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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions[1]

This standard is issued under the fixed designation D 5032; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes a method for obtaining constant relative humidity ranging from 30 to 98 % at temperatures ranging from 0 to 70°C in relatively small containers by means of an aqueous glycerin solution.

1.2 This practice is applicable for closed systems such as environmental conditioning containers.

1.3 This practice is not recommended for the generation of continuous (flowing) streams of constant humidity unless precautionary criteria are followed to ensure source stability.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 4023 Terminology Relating to Humidity Measurements[3]

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions[3]

2.2 *Other Documents:*

DIN50008 "Konstantklimate uber wasserigen Losungen" (Constant Climates Over Aqueous Solutions)

Part 1: Saturated Salt and Glycerol Solutions

Part 2: Sulfuric Acid Solutions (1981)[4]

3. Summary of Practice

3.1 Controlled relative humidity environments are generated using mixtures of glycerin and water.

3.2 Practice E 104 contains methods for maintaining constant relative humidity environments using aqueous saturated salt solutions or various strength sulfuric acid-water systems.

4. Significance and Use

4.1 Controlled relative humidity environments are important for conditioning materials for shelf-life studies or for investigating the change in physical or dielectric properties after exposure.

4.2 The use of aqueous-glycerin solutions reduces the possibility of contamination of the materials or corrosion of electrode systems which would be more likely to result from saturated salt or acid water solutions.

4.3 Applicable material specifications should state the exposure conditions, including time, temperature and relative humidity, that a material should be subjected to before subsequent testing. Typical conditions are given in Practice D 618.

5. Apparatus

5.1 *Container*, airtight, of a material not acted upon by copper sulfate (or with the glycerin solution contained in a tray made of a material not acted upon by copper sulfate).

5.2 *Refractometer*, covering the range of 1.33 to 1.47 (sodium) with an accuracy of 0.0003.

6. Glycerin Solution

6.1 Use a good industrial grade of glycerin ("high gravity" and "dynamite" grades are satisfactory) in distilled water. Calculate the concentration in terms of the refractive index, (R), at 25°C for the desired relative humidity at any temperature between 0 and 70°C as follows:

$$R = \left(\sqrt{(100 + A)^2 + A^2 - (H + A)^2} - A\right)\frac{1}{715.3} + 1.3333 \quad (1)$$

where:

T = temperature of the solution, °C,
A = $25.60 - 0.1950T + 0.0008T^2$, and
H = relative humidity, percent.

6.1.1 This will give the desired relative humidity with an accuracy of ±0.2 % at a constant temperature of 25°C. At other constant temperatures, the error, if any, may increase with the deviation of the temperature from 25°C. The relative humidity values at 0, 25, 50 and 70°C for a number of refractive index values are given in Table 1. Obtain the refractive index for intermediate values of relative humidity and temperature by plotting curves from the values in the table or by calculating from the above formula.

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[1] This practice is under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.12 on Electrical Tests.

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[2] *Annual Book of ASTM Standards*, Vols 08.01 and 10.01.

[3] *Annual Book of ASTM Standards*, Vol 11.03.

[4] Available from *Deutsches Institut fur Normung*, 4-10 *Burggrenzenstrasse Postfach* 1107, D-1000 Berlin, Federal Republic of Germany. Also available from American National Standards Institute, Publication Office, 1430 Broadway, New York, NY 10018.

TABLE 1 Relative Humidity Over Glycerin Solutions

Refractive Index at 25°C	Relative Humidity, %			
	0°C	25°C	50°C	70°C
1.3463	97.7	98.0	98.2	98.4
1.3560	95.6	96.0	96.4	96.7
1.3602	94.5	95.0	95.5	95.8
1.3773	89.2	90.0	90.7	91.2
1.3905	84.0	85.0	85.9	86.6
1.4015	78.8	80.0	81.1	81.8
1.4109	73.7	75.0	76.2	77.0
1.4191	68.6	70.0	71.3	72.2
1.4264	63.4	65.0	66.4	67.3
1.4329	58.4	60.0	61.4	62.5
1.4387	53.3	55.0	56.5	57.6
1.4440	48.3	50.0	51.5	52.6
1.4486	43.3	45.0	46.6	47.7
1.4529	38.3	40.0	41.6	42.7

6.2 To prevent fungus growth in the solution, add about 0.1 % by weight of copper sulfate to the glycerin solution. The most convenient way of measuring the copper sulfate is to prepare a saturated solution in water and add four drops of the saturated solution per 100 mL of the glycerin solution. Use a container, or tray holding the glycerin solution, made of a material that will not react with the copper in the copper sulfate. If the copper is removed, fungus growth can occur, which will cause lowering of the humidity value of the glycerin solution.

