PRECISION VIRTUAL HYGROMETER MODEL PVH-2022

BULLETIN PVH-2022

General Description

The Model PVH-2022 Precision Virtual Hygrometer uses the chilled-mirror principle to determine the absolute humidity of any gas in terms of its dew or frost-point temperature. It provides fully automatic measurements and is the *first* instrument to harness the processing power of the personal computer (PC) to provide flexibility in data collection, presentation, and analysis. The PVH-2022 converts a PC into a complete humidity analysis system and includes a mirror inspection microscope, flow gauge, and graphical display software.

System Configuration

The PVH-2022 consists of a two stage chilled mirror hygrometer sensor, a PCI plug-in control card that inserts in an empty slot in your PC, and a LabVIEW® interface program that runs in the Windows™ environment. This configuration maximizes the display, processing, and connectivity capabilities of your PC. Other 2022 series instruments are available for environments where a computer may not be practical or desirable. System can be equipped with optional pressure and temperature sensors.

Features

The PVH-2022 system offers all the benefits of a chilled-mirror hygrometer plus the flexibility of a virtual instrument:

- A graphical front panel provides an easy-to-use interface to the instrument system
- A virtual strip chart recorder with variable chart speed and scale can be started and stopped at any time
- A data logging option produces data files in a format that is compatible with popular spreadsheet programs
- LabVIEW™ program drivers enable users to develop custom instrument panels
- A 304 stainless steel-sheathed mirror provides extra durability in industrial applications
- An automated balance cycle can be programmed to begin at a specified time and repeat according to a designated interval
- A backscatter detection scheme can discern between dew and frost

PVH-2022 system

Applications

Two stage chilled mirror hygrometers are used to measure humidity in industrial, laboratory, and process-control applications to ensure product quality and safety as well as ensure cost savings. Common applications include:

- Industrial process control for pharmaceutical, plate glass, paper, and injection-molding production
- Food production monitoring for dried foods and dry snack processing
- Building monitoring for air quality and structural integrity of steel-reinforced concrete
- Monitoring of storage environments and special purpose rooms such as museums, computer rooms, clean rooms, and steel warehouses
- Manufacturing process control for fabrication of sensitive electronic components such as semiconductors

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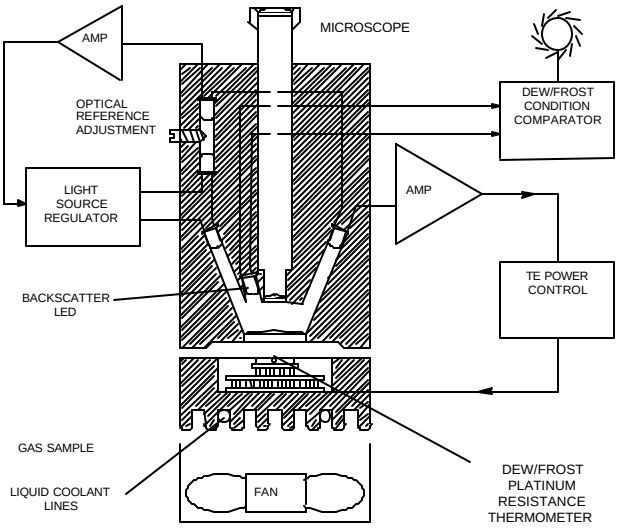
Principle of Operation

The measurement of the water vapor content of a gas by the dew-point technique involves chilling a surface, usually a metallic mirror, to the temperature at which water at the mirror surface is in equilibrium with the water vapor pressure in the gas sample above the surface. At this temperature, the mass of water on the surface is neither increasing (too cold a surface) nor decreasing (too warm a surface).

This equilibrium temperature defines the saturation temperature for the water vapor in the gas. From this dew-point temperature, all other representations of the absolute humidity of the gas can be determined. With the additional measurements of the temperature and pressure of the gas, all other reporting forms for the humidity of the gas can be determined, including the wet bulb temperature and parts per million.



In the chilled-mirror technique, a mirror is constructed from a material with good thermal conductivity such as silver or copper and properly plated with an inert metal such as iridium, rubidium, nickel, or gold to prevent tarnishing and oxidation, and then chilled by means of a thermoelectric cooler until dew begins to form. A beam of light, typically from a light emitting diode, is aimed at the mirror surface and a photodetector monitors the amount of light reflected from the surface.

As the gas sample flows over the chilled mirror, dew droplets begin to form on the mirror surface, and the reflected light becomes scattered. As the amount of reflected light decreases, the photodetector output also decreases. This in turn controls a thermoelectric heat pump that maintains the mirror temperature at the dew point. A precision miniature platinum resistance thermometer (PRT) properly embedded in the mirror monitors the mirror temperature at the established dew point.

