Designation: E 2323 – 04

Standard Test Method for Calculating the Concentration of Fill Gas in a Sealed Insulating Glass Unit Using Measurements From an Oxygen Analyzer[1]

This standard is issued under the fixed designation E 2323; 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 test method covers procedures for the use of oxygen analyzers to measure the percentage of oxygen in an insulating glass unit where normal atmospheric air has been replaced with other gases such as argon, krypton, xenon, or sulfur hexafluoride (SF_6). The procedure shows how to convert the measured percentage of oxygen in an insulating glass unit to the percentage of air in the unit, and subtracts the air percentage from 100 % to calculate the percentage of fill gas in the unit.

1.2 This test method does not determine the type of fill gas. It only measures the percentage of oxygen in the gas in the space between the lites of an insulating glass unit.

1.3 This test method is not applicable to insulating glass units containing open capillary/breather tubes.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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:* [2]

C 162 Terminology of Glass Products

C 717 Terminology of Building Seals and Sealants

E 631 Terminology of Building Constructions

3. Terminology

3.1 *Definition of Terms:*

3.1.1 For definitions of terms found in this standard, refer to Terminologies C 717, C 162, and E 631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *Fill Gas*—Any gas, or mixture of gases intended to replace atmospheric air in the space between the lites of a sealed insulating glass unit. A fill gas is typically inert. The most commonly used fill gases include argon, krypton and sulfur hexafluoride (SF_6).

3.2.2 *Sealed Insulating Glass Unit*—a pre-assembled unit, comprising lites of glass, which are sealed at the edges and separated by dehydrated space(s), intended for clear vision areas of buildings. The unit is normally used for windows, window walls, picture windows, sliding doors, patio doors, or other types of fenestration.

4. Significance and Use

4.1 Air between the lites of an insulating glass unit can be replaced with other gases such as argon, krypton, xenon or SF_6 to modify the thermal or acoustical performance, or both, of the unit.

4.2 The primary use of this test method is as a quality control test for gas filling of insulating glass units.

4.3 This test method can be used to verify and ensure a fill gas percentage during manufacturing.

4.4 This test method is used to calculate the percentage of fill gas.

4.5 This test method does not identify the composition of the fill gas.

NOTE 1—If the atmospheric air is intended to be replaced in total or in part by filling with a gas of known composition, then the user may reasonably infer that the composition of the fill gas in the insulating glass unit is a mixture of the fill gas and atmospheric air.

4.6 Calculation of the thermal performance of an insulating glass unit using fill gas values generated by this test method also requires that the composition of the fill gas in the space between the lites of the sealed insulating glass unit be determined.

4.7 This test method can be used before, during or after accelerated weathering testing.

NOTE 2—Due to differences in diffusion rates of gases into or out of the insulating glass unit, the calculation may only be an approximation if the method is used during or after weathering. Similarly, if a period of time has passed since the original filling of the insulating glass unit then the accuracy of the calculated results may be affected.

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[1] This test method is under the jurisdiction of ASTM committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.22 on Durability Performance of Building Constructions.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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4.8 It takes time after the filling of the insulating glass unit for the fill gas to mix with any residual atmospheric air so that a gas sample drawn from any portion of the airspace will be uniform in concentration. This is particularly important in insulating glass units containing interior components, such as tubular muntin bars and tubular spacer bars. The air inside these components may not easily be replaced by the fill gas during the filling process, and after the unit is sealed, time is required for the fill gas to mix with the residual atmospheric air in these components. Performing this test before the fill gas has uniformly mixed with the residual atmospheric air could affect the calculated results.

NOTE 3—Some labs have found that mixing of the fill gas into the hollow tube spacer of an insulating glass unit can occur within 24 hours. This will vary based on unit construction and gas filling methods. It is recommended that users of this method establish their own equilibrium times.

4.9 This test method assumes that atmospheric air contains 20.9 % oxygen. Because the oxygen concentration in air can vary slightly, the calculated percentage of fill gas may vary.

5. Apparatus

5.1 *Oxygen Analyzer*:

5.1.1 Typically, oxygen analyzers are paramagnetic, fuel cell, or zirconium oxide cell by design.

5.1.2 The uncertainty in the measured % oxygen will vary with the concentration of oxygen and the type of oxygen analyzer used.

5.1.3 Tubing used to collect samples shall be kept to as short a length and as small a diameter as possible. This is to minimize the amount of sample that needs to be drawn through the tubing in order to obtain a stable reading.

NOTE 4—Atmospheric air contained in the tubing could lead to contamination of the sample and/or signal. Proper technique in handling the tubing can minimize this effect.

6. Sampling

6.1 *Method A*:

6.1.1 Condition the insulating glass unit so that at the time of sampling a positive pressure exists inside the unit. This is achieved by heating the unit so that positive pressure exists. Alternatively, placing the unit horizontally on a flat surface and applying a weight to the center of glass will result in positive pressure inside the unit.

NOTE 5—If the gas sampling occurs with the unit under negative pressure, contamination of the gas sample will occur.

6.1.2 Wrap the shank of the oxygen analyzer sampling needle with polyisobutylene (PIB) sealant or other sealing mastic.

6.1.3 Drill or punch an approximate 1.6 mm (1⁄16 in.) hole through the edge sealant and the spacer. The hole shall be located approximately 75 mm (3 in.) from a corner.

NOTE 6—Drilling a hole is not necessary in spacers that allow the needle to pass through the spacer without damage or obstruction to the needle.

6.1.4 Remove the drill or punch and immediately plug the hole with a finger.

6.1.5 Slide the finger off the hole and immediately insert the PIB wrapped sampling needle.

6.1.6 Seal the needle into the hole with the PIB sealant.

6.2 *Method B*:

6.2.1 Fill a container that is large enough to completely submerge the sealed insulating glass unit with water. For an example, please refer to Fig. 1.

6.2.2 Place the sealed insulating glass unit into the tank of water vertically. The unit shall be completely submerged in the water. The top edge of the sealed insulating glass unit shall be a minimum of 12 mm (½ in.) below the water surface.

6.2.3 Drill or punch a small hole through the upper edge of the insulating glass unit. The hole shall go completely through the spacer and into the interior of the unit.

NOTE 7—Drilling a hole is not necessary in spacers that allow the probe to pass through the spacer without damage or obstruction to the probe. This hole is drilled while the unit is submerged under water. The depth of water above the specimen should not excess one-half the exposed length of the drill bit. While only the drill bit will actually be under water, proper precautions must be taken. The use of a cordless drill is suggested.

6.2.4 Remove the drill bit from the hole and place a finger over the hole.

6.2.5 Invert the unit so that the hole is on the bottom edge of the unit. Keep the unit completely submerged during the repositioning.

6.2.6 Once repositioned, remove the finger from the hole. It is normal for a small amount of water to begin to enter the unit.

6.2.7 Repeat step 6.2.3

6.2.8 Insert the needle into the insulating glass unit through this top hole. Use PIB sealant, bee's wax, plumber's putty, or other sealing material to seal the penetration around the needle.

7. Procedure

7.1 Calibrate the oxygen analyzer using the instructions furnished with the unit.

7.2 Calibrate before each use of the instrument.

7.3 With the insulating glass unit and the needle in the proper positions, turn on the instrument pump or otherwise introduce the gas sample to the analyzer.

7.4 When the oxygen readout stabilizes, record the oxygen percentage and turn off the instrument.

NOTE 8—The stabilization of the reading will vary depending on the type of oxygen analyzer used.

