



STANDARD

ANSI/ASHRAE Standard 41.10-2013
(Supersedes ANSI/ASHRAE Standard 41.10-2008)

Standard Methods for Refrigerant Mass Flow Measurement Using Flowmeters

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NOