The V-Gen™ Dew Point / RH Generator

Designed, built, and supported by InstruQuest Inc.

Model 2: Auto/Manual operation with multi-mode control via PC software

The V-Gen is a novel and versatile water vapor generation and calibration system. Its low cost, high quality and performance, and simplicity of operation make it ideally suited for a wide variety of applications requiring an accurate and stable source of water vapor. Its modular design, easy upgrade path, and versatility of control and software of higher models allow easy integration into a larger analytical setup or interfacing with other devices.

The V-Gen uses the fundamental, Two-Temperature principle to generate stable dew points suitable for calibration from 0 to 80 ˚C. A novel design substantially reduces stabilization time when changing the dew point temperature. Additional, Divided-Flow method is employed to generate low values of relative humidity (RH) that are not available by the Two-Temperature method alone. Thus, RH values from 0 to 100% are readily available up to 80 ˚C.

A precision pressure regulator isolates the selectable flow rate from fluctuations in the supply line. An automatic water supply system eliminates frequent user intervention inherent to other generators. The generated water vapor stream is delivered to the location of choice via flexible heated transfer line. To avoid condensation problems, the temperature of the transfer line is automatically maintained at a higher temperature than the current dew point value

Applications

Stable Dew Point / RH source suitable for:

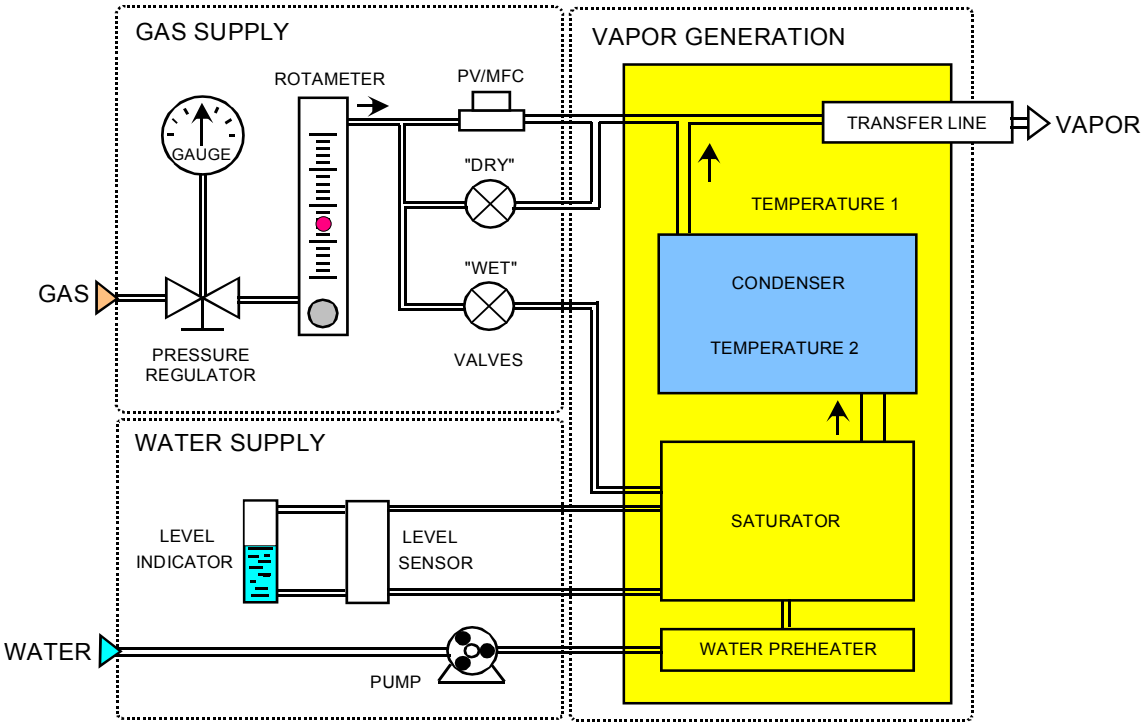
- Gravimetric sorption systems
- Permeation measurement instruments
- Relative humidity sensors calibration
- Sample conditioning in specialized instrumentation
- Study of materials hydration

Operation

A dry or semi-dry gas source is connected at the instrument back via standard 1/8” compression fitting. Typically, the gas source can be air generated from oil-less compressor or an inert gas can be supplied from a gas cylinder. The dryness of the gas will affect the lowest achievable RH values.

The high quality gas pressure regulator allows the selection of desired pressure and observing it on the gauge. Flow rate can be selected by adjusting the metering valve of the rotameter. Depending on application, rotameters with different ranges can be used and replaced by user.

The rotameter output is connected to the 3-valve manifold. In the two-temperature mode only the “WET” valve is open. If dry purge is desired at the selected flow rate, only the “DRY” valve is open. For divided flow operation the “WET” valve is open and the proportional valve, PV, is used. By increasing voltage to the PV driver, the



amount of flow bypassing the saturator increases. Thus, while maintaining the total flow constant, different ratios of dry gas flow to the saturated with water vapor gas flow can be obtained. An external RH sensor at the target needs to be used to monitor the output stream when the divided-flow method is employed.

The gas passing through the “WET” valve enters the saturator. Combined techniques of fine gas dispersion and passing it through media of large surface area are used to assure the highest degree of saturation for large range of temperatures and flow rates. Since evaporation of water causes small lowering of temperature inside the saturator and to account for any inefficiency, a second chamber called condenser is maintained at lower temperature to assure the 100% saturation (dew point). A RTD sensor is used for enhanced accuracy and resolution of the condenser temperature monitoring. The Watlow temperature controllers maintain the saturator and condenser temperatures selected by user.

The saturated stream leaving condenser enters the mixing manifold where it can be combined with dry gas. From the manifold the output stream is delivered via the heated transfer line to the location of choice. The temperature of the transfer line is automatically maintained at saturator temperature by a special controller board. Since the saturator temperature is normally maintained a few degrees above the condenser temperature, such setup eliminates any condensation problems.

The water used for gas saturation should be de-ionized and of high purity to avoid clogging of gas sparger and to minimize maintenance. The autonomous water delivery system consists of peristaltic pump and its controller, water level sensor, visual level indicator, pump enable switch (ON/OFF), and pump direction switch (Forward/Reverse) located at the back. When water level drops below certain level, the pump is activated and it supplies enough water to restore the required level. This amount of water is preheated to the saturator temperature to avoid any temperature drops in the saturator chamber. If automatic refill action is temporarily not desired, the pump enable switch can be turned off. In a case the water has to be removed from the system, e.g. for shipping purposes, the pump direction switch has to be switched to the REV position until the water is emptied.

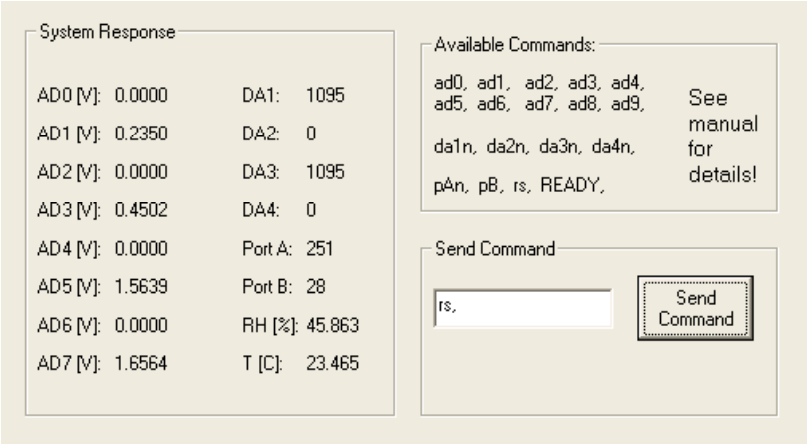
Control

Addition of microcontroller board and ancillary electronics to the basic model opens many possibilities in implementation of automatic operation of the instrument and interfacing to external hardware. From an OEM user point of view, the analog and digital resources of the microcontroller board add the convenience of relinquishing any master controller from providing them. To ensure modular and "open-architecture" approach to design of control system, a command language was developed to control the instrument via serial port. Using those commands, versatile PC software for experiment design, control, and interfacing to external sensor(s) has been developed.

The ancillary electronic board consists of additional RTD circuit for monitoring temperatures at user defined location and interface board. The interface board provides easy access to the microcontroller resources, like connecting analog voltage channels for monitoring voltage from external sensors. Spare digital lines and D/A channel(s) can be also used for custom interfacing.

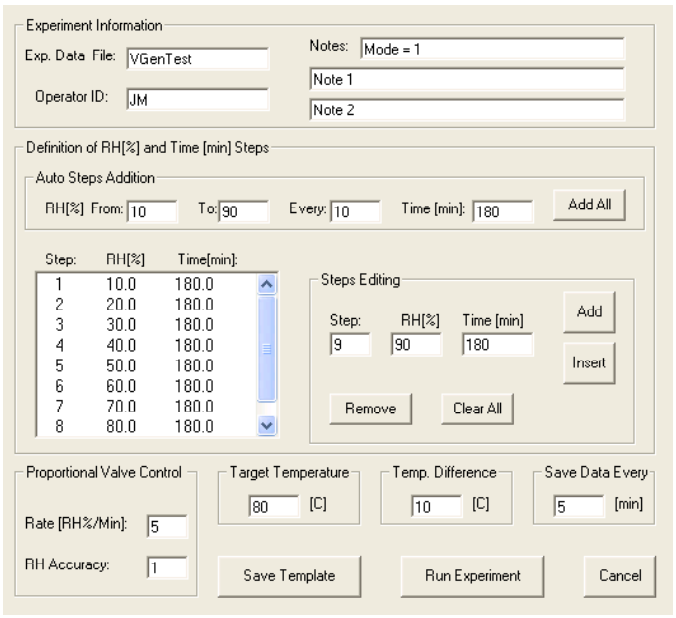
Direct control via serial port using command language

To allow users direct control over the instrument hardware but without the need of knowing details of complex electronics, the following strategy is employed. Monitoring or changing each resource, like A/D and D/A channels or digital ports, is carried out by issuing a simple command via serial port. Command handlers written in the firmware software carry out requested tasks. Single-wire data transfer protocol for some digital RH probes (16-bit resolution) from Rotronic Instrument Corp. is also implemented. Basically, the instrument with any external hardware (sensors) connected to it can be perceived as a black box that can be easily operated using a simple set of commands. For example, the Diagnostics screen in the provided PC software will report the entire state of the system with one simple command: "rs,". Please see a portion of the screen below.

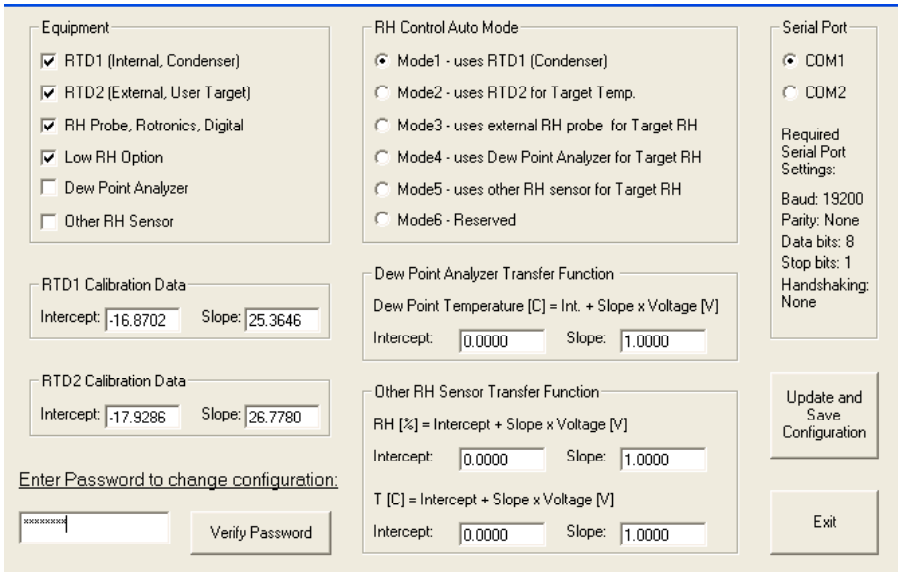


Experiment design and control using Windows® based PC software

User friendly software for execution of different RH steps, diagnostics, calibration, graphing, reporting, and RH calculations has been designed. Automation of templates design, flexibility in experiment modification during run, and ability to switch between Auto and Manual operation are very useful in any research work. A snapshot of the template design screen is presented below.



The instrument can be equipped with different hardware configurations and it can be used as a calibrator or generator. Depending on which sensor is currently used for determining the final RH, one of several modes of operation can be selected. The system can be easily accommodated to different RH needs by user.

