Thunder Scientific Corporation

Humidity Generation,
Calibration and Measurement

Model 4500

Automated Low Humidity Generator

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FEATURES

- **Traceable to NIST**
- **Accuracy ± 0.1˚C Frost Point**
- **Two-Pressure Two-Temperature Principle**
- **ControLog™ Automation Software**
- **Computerized Internal Transducer Calibration**
- **Automatically Applies Enhancement Factors**
- **Computes System Uncertainties in Real Time**

DESCRIPTION

The **Model 4500** automated low humidity generating system is based on the fundamental, NIST proven, "two temperature" and "two pressure" principles. This system is capable of continuously supplying extremely accurate humidity values for instrument calibration and evaluation. When used within the specified frost/dew point range of -95°C to 10°C, this system will automatically generate multipoint profiles as well as manually entered setpoints for days or even weeks.

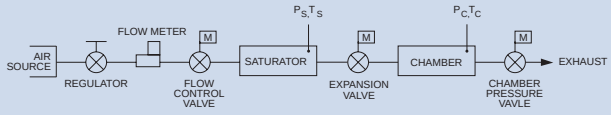
Virtually all functions of the **4500** humidity generator are controlled automatically. All desired humidities, temperatures, test pressures, and time intervals may be programmed. Visual indications of system status are displayed in real time on the computer monitor.

Simply apply power to the system, and the computer will load the controller with power-up and generation routines. A menu of options will appear, manual or automated control is selected, humidity and temperature setpoints are entered, or a profile is selected and generation begins. Humidity and temperature setpoints and profiles are limited only by the physical response time and range of the **4500** humidity generator.

Automated features of the **4500** allow the generator to perform humidity and temperature profiles completely unattended, while continuously recording and printing system data. This frees the operating technician from the task of system monitoring and adjustment. Upon completion of a profile, the system will adjust to a pre-selected humidity value and await a new instrument load or shutdown.

PRINCIPLE OF OPERATION

The "two-temperature two-pressure" humidity generation process involves saturating air or some other gas, such a nitrogen, with water vapor at a known temperature and pressure. The saturated high pressure gas flows from the saturator, through a pressure reducing valve where the gas pressure is reduced to test pressure, at the desired humidity and temperature conditions.



Elemental Schematic of the **4500** generator

Humidity generation by the **4500** does not depend upon measuring the amount of water vapor in the gas, but rather is dependent on the measurements of temperature and pressure alone. The precision of the system is determined by the accuracy of the temperature and pressure measurements and on the constancy of them throughout. When setpoint equilibration has been reached, the indication of saturation temperature, saturation pressure, test temperature, and test pressure may be used in the determination of all hygrometric parameters.

COMPUTER / CONTROL SYSTEM

The Computer/Control System performs all control functions required for humidity generation, as well as displaying, printing, and storing system parameters in real time. The computer/controller is made up of several main components, each with individual yet cooperative functions. The Computer/Control System utilizes a Windows based computer system that communicates with an HP3852A data acquisition/control system. The system consists of an integrating 5-1/2 digit volt/ohmmeter employing: multiplexed inputs to read transducers and PRT's; digital outputs for control of temperatures, pressures, and mass flow; and relay outputs for control of system power, heaters, compressors and circulation pumps.

Temperature Control: Temperature setpoint control is attained by controlling the temperatures of the two independent circulating fluid mediums that jacket the saturator and test chamber of the generator. The saturation and chamber temperatures are governed by the temperature of the circulating fluids, which are digitally controlled by the computer through the use of PID (proportional-integral-derivative) algorithms. Each fluid medium is heated by time proportioning an immersion heater in the fluid circulation path. Cooling, while also time proportioned, is accomplished by injecting refrigerant into a heat exchanging evaporator located in the fluid circulation path. Using PID algorithms for temperature control allows the fluid temperature to be maintained at the desired saturation temperature with a stability to within approximately 0.02°C over the operating range.

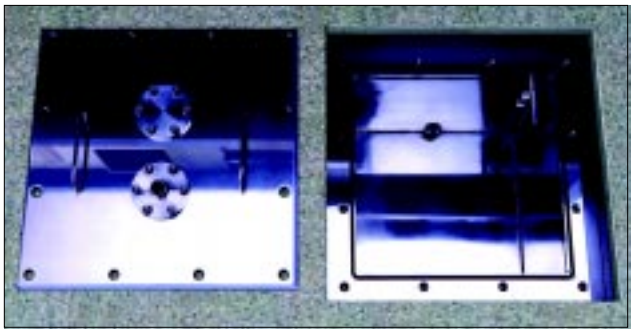
Pressure and Flow Control: Pressure control and mass flow control are accomplished through computer actuation of electromechanical valve assemblies. Saturation pressure, chamber pressure, and mass flow are measured continuously and controlled using PID algorithms similar to those employed in temperature control.

Calibration: Proper calibration of the temperature and pressure transducers ultimately determines the accuracy of the generator. The **4500** employs an integral programmatic calibration scheme allowing the transducers to be calibrated while they are electrically connected to the humidity generator. Coefficients for each transducer are calculated by the computer and stored in memory.

TEST CHAMBER

The **Model 4500** low humidity generating system incorporates a test chamber that is surrounded by a fluid jacket on five sides. The fluid provides temperature conditioning, as well as thermal stability to the test space. Chamber temperature is tunable from -10°C to 85°C.

Interior chamber dimensions are 8"x8"x8". Test chamber pressure range is ambient to 30 psiA. User access for sensors, cables, and tubing is available through two 1.25" diameter ports. Removal of the chamber cover allows a full eight inch by eight inch access to the test space.



