Chamber Temperature Uniformity Analysis
of the
Thunder Scientific Model 1220 Two-Pressure Humidity Generator

By Michael Hamilton

1 Introduction

Described here is the Chamber Temperature Uniformity for a Model 1220 Humidity Generator equipped with a standard no window door. Chamber temperature uniformity has a direct influence on relative humidity gradients within the test chamber. To determine the chamber temperature uniformity, ten 100 Ohm RTD probes of equivalent type were calibrated together over the temperature range of 5 °C to 60 °C. The probes were then strategically placed at various locations within two inches of the chamber walls and two inches from the chamber door as shown in Figure 1.

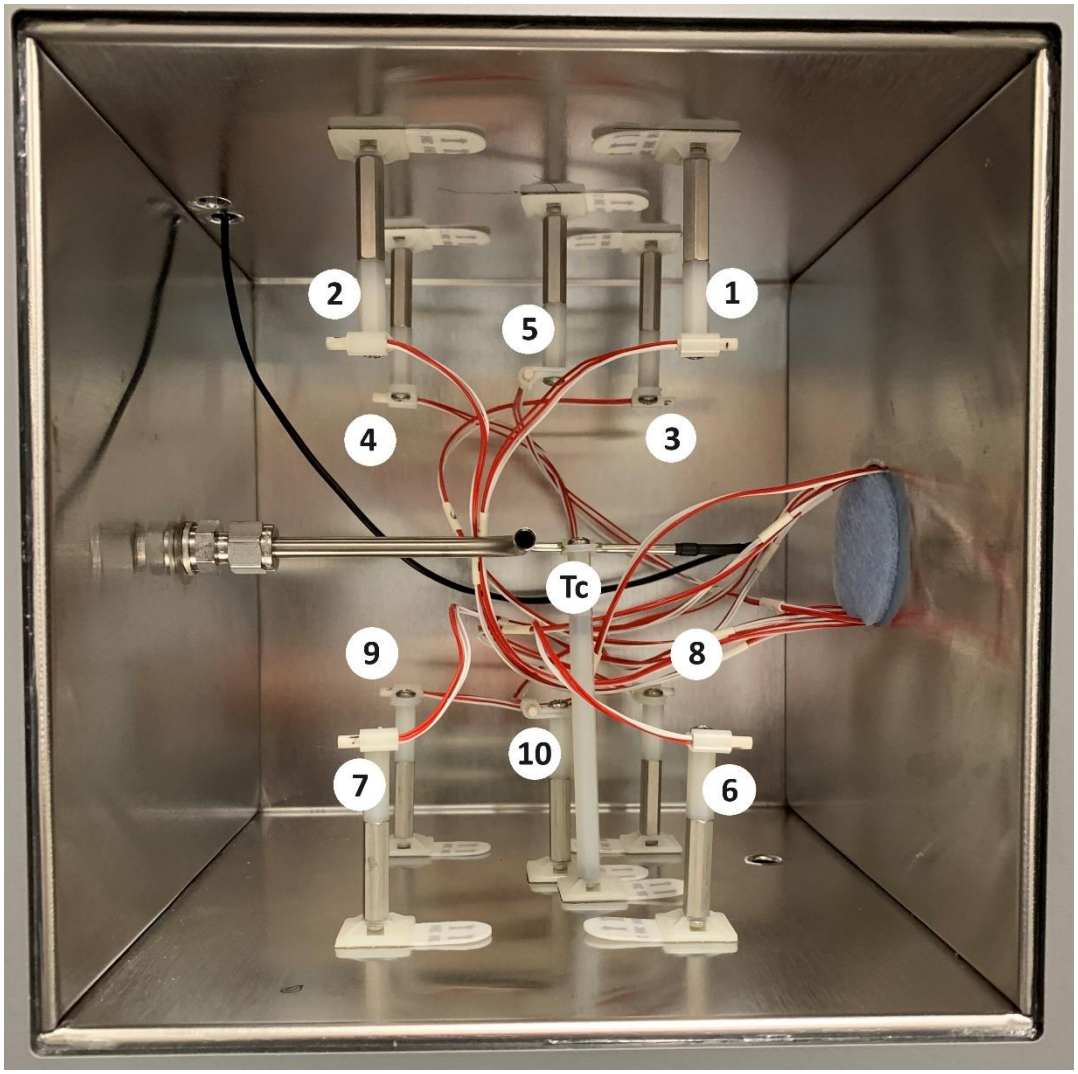

Figure 1

Document: Model_1220_Temperature_Uniformity_Analysis
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2 Calibration of Thermometers

The ten RTD probes were calibrated at the same time, in the same bath, against the same reference thermometer. Although they were calibrated in a well stirred fluid bath, yet used in air, self-heating is not considered a significant contributor since all probes are used in the same type of environment. All probes were subjected to similar self-heating effects which tend to cancel one another when viewing differences between probes. Each probe's combined uncertainty consists of repeatability, reproducibility and the reference thermometer uncertainty (Fluke 1595A). The uncertainty for any probe (u(T)) is then determined as the average uncertainty due to probe error using each probe's combined uncertainty.

$$u(T) = \pm 0.01°C$$

3 Defining Equations

The maximum measurement deviation from the mean will be determined by noting the average maximum and minimum readings from the set of probes over a ten-minute sample and then taking half the difference of these values.

$$MaxDev = \pm 0.5 * (MaxReading - MinReading) \quad [1]$$

The uniformity will then be computed by RSS combination (root of the sum of the squares) of the maximum deviation (MaxDev) and the estimated probe uncertainty (u(T)).

$$uniformity^2 = MaxDev^2 + u^2(T) \quad [2]$$

3.1 Measurement of Chamber Temperatures

The following data was gathered during the uniformity analysis conducted in 2024, using a Model 1220 serial number 24050001. The generator was operated at a fixed humidity of 50% RH using an automated profile to assure stability at each point. Ten minutes of data was collected for each probe at each temperature point. The uniformity was then calculated using equations 1 and 2 and the results are given in Table 1 and figure 2.