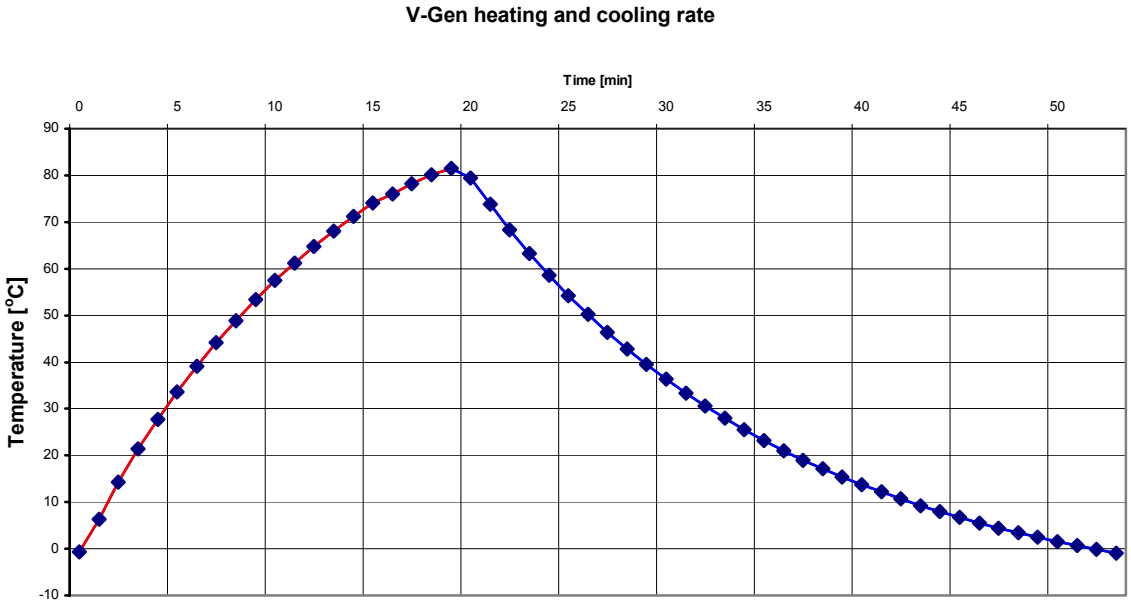


Calibration

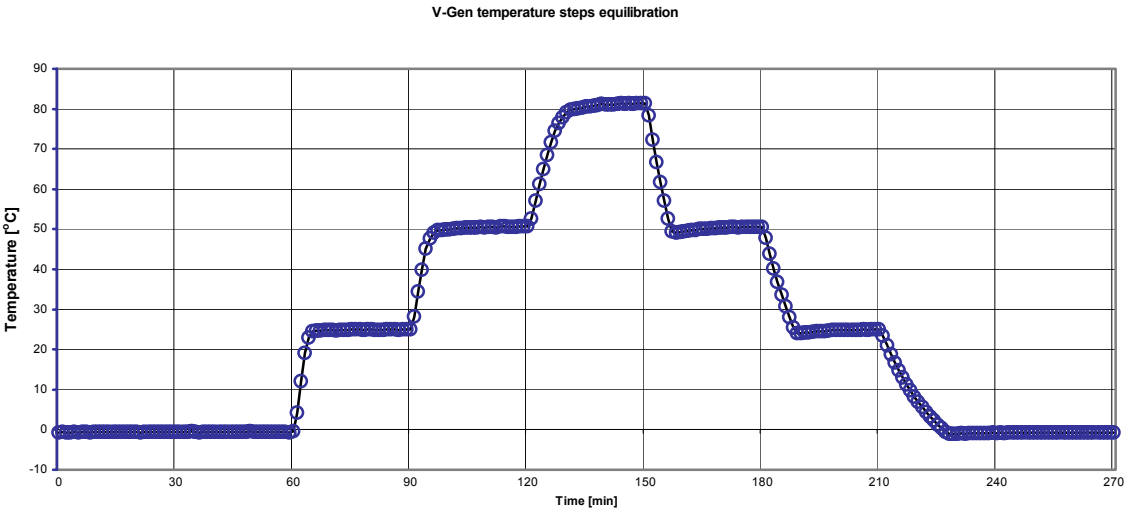
One RTD used for precise dew point determination is calibrated using NIST-traceable precision glass thermometers. The second RTD used in control of condenser temperature is calibrated in situ using an independent RTD that has been calibrated using NIST-traceable precision glass thermometers. The calibration certificate for both RTD's is provided.

System Dynamics

One of the objectives of V-Gen design was to improve the two-temperature system dynamics while assuring accuracy and stability.



The figure shows the heating and cooling rate of the condenser chamber. The whole cycle of heating the chamber and cooling it back takes less than an hour for the 80˚C temperature span.



This figure shows equilibration dynamics for several large temperature steps in the increasing and decreasing direction versus time. The room temperature was varied often throughout the experiment by about 2 ˚C.

Specifications

Dew Point Temperature:
Range: 0 to 90 ˚C
Accuracy: ± 0.2˚C
Stability: 0.1C
Settability: 0.1˚C

RH range: 0 to 100 %

Maximum temperature of saturator: 95 ˚C

Maximum temperature of condenser: 90 ˚C

Thermal protection: Thermal cut-offs for the saturator and condenser heaters. Temperature limits are also set in the temperature controllers.

Flow Rate: Determined by the rotameter range, Available ranges: 50, 100, 200, 500, 1000 cc/min.

Gas Type: Inert gas, typically air or N_2

Gas Inlet Port: 1/8" (Swagelok® type bulkhead)

Gas Inlet Pressure:
Maximum: 100 psi (7 bar)
Minimum: 10 psi (0.7 bar)

Outlet port: 0.25" (6.35 mm) OD tubing – (the fitting can be easily replaced to accommodate other sizes).

Transfer line dimensions:
Heated length about - 40" (1.0 m)
0.25" OD, 3/16" ID
Thickness w/ insulation: about 0.65" (16-17 mm)
Other lengths and sizes available as options

Transfer Line Temperature:
Maximum (Continuous) 100 ˚C
Minimum: Ambient

Dimensions: (W x H x D)
8.7" x 11.4" x 16"
(22.2 x 29 x 40.7 cm)
(Not including protrusions in front and back)

Instrument Weight:
27 lb (12 kg)

Power Requirements:
110 VAC, 400VA, 60 Hz nominal
(Optional): 220 VAC, 400VA, 50 Hz nominal

These specifications are subject to change at any time