APPLICATIONS

The test chamber can accommodate various solid state sensors, chilled mirror hygrometers, and various material samples for environmental testing. Virtually any humidity, test temperature, and test pressure, for any length of time, may be generated within the operational limits of the generator. The output or recording of the device under test may then be compared with the generator's printed data for analysis.

Humidity Sensors and Electrolytic Hygrometers: Insert your humidity probes through a test port in the chamber or connect the Electrolytic Hygrometer to a test port and you can: determine humidity calibration accuracy and/or characterize humidity sensitivity by subjecting the humidity sensor to a variety of humidity levels; perform operational checks such as the sensing systems capability to correctly calculate and display other humidity parameters; determine the repeatability, stability, hysteresis, and drift characteristics of various humidity sensing systems.

Chilled Mirror Hygrometers: Install the actual chilled mirror head into the chamber or connect a sample tube to the test port and feed a sample through the chilled mirror head and you can: verify mirror temperature measurement accuracy (calibration) when the hygrometer is in thermal equilibrium with its environment; perform operational checks of the heatpump and optical components before and after mirror cleaning and balancing; determine whether the hygrometer is controlling the mirror deposit in the liquid phase or ice phase when operating dew or frost points below 0°C; determine if the hygrometer is correctly calculating other humidity parameters; determine hygrometer's repeatability, stability, and drift characteristics.

Environmental Testing: The **4500** can serve as a test bed for evaluation and R&D of humidity sensors, humidity sensing systems, and humidity sensitive products, e.g., polymers, composites, film, magnetic medium, pharmaceuticals, soil hydrology, consumables, electronics, optics, etc.

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SPECIFICATIONS

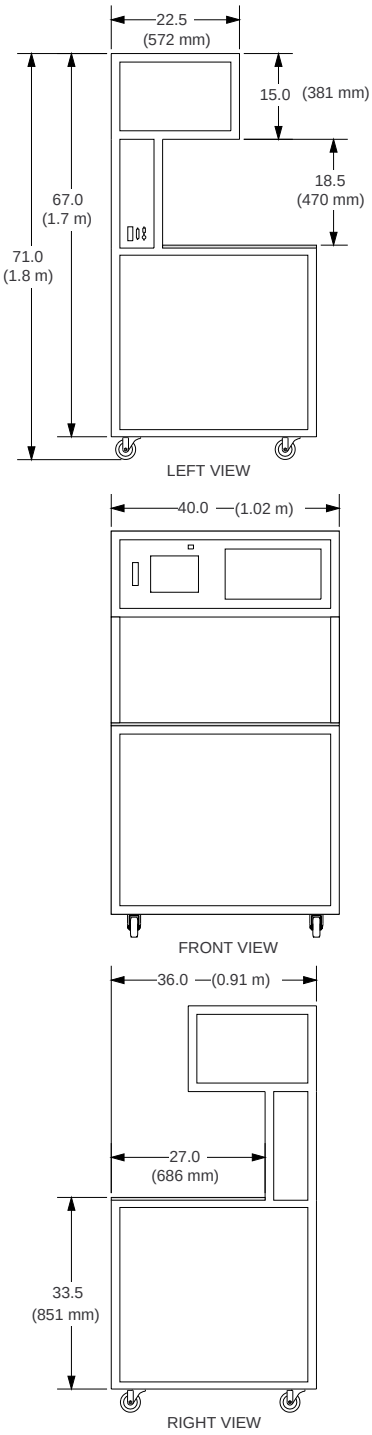
Frost Point Accuracy: ..... ±0.1˚C
Frost Point / Dew Point Range: ..... -95 to +10˚C
Frost Point Resolution: ..... 0.001˚C
Parts Per Million Range: ..... 0.04 to 12000 PPMv
Saturation Pressure Range: ..... 15 to 30 psiA
Saturation Pressure Accuracy (10-45 psiA): ..... ±0.0045
Saturation Pressure Accuracy (30-300 psiA): ..... ±0.030
Saturation Pressure Resolution (10-45 psiA): 0.001
Saturation Pressure Resolution (30-300 psiA): 0.01
Saturation Temperature Range: ..... -80 to +15˚C
Saturation Temperature Accuracy: ..... ±0.05˚C
Saturation Temperature Resolution: ..... 0.001˚C
Saturation Temperature Heating/Cooling Rate: ..... 2 Minutes Per ˚C Average
Chamber Pressure Range: ..... Ambient to 30 psiA
Chamber Pressure Accuracy: ..... ±0.003 psiA
Chamber Pressure Resolution: ..... 0.001 psiA
Chamber Temperature Range: ..... -10 to 85˚C
Chamber Temperature Range: (Optional)* ..... -80 to +20˚C
Chamber Temperature Accuracy: ..... ±0.05˚C
Chamber Temperature Resolution: ..... 0.001˚C
Chamber Fluid Heating/Cooling Rate: ..... 2 Minutes Per ˚C Average
Chamber Dimensions: ..... 8" x 8" x 8" (203 mm x 203 mm x 203 mm)
Generation Gas Flow Rate Range: ..... 0.1 to 5 slpm
Physical Dimensions: ..... 40" x 36" x 71" (1.02 m x 0.91 m x 1.8 m)

UTILITIES

Electrical Power: ..... 200/240 V~, 13 A, 50/60 Hz
Gas Supply (External): ..... 350 psiG, 5 l/m, with ambient pressure frost point <-80°C
Cooling Water: ..... 1 gpm (4 l/m) Maximum @ 21˚C

ENVIRONMENTAL

Operating Temperature: ..... 15 to 30˚C
Storage Temperature: ..... 0 to 50˚C
Humidity: ..... 5 to 95% Non-condensing



* –LT, LOW TEMPERATURE OPTION

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