Cooled Mirror Sensor
Technology

Fundamental, automatic dew point principle giving high accuracy, drift-free operation and reliability for process and calibration applications

- Fundamental technology
- Fast, highly accurate
- Robust and reliable
- Industry standard
- Drift-free operation

Fundamental Technique

The optical condensation principle of dew point measurement has been established for centuries as the most fundamental method of determining the moisture content of a gas. The dew-point temperature (that is, the temperature at which water vapour begins to condense to liquid or ice as the gas is cooled) describes precisely the moisture concentration of the gas. The major uncertainties in this measurement are related to the instantaneous detection of the on-set of condensation and the accuracy to which the temperature of the condensing surface can be measured. Early manual dew-point hygrometers suffered inaccuracies due to their cyclical nature, being cooled by an external coolant such as carbon dioxide or by the evaporation of a solvent, and also because of the time taken to produce an observable layer of condensate, often leading to an under-estimation of the moisture content. The modern, automatic cooled mirror sensor addresses these deficiencies and also provides an instrument that is rugged and reliable enough to be applied to process control measurement as well as laboratory use.

Principle of Operation

In Michell's Cooled Mirror Sensors, a miniature polished metal mirror is cooled by a solid state Peltier thermoelectric heat pump until it reaches the dew point of the gas under test. When this temperature has been reached, condensation will begin to form on the mirror surface. An electro-optical loop, comprising a visible red light emitting diode and a high gain photo-detector, detects that condensation is forming. A reduction in the intensity of light reflected from the mirror surface is used as a feed input into the instrument control electronics to modulate the cooling power applied to the Peltier. The mirror surface is then controlled in an equilibrium state whereby evaporation and condensation are occurring at the same rate. In this condition the temperature of the mirror (measured by a platinum resistance thermometer) is equal to the dew-point temperature of the gas. This process is shown diagrammatically in Figure 1.

At trace moisture levels, the rate of formation of condensation (ice crystals) is slow and so Michell employs a novel dual optics system that measures both the reflected and scattered light intensities from the mirror surface. By using these two signals in a differential mode of operation, much smaller layers of condensate can be detected, allowing faster and more precise operation of the sensor. A further enhancement at these trace levels is by the use of Michell's unique Speed Pipe technology, a system that concentrates condensation formation on the mirror surface to render an even faster response. Dual Optics are featured on the complete S4000 range and Speed Pipe technology is fitted as standard to the S4000 RS and TRS models.

Contamination Correction

Any optical system can be affected by contamination. Cooled mirror dew-point hygrometers are no exception. Particulate

contamination will reduce the light reflected by a clean mirror and, although this will have no measurable effect on the performance of the instrument up to a certain level, beyond that level it will render the system unable to operate correctly. For this reason, all Michell cooled mirror instruments incorporate an automatic compensation system - Automatic Balance Compensation (ABC) - that periodically re-balances the sensor optics to compensate for any reduction in light intensity caused by the contamination. The S4000 range features an ABC system with variable period and duration, allowing the user to select appropriate time intervals for his particular process. The instruments also feature a configurable data hold system that fixes the display and outputs during an ABC cycle in order to allow full and continuous process control. Our latest instrument, Optidew, features Dynamic Contamination Correction (DCC). DCC is an intelligent, microprocessor controlled system that works on the same principles as ABC but can detect and compensate for much higher levels of contamination and also can automatically correct a saturation condition, for example when a sensor has been subjected to condensing gas conditions.

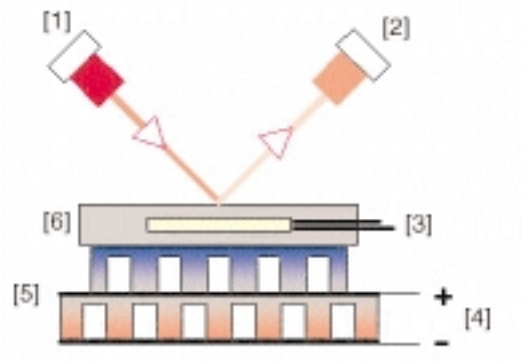


Figure 1

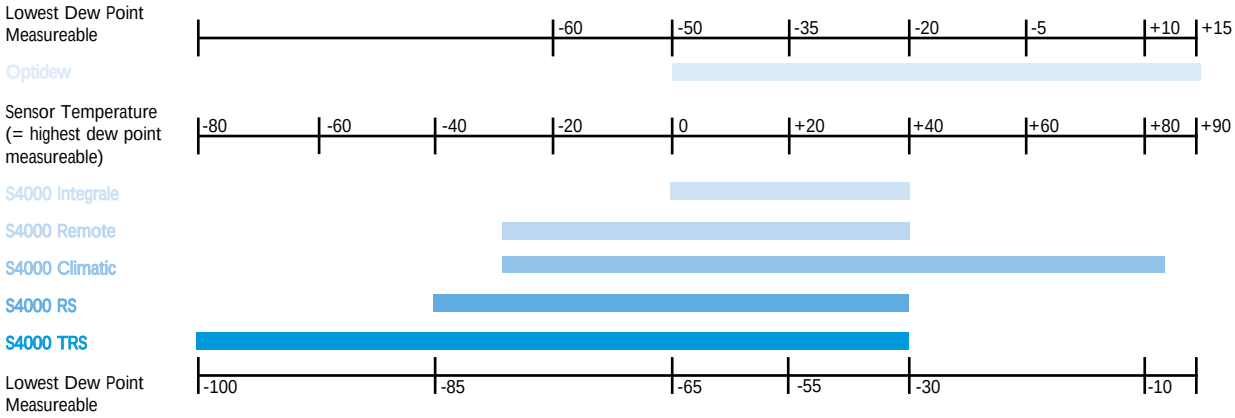
Key:
[1] LED light source
[2] Photodetector
[3] Resistance thermometer PT100
[4] Peltier supply
[5] Peltier thermoelectric two stage heat pump
[6] Mirror

Technical Specifications

Operating range	-100 to +90 °C dew point (dependent upon sensor and location)
Accuracy	±0.1 °C (S4000) ±0.2 °C (Optidew)
Repeatability	Better than 0.1 °C
Response speed	Up to 1 °C s^{-1} plus settling time (dew point dependent)
Pressure rating	1 MPa(g) (S4000), 25 MPa(g) (Optidew)
Operating temp	-30 to +90 °C dew point
Peltier heat pump	2 stage (Optidew), 3 stage (S4000)

Temp measurement	Three or four wire 1/10 DIN CLass A 100 Ω platinium resistance thermometer
Flow rate	0.05 to 2 $Nlmin^{-1}$
Mirror construction	Rhodium plated copper (S4000), stainless steel (Optidew with HT Sensor), gold plated copper (Optidew)
Optical system	Single optics, red LED (Optidew), dual optics, red LED (S4000)
Contamination correction	ABC system

Sensor Measurement Ranges



Note: for Optidew Climatic Sensor the lowest dew point measureable = 10 °C less than the standard sensor (shown above).

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