8. Calculation

8.1 Record the oxygen concentration from the readout on the analyzer.

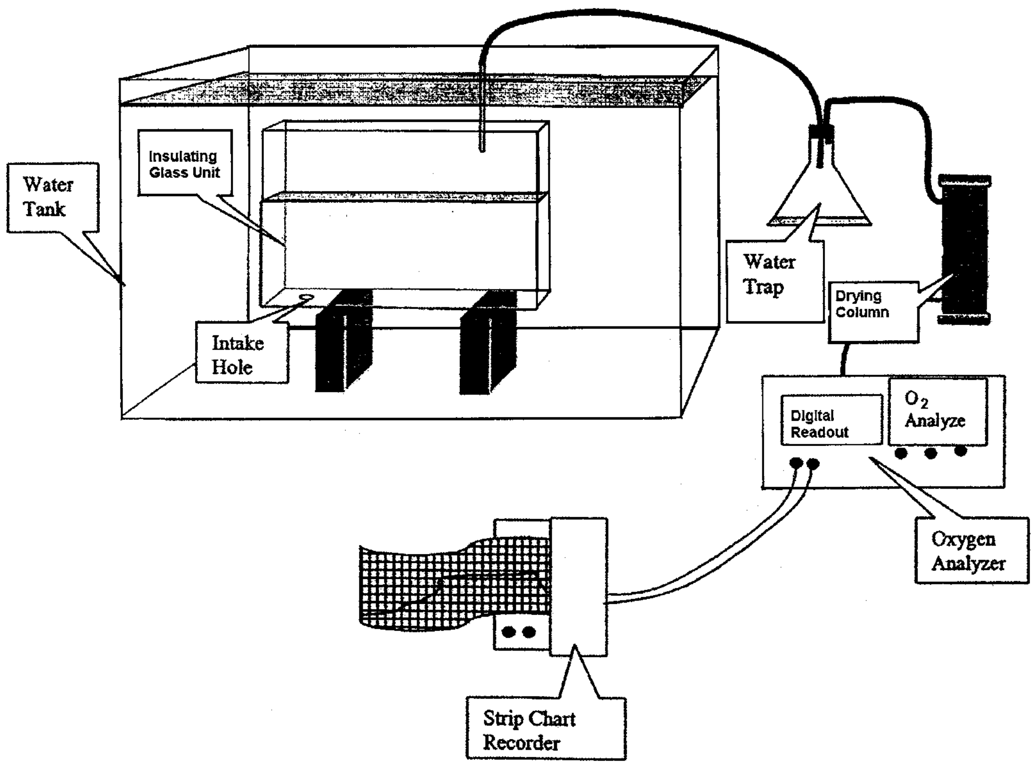
8.2 Calculate the fill gas concentration using the following equation:

$$\text{Fill gas \%} = 100\ \% - \frac{\text{oxygen readout (in percent)}}{0.209} \quad (1)$$

NOTE 9—In this equation, air is assumed to contain 20.9 % oxygen. This calculation does not account for the percentage of fill gas found in air. The oxygen concentration in air can vary slightly resulting in the calculated percentage of fill gas to vary.

9. Report

9.1 *Provide a Complete Description of Specimen Tested*:



NOTE—For Sampling Method A, the water tank, water trap, and drying column are not used (see 6.1).

FIG. 1 Example of Test Set Up Using Sampling Method B

9.1.1 Report the dimensions of the test specimen (width by height) and overall thickness.

9.1.2 Identify the type and thickness of glass.

9.1.3 Identify any glass coatings and surface locations, if applicable.

9.1.4 Report the airspace thickness(es).

9.1.5 Describe the spacer composition(s) and configuration(s).

9.1.6 Describe the corner construction including the type and number of corner keys.

9.1.7 Identify the desiccant type and quantity, if provided.

9.1.8 Identify the sealant used.

9.1.9 Report the presence , composition (if known), size and configuration of muntin bars.

9.2 Report the sampling technique used (Method A or B).

9.3 Report the oxygen level and the calculated fill gas level.

10. Precision and Bias

Precision and Bias for this test method are being determined.

11. Keywords

11.1 fill gas; gas concentration; oxygen; oxygen analyzer; sealed insulating glass unit

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