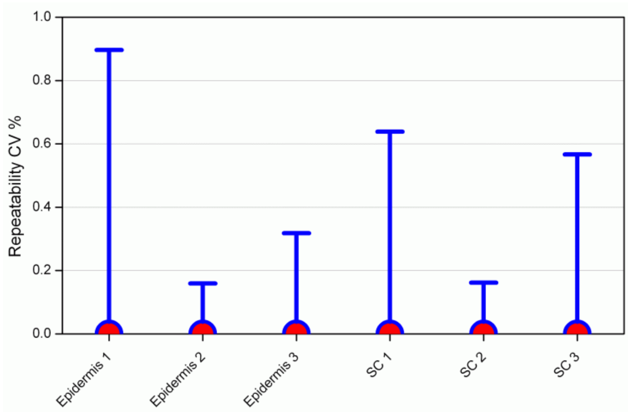


Therefore, if the instrument's own scatter is small compared with skin variability, then your measurements are meaningful in terms of skin properties. But you are wasting your time with an instrument of poor repeatability, because skin properties are masked by instrumental scatter. This is illustrated in the table below, where 7 untreated volar forearm sites were measured in a 12-times repeated sequence with two different instruments.

	Coefficient of Variation %						
Test Site	1	2	3	4	5	6	7
Biox AquaFlux	4.6	3.4	3.0	2.5	3.5	4.7	4.9
Delfin VapoMeter	8.2	9.9	8.5	11.2	12.3	9.4	11.9

The Coefficients of Variation (CVs) of the AquaFlux TEWL measurements indicate skin variability – small in the central part and increasing towards the wrist and elbow. But the equivalent CVs of the VapoMeter give little indication of skin variability, because they are dominated by its poor instrumental repeatability.

AquaFlux repeatability in Franz cell membrane integrity tests was assessed using a number of human excised stratum corneum and epidermis samples, as shown below.

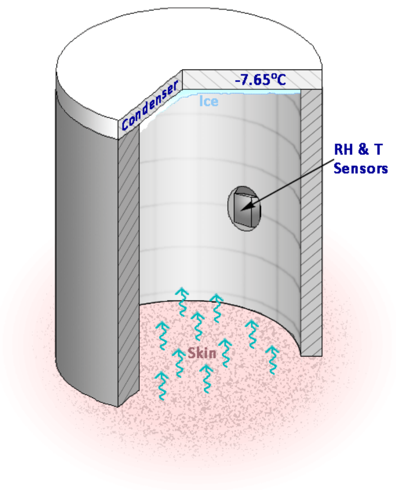


These examples illustrate the performance you can expect from an AquaFlux.

How does it work?

The AquaFlux uses the same steady-state diffusion gradient measurement principle as the open-chamber method. However, its measurement chamber is closed in order to eliminate disturbance by external air movements. The apparent contradiction between continuous flux measurement in a closed measurement chamber is resolved by a condenser (Patent PCT/GB99/02183) that continuously removes water vapour by converting it to ice.

The AquaFlux measurement chamber, illustrated below, is in the form of a cylinder about the size of a thimble. Its lower end acts as a measurement orifice that is placed into contact with the skin. Its upper end is closed with a condenser that is maintained below the freezing temperature of water by means of an electronic refrigerator.



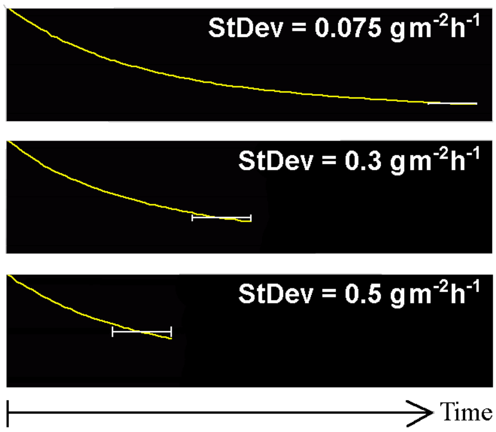
The condenser controls the humidity in the chamber independently of ambient conditions. It acts as a vapour sink by forming ice on its surface, thus creating a zone of low humidity in its immediate vicinity. By contrast, the skin is a vapour source, creating a zone of higher humidity in its immediate vicinity. This humidity difference causes water vapour to migrate from source to sink by passive diffusion, leading to a linear distribution of humidity parallel to the chamber axis under steady conditions. The water vapour flux is calculated from measurements of this humidity gradient and Fick's first law of diffusion.

Another unique aspect of the AquaFlux design is the wall-mounted RH & T sensors (Patent PCT/GB03/00265), where traditionally, such sensors are mounted centrally, on thin wires, where they are exposed to contamination and misalignment.

How fast is it?

For the AquaFlux, there is a trade-off between speed and accuracy. Measurements are terminated automatically by the software as soon as your pre-set criteria are met. For the flux to be equated with TEWL, it must settle to a steady level where other flux sources, such as skin surface water loss (SSWL), have decayed away. This steady level is determined in the software by the standard deviation (StDev) of a moving average of the most recent flux readings. A well-settled, steady flux would be characterised by a low StDev.

This trade-off between speed and accuracy is illustrated in the figure below. The default StDev setting for the AquaFlux is $0.075 gm^{-2}h^{-1}$, which clearly takes longer to satisfy than the values of 0.3 and $0.5 gm^{-2}h^{-1}$ also shown in the illustration. These larger StDev values look inappropriate when superimposed on low-noise AquaFlux signals, but such settings are common with open-chamber instruments.



Another component of measurement speed is recovery time, which can exceed the measurement time with some instruments. With the AquaFlux you can go from site to site without having to wait for the instrument to recover and get the job done with maximum efficiency [2].

References

[1] I Angelova-Fischer, TW Fischer & D Zillikens. Die Kondensator-Kammer-Methode zur nicht-invasiven Beurteilung von irritativen Hautschäden und deren Regeneration: eine Pilotstudie. Dermatol Beruf Umwelt. 57(3):125 (2009).

[2] RE Imhof, P Xiao, EP Berg & LI Ciortea: Rapid measurement of TEWL with a condenser-chamber instrument. In: 15th International Meeting of the ISBS, Philadelphia (2005). Download from www.biox.biz.