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Standard Practice for
Calibrating Moisture Analyzers[1]

This standard is issued under the fixed designation D 4178; 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 calibration technique based on the preparation of standards of known water content. This technique is applicable to the production of standards between 20 and 2000 cm^3/m^3 water.

1.2 The values stated in acceptable metric units are to be regarded as the standard.

1.3 *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. Summary of Practice [2]

2.1 The practice is based on the principle that ice has a vapor pressure of 0.611 kPa at 0°C. Therefore, when a carrier gas at a constant gage pressure of 207 kPa (30 psig) is passed through a molecular sieve saturated with water and held at 0°C, the total pressure is equal to 207 kPa plus 98 kPa (one atmosphere) and the water concentration of the gas leaving the molecular sieve is $[0.611/(207 + 98)] \times 10^6$ ppm or 2000 ppm volume water, regardless of flow.

2.1.1 A carrier gas at a constant gage pressure of 207 kPa is passed through a molecular sieve drier and then routed over a molecular sieve support saturated with water and equilibrated at 0°C.

2.1.2 By blending different volumes of the wet carrier gas with dried carrier gas, gas standards of known water concentration can be prepared.

2.2 The moisture analyzer to be calibrated is then connected to the source of the gas standard of known water concentration.

3. Significance and Use

3.1 This practice is intended to provide a method to calibrate moisture analyzers used on-stream or in the laboratory.

4. Apparatus

4.1 *Ice Bath Primary Standard Moisture Apparatus*—Fig. 1 illustrates a typical system.

4.2 *Wet Test Meter*, 1-L divisions.

4.3 *Bubble Meter*, graduated in cubic centimetres.

4.4 *Pressure Gage*—A Bourdon-type spring gage of test gage quality, 100 to 250 mm in diameter, with a scale range from 0 to 400 kPa (0 to 60 psi), maximum intermediate graduations of 1.5 kPa (0.25 psi).

4.5 *Wet Mole Sieve 5A*, 60/80 mesh (other mesh sizes may be used, except powder).

5. Preparation of Apparatus

5.1 Saturate mole sieve with water.

5.1.1 Cover in beaker enough mole sieve to fill the wet mole sieve container. Add water to cover mole sieve. Let stand overnight.

5.1.2 Drain the excess water by pouring the mole sieve slurry into a filtering funnel and letting all the free water drain out.

NOTE 1—The useful lifetime of the wet mole sieve is not known. It is recommended that the procedure described in 5.1.1 and 5.1.2 be followed prior to each calibration.

6. Procedure

6.1 Fill the ice bath bucket for the primary standard apparatus one third full of water; then add ice to bring the level to full.

6.2 Close the wet flow and the diluent flow needle values.

6.3 Turn on the carrier gas supply (nitrogen or air) and adjust the regulator to 207 kPa (30 psig).

6.4 Open the diluent flow needle valve to obtain a carrier gas flow of 1 L/min, as measured with a wet test meter.

6.5 Allow the apparatus to equilibrate for 1 h. This allows the wet mole sieve to equilibrate at 0°C.

6.6 After 1 h, attach the moisture analyzer to be calibrated and check that the blank moisture content of the carrier gas is 6 ppm or less.

6.7 Turn off the diluent flow, cm^3/m^3.

6.8 Attach a bubble meter to the exit of the apparatus and check that there is no flow through the system.

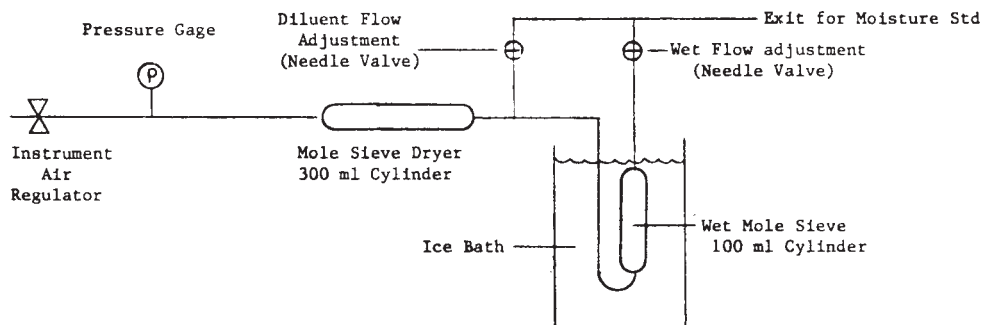6.9 Adjust the wet flow needle valve to obtain a flow of 40 cm^3/min, as measured with a bubble meter.

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[1] This practice is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.D0.01 on C2 Test Methods.

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[2] For a more complete discussion of this procedure, see Mator, R. T., Trace Moisture Analyzers and Their Calibration," *Proceedings of the 20th Annual ISA Analysis Instrumentation Symposium, May 12-15, 1974, Pittsburgh, Pa., "Session: Sampling and Calibration Systems,"* 1974, p. 125.

FIG. 1 Schematic of Ice bath "Primary Standard" Moisture Apparatus

6.10 In a similar manner, adjust the diluent flow needle valve to obtain a *total* flow of 200 cm^3/min, as measured with a bubble meter.

6.11 Connect the moisture analyzer to be calibrated to the exit of the "primary standard" moisture apparatus and allow its probe to equilibrate (10 to 15 min).

6.12 The analyzer should read the calculated value of 400 ppm for a carrier gas pressure of 207 kPa gage. If it does not, adjust the necessary analyzer controls to obtain the correct reading.

6.13 Turn off both the wet flow and the diluent flow needles valves.

6.14 Attach a bubble meter to the exit of the apparatus and check that there is no flow through the system.

6.15 Adjust the wet flow needle valve to obtain a flow of 10 cm^3/min using a bubble meter, and then adjust the diluent flow needle valve to obtain a *total* flow of 1 L/min. Use a wet test meter to check the total flow.

6.16 After the analyzer equilibrates (10 to 15 min), check to see that it reads the correct calculated value of 20 cm^3/m^3 plus the blank moisture content found in 6.6 for 207 kPa gage carrier gas supply.

6.17 When the analyzer reads correctly at the 400-ppm level but is not within ± 2 ppm of the 20 ppm plus the blank moisture content value, then the sensor may be bad and needs replacing.

7. Calculation

7.1 Calculate water concentration in saturated gas (wet flow) as follows:

$$P_{H_2O} @ 0°C = 0.611 \text{ kPa} \qquad (1)$$

$$P_{total} = A \text{ kPa} + 98 \text{ kPa gage}$$

$$A \text{ kPa} = \text{carrier gas pressure (should be } 207 \pm 2 \text{ kPa)}$$

$$C_{H_2O} = \frac{(P_{H_2O})(10^6)}{P_{total}} = \frac{(0.611)(10^6)}{207 + 98} = 2000 \text{ cm}^3/\text{m}^3$$

where:
$P_{H_2O} @ 0°C$ = vapor pressure of water at 0°C,
P_{total} = total pressure applied to the water on the molecular sieve, and
C_{H_2O} = cm^3/m^3 volume moisture in wet flow.

7.2 Calculate water concentration in blended gas (total flow) as follows:

$$CT_{H_2O} = \frac{(\text{wet flow})(C_{H_2O})}{total\ flow} + ppm\ H_2O\ blank \qquad (2)$$

where:
C_{H_2O} = cm^3/m^3 moisture in wet flow,
CT_{H_2O} = cm^3/m^3 moisture in total flow, and
total flow = wet flow plus diluent flow.