6.3 Loss of water through evaporation when the container is open, or by absorption by the material being conditioned, will reduce the humidity value of the solution. The rate of loss with the container open is quite low and is negligible for the normal time the container would be open for loading and unloading (Note 1). A material being conditioned that will absorb a large amount of water may seriously reduce the humidity unless proper precautions are taken. For example, a loss of 0.26 mL water/cubic in.^{3} of a glycerin-water solution adjusted to produce a 96 % relative humidity at 25°C will reduce the humidity by 0.5 % relative humidity. If it is estimated that the reduction in humidity will be greater than desired, one or both of the following may be done: the loading may re reduced below that suggested in 7.5 or the depth of the solution may be increased.

NOTE 1—A solution adjusted to produce a 96 % relative humidity atmosphere at 25°C in an open container, in a still atmosphere of 50 % relative humidity at 25°C, will lose water at the rate of approximately 0.01 mL/h/in.^{2} of solution surface area. This rate will reduce the relative humidity value of a 96 % solution having a depth of 1 in. by 0.5 % relative humidity in 26 h.

7. Precautions

7.1 *Container*:

7.1.1 Make the container small so that the temperature throughout the container will be the same as that of the solution. Keep the volume of the air space per unit area of surface of solution low. Ten cubic inches or less per in.^{2} of solution surface is advisable unless a larger volume is necessary because of the device to be conditioned.

7.1.2 Although an airtight container is recommended, it is desirable to have a vent under certain conditions of test or with some kinds of containers. (Changes in pressure may produce undesirable cracks in some types of containers.) Make the vent as small as practical as there will be a continual loss of vapor through the vent. Check the concentration of the solution periodically and adjust if necessary in this case.

7.1.3 Make the surface creepage distance between the solution and the material being conditioned long enough to prevent the solution creeping to the material being conditioned.

7.2 *Temperature Fluctuations*:

7.2.1 Avoid temperature fluctuations. Best results are obtained in a controlled temperature room where the average temperature is constant and the fluctuations are of relatively short duration. Cover the container to shield from drafts. Drafts may cause temperature differences inside the container. Changing ambient temperature causes a temperature difference between that of the solution and the air above it. As a rule, changes in the solution temperature lag behind that of the air in the container. This results in a low humidity with rising temperature and a high humidity with falling temperature.

7.2.2 If a controlled temperature room is not available, fair results may be obtained by placing the container in a location having the minimum change in temperature and thermally insulating the container with at least 1 in. of glass wool, or the equivalent. Reducing the volume of air space in the container per unit area of solution surface will also reduce the effect of changing temperature.

7.2.3 A glass desiccator covered with a corrugated paper box will stand short time (30 min or less) fluctuations of temperature of± 1°C without changing the relative humidity over ±0.1 %. Where larger fluctuations or long time fluctuations are encountered, thermally insulate the container. It is estimated that a thermally insulated container will withstand fluctuations of temperature of ±3°C without changing the relative humidity over ±0.1 %.

7.2.4 A thick aluminum cover or base plate, or both, on the container will also effectively dampen temperature fluctuations.

7.3 *Temperature Above Room Temperature*—Operating at temperatures above or below room temperature is not as satisfactory as operating at room temperature, because of the greater possibility of the air in the container not being at the solution temperature and not being the same throughout the container. For example, with a solution for a relative humidity of 96 %, a spot having a temperature 0.3°C higher than that of the solution would have a relative humidity of 94 %, while that having a temperature 0.3°C lower would have a relative humidity of 98 %. However, with proper care, humidities at temperatures above room temperature are attainable by heating the container in an oven. Thermally insulate the container as described in 7.2 and adjust the oven air circulation so as to have as nearly uniform temperature throughout the container as possible. Load the container while at room temperature.

7.4 *Temperatures Below Room Temperature*—Follow the same precautions as for temperatures above room temperature except reduce the temperature of the container (open) below the conditioning temperature before loading.

7.5 *Loading*—Avoid overloading as this may decrease the rate of rise of the humidity in the container to such an extent that an unreasonably long time is required for the humidity to reach a steady state. The limit of loading cannot very well be

specified as this depends upon the amount of moisture the material will absorb; this differs for different materials. As a general rule, make the over-all area of the material less than the surface area of the solution.

7.6 *Opening of the Chamber During Test*—Avoid opening the chamber during a test since the rate of establishing equilibrium after reclosing the chamber is not known. Equilibrium in the chamber depends on the ratio of chamber volume to solution surface area, type of material in thechamber, amount of material in the chamber and temperature difference between the solution and the chamber atmosphere.

8. Keywords

8.1 aqueous glycerin solutions; conditioning; constant relative humidity; glycerin; relative humidity