Important advantages of *chilled-mirror* hygrometers over all other humidity sensors

The chilled-mirror dew-point hygrometer has at least five distinct advantages over all other humidity sensors:

- The chilled-mirror hygrometer is essentially a primary measurement method that *uses basic principles to determine the water vapor content of gas*. The chilled-mirror configuration is very precise compared to chemical-based humidity sensors whose electrical characteristics change with changes in humidity.
- The *accuracy of the dew-point hygrometer depends predominantly on its ability to measure the temperature of the mirror surface*. Other factors, such as the Raoult and Kelvin effects, also influence its accuracy, but to a much lesser extent. Since the accuracy depends mostly on the thermometry system, the overall accuracy of the device can be user-verified by simply checking the mirror thermometer calibration.
- The *performance of the sensing scheme can be checked at any time* by simply overriding the servo control and forcing the mirror to heat up above the dew point, then observing the evaporation of the dew either electronically or visually, re-closing the control loop, and then observing the sensor return to the same dew-point temperature. Other types of humidity-sensing instruments do not offer this feature.
- The *sensing head and its components—mirror, optics, and enclosure—are completely inert*, making the sensor well suited to industrial environments where gas samples may be contaminated with other constituents. Since the sensor is inert, it is not damaged by contaminants; the mirror, lens, and sensor body can be easily and repeatedly cleaned and reused. Other types of humidity sensors are destroyed by contaminants and must be replaced.
- There is *no measurable hysteresis*.

The PVH-2022 is the most significant advancement in chilled mirror hygrometry since the advent of thermoelectric cooling.

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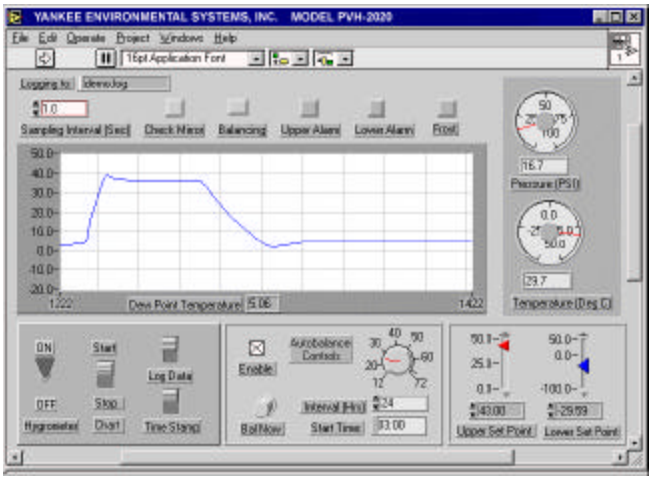
Important advantages of the 2022 series over all other chilled-mirror hygrometers

The YES 2022 two stage chilled mirror hygrometer series represents the state-of-the-art in dew point hygrometers. The following features are not available in other chilled-mirror hygrometers:

- An improved means of monitoring the optical condition of the mirror surface using a backscatter detection scheme allowing unambiguous *automatic* determination of the phase (water or ice) of the deposit on the mirror
- An improved condensation surface control using a loop-within-a-loop digital servo system that linearizes the highly nonlinear characteristics of the thermoelectric cooler for precise control even under dynamic sample gas conditions
- A four-wire Kelvin connection to a NIST-traceable platinum resistance mirror thermometer that is measured with a 20-bit A/D converter employing AC excitation
- Thermometer calibration and interpolation for the PRT are in accordance with ITS-90, ensuring state-of-the-art mirror temperature measurement
- A digital control system that indicates the point at which contamination or dirt on the condensation surface is to the point where the mirror must be cleaned
- An inert 304 stainless steel-sheathed copper condensate mirror ensures long life even in harsh conditions
- An integral microscope for visual inspection of the mirror

The Virtual Instrument Concept



The PVH-2022 interface is based on the popular National Instruments LabVIEW™ operating environment. This *virtual* control panel along with the plug-in "instrument-on-a-card" maximizes price and performance by leveraging your existing PC hardware investment. A virtual instrument can control several devices through one user interface. Separate bulky control boxes, power supplies, strip-chart recorders, and cables are not required and need not clutter your work area. Moreover, the data is already in the PC where you need it—interfacing is not required. In addition, custom user interfaces for integration with existing systems may be created using the supplied LabVIEW drivers.

The PVH-2022's control card is a 3/4 length PCI-type printed circuit card that mounts in a free slot in your MS-Windows 9x/NT PC (Note: your PC must have PCI slots). This card contains all the circuitry for the servo control logic as well as for monitoring the auxiliary dew point, pressure, and temperature sensors. The control card also provides circuits to monitor the contamination level of the mirror and the condition (dew or frost) of the mirror deposit. A wide variety of outputs, analog voltages, as well as digital formats for remote display and/or recording are provided. Two type Form C settable alarm relay contacts are also included for interfacing to control or SCADA systems.

PVH-2022 sensor

The PVH-2022 hygrometer sensor is mounted on a rugged aluminum bracket equipped with a valve and flow gauge to monitor sample flow rates. An integral fan with filter removes heat from the thermoelectric heat pump, and auxiliary cooling coils are integrated with a finned air heat sink to allow the use of liquid coolants to achieve the maximum capabilities of the instrument. An integrated mirror inspection microscope is provided standard.

