Relative Humidity Calibration Chamber Using Saturated Chemical Salts

Instructions for Use

1. Background

It has been demonstrated that saturated aqueous solutions of certain stable Salts, confined in a vessel, at equilibrium, are able to generate extremely constant relative humidity in the confined air space above the liquid surface (the so-called "Head Space"). The Table on the following page lists Salts capable of generating constant humidity that are suitable for the calibration of Relative Humidity (RH) Sensors.

2. General Approach

To successfully use Salts for calibration of a Sensor, the following steps are required:
2.1 Obtain a pure form of selected Salt (ionic chemical compound);
2.2 Mix salt with pure water in such a ratio that un-dissolved salt remains at equilibrium;
2.3 Stir mixture in an enclosed vessel (chamber) until saturation equilibrium is attained;
2.4 Verify the presence of some un-dissolved salt in the vessel (chamber) after stirring;
2.5 Insert Sensor into chamber Head Space, and confine Sensor within the Head Space;
2.6 Allow Head Space, Sensor, and solution to equilibrate, then read the Sensor output;
2.7 Adjust Sensor output to conform to the true RH generated by the salt solution.

3. Instructions

3.1 Remove Calibration Chamber Lid.
3.2 Add entire pack (zip-lock bag) of pure Salt into the Chamber.
3.3 Check appropriate box on label (if applicable) to indicate which Salt was used. If the label does not include a check box for the Salt Solution used, make a note of which Salt Solution for your records.
3.4 Add 100 mL of chemically pure water (a) to the Chamber.
3.5 Add a magnetic stirrer (not provided) to the Chamber, or agitate the mixture by other suitable means.
3.6 Replace the Chamber Lid, then agitate the mixture for > 4 hours, preferably overnight.
  3.6.1 Agitate Chamber at Room Temperature at which it will be used, DO NOT HEAT.
3.7 When you are confident the Salt Solution has attained equilibrium (vigorous stirring for > 4 hours, or moderate stirring overnight), verify the presence of un-dissolved solids, and remove the liquid stirrer.
3.8 Remove the Port Cap from the Chamber Lid and insert the RH Sensor, (sold separately), to be calibrated so that it intrudes into the Head Space but not into the liquid. DO NOT ALLOW SENSOR TO TOUCH THE LIQUID.
3.9 Activate the Sensor and its read-out device.
3.10 Plug in the Power Cord and activate Head Space stirrer via ON/OFF Switch on top of the Chamber.
3.11 Verify that Head Space stirring is activated, and stir for at least 5 minutes. To verify vapor equilibrium in the Head Space, observe the Sensor output, and stir until a constant Sensor reading has been obtained.
3.12 Adjust the Sensor Calibration to conform to the actual %Relative Humidity generated by the Salt Solution by referring to the Table on the following page.
  3.12.1 Note that the %RH generated by each Salt Solution has a slight temperature dependence.
  3.12.1 Measure temperature in the Chamber.
  3.12.2 Select %RH from the Table corresponding to the measured temperature.

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(a) Purified Water - ASTM Type I having Resistivity > 18 MOhm-cm (conductivity < 0.06 µS/cm) with low organics (< 100 µg/L).

Equilibrium Relative Humidity
Saturated Salt Solutions

Relative Humidity (%RH)			
Temperature °C	Lithium Chloride	Potassium Acetate	Magnesium Chloride
0	11.23 ± 0.54		33.66 ± 0.33
5	11.26 ± 0.47		33.60 ± 0.28
10	11.29 ± 0.41	23.28 ± 0.53	33.47 ± 0.24
15	11.30 ± 0.35	23.40 ± 0.32	33.30 ± 0.21
20	11.31 ± 0.31	23.11 ± 0.25	33.07 ± 0.18
25	11.30 ± 0.27	22.51 ± 0.32	32.78 ± 0.16
30	11.28 ± 0.24	21.61 ± 0.53	32.44 ± 0.14
35	11.25 ± 0.22		32.05 ± 0.13
40	11.21 ± 0.21		31.60 ± 0.13
45	11.16 ± 0.21		31.10 ± 0.13
50	11.10 ± 0.22		30.54 ± 0.13
55	11.03 ± 0.23		29.93 ± 0.16
60	10.95 ± 0.26		29.26 ± 0.18
65	10.86 ± 0.29		28.54 ± 0.21
70	10.75 ± 0.33		27.77 ± 0.25
75	10.64 ± 0.38		26.94 ± 0.29
80	10.51 ± 0.44		26.05 ± 0.34
85	10.38 ± 0.51		25.11 ± 0.39
90	10.23 ± 0.59		24.12 ± 0.46
95	10.07 ± 0.67		23.07 ± 0.52
100	9.90 ± 0.77		21.97 ± 0.60