3.1.1 No Window Door

The Model 1220 no-window door is a standard insulated door without a glass window. The chamber door plays a significant role in achieving good chamber uniformity. Throughout testing, the chamber inlet was directed toward the center of the door using a 90° stainless steel tube (Figure 2) to help address the heat loss through the door (especially at temperatures more than ±10 ℃ ambient) and to avoid blowing directly at the large number of probe wires coming through the side access port. This directed chamber inlet functions similarly to a chamber fan in a larger generator.

Figure 2

The calculated uniformity using equations 1 and 2 for the no window door at each temperature is summarized in Table 1 and Figure 3.

No Window Door		
°C	**Chamber Uniformity**	**Uniformity Specification**
60	0.047	0.05
50	0.038	0.05
40	0.027	0.05
35	0.024	0.05
30	0.019	0.05
25	0.015	0.05
20	0.014	0.05
15	0.018	0.05
10	0.024	0.05
5	0.030	0.05

Table 1

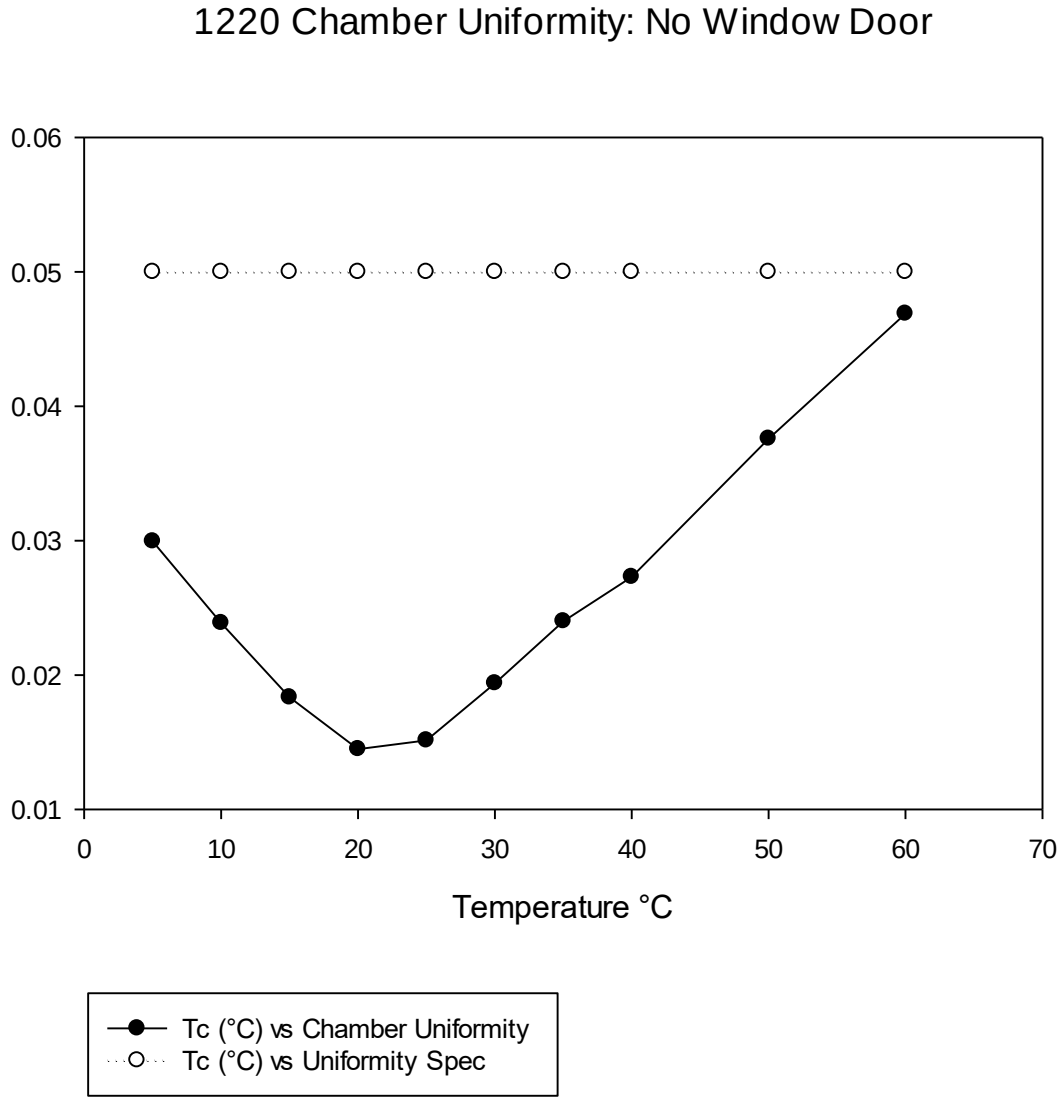

Figure 3

4. Chamber Temperature Uniformity

The maximum chamber uniformity value was selected from Table 1 and rounded up to determine the Uniformity Specification for the Model 1220 Two-Pressure Humidity Generator.

uniformity specification = 0.05 °C [1]

[1] Between the temperature range of 5 °C to 60 °C while directing chamber flow towards the center of the door.

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