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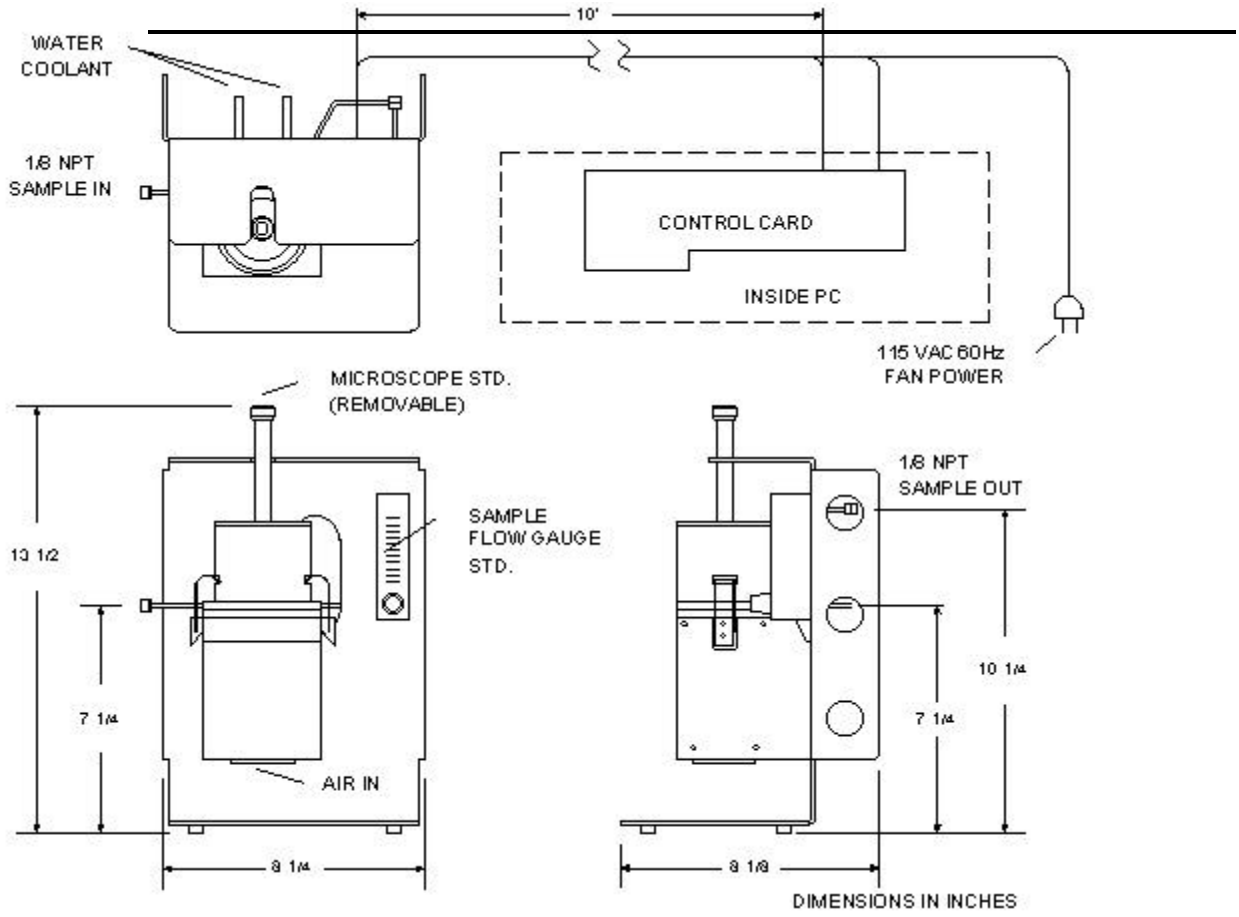
Mechanical Interface



Specifications

Dew/frost point range	62°C depression; from a room ambient temperature of 22°C and forced air cooling of the sensor, dew/frost point measurements can be made to -40 °C. With 5 °C chilled water coolant, dew/frost points to –50 °C can be achieved.
Accuracy	For the sensor only, operating at room temperature: Dew point: ±0.1°C, Ambient temperature: ±0.1°C Pressure: Typically ±1% of full scale; depends on pressure sensor used.
Sensitivity	±0.01 °C
Repeatability	±0.01 °C
Hysteresis	None
Response time	Dew point: Typically 1.5 °C/sec Temperature: typ 5 to 10 sec Pressure: typ 1 sec for 90% step
Balance cycle	Auto-balance interval is user adjustable from 6 to 72 hours
Gas sample	anodized aluminum, glass, 304

contacts	stainless steel, Viton,
Output signals	Analog: -5.00 to +5.00 VDC, corresponding to –50 °C to +50 °C Digital: RS-232 standard; others available upon special order
Instrument operating temperature and pressure regimes	Temperature sensor: –80 °C to +100 °C;Pressure sensor: 150 psig; PCI card 0 °C to +40 °C
PCI interface card	Variable sampling: 0.5 to 60 secs

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