Saturated Salt Solutions
A very convenient method to calibrate humidity sensors is the use of saturated salt solutions. At any temperature, the concentration of a saturated solution is fixed and does not have to be determined. By providing excess solute, the solution will remain saturated even in the presence of modest moisture sources and sinks. When the solute is a solid in the pure phase, it is easy to determine that there is saturation.

The saturated salt solution, made up as a slushy mixture with distilled water and chemically pure salt, is enclosed in a sealed metal or a glass chamber. Wexler and Hasegawa measured the humidity in the atmosphere above eight saturated salt solutions for ambient temperatures 0 to 50°C using a dew-point hygrometer. Later, Greenspan compiled, from the literature, data on 28 saturated salt solutions to cover the entire range of relative humidity. Using a data base from 21 separate investigations comprising 1106 individual measurements, fits were made by the method of least squares to regular polynomial equations to obtain the "best" value of relative humidity in air as a function of temperature. These values are summarized in the table shown.

Relative Humidity (%RH)						
Temperature °C	Potassium Carbonate	Magnesium Nitrate	Sodium Chloride	Potassium Chloride	Potassium Nitrate	Potassium Sulfate
0	43.13 ± 0.66	60.35 ± 0.55	75.51 ± 0.34	88.61 ± 0.53	96.33 ± 2.9	98.77 ± 1.1
5	43.13 ± 0.50	58.86 ± 0.43	75.65 ± 0.27	87.67 ± 0.45	96.27 ± 2.1	98.48 ± 0.91
10	43.14 ± 0.39	57.36 ± 0.33	75.67 ± 0.22	86.77 ± 0.39	95.96 ± 1.4	98.18 ± 0.76
15	43.15 ± 0.33	55.87 ± 0.27	75.61 ± 0.18	85.92 ± 0.33	95.41 ± 0.96	97.89 ± 0.63
20	43.16 ± 0.33	54.38 ± 0.23	75.47 ± 0.14	85.11 ± 0.29	94.62 ± 0.66	97.59 ± 0.53
25	43.16 ± 0.39	52.89 ± 0.22	75.29 ± 0.12	84.34 ± 0.26	93.58 ± 0.55	97.30 ± 0.45
30	43.17 ± 0.50	51.40 ± 0.24	75.09 ± 0.11	83.62 ± 0.25	92.31 ± 0.60	97.00 ± 0.40
35		49.91 ± 0.29	74.87 ± 0.12	82.95 ± 0.25	90.79 ± 0.83	96.71 ± 0.38
40		48.42 ± 0.37	74.68 ± 0.13	82.32 ± 0.25	89.03 ± 1.2	96.41 ± 0.38
45		46.93 ± 0.47	74.52 ± 0.16	81.74 ± 0.28	87.03 ± 1.8	96.12 ± 0.40
50		45.44 ± 0.60	74.43 ± 0.19	81.20 ± 0.31	84.78 ± 2.5	95.82 ± 0.45
55			74.41 ± 0.24	80.70 ± 0.35		
60			74.50 ± 0.30	80.25 ± 0.41		
65			74.71 ± 0.37	79.85 ± 0.48		
70			75.06 ± 0.45	79.49 ± 0.57		
75			75.58 ± 0.55	79.17 ± 0.66		
80			76.29 ± 0.65	78.90 ± 0.77		
85				78.68 ± 0.89		
90				78.50 ± 1.0		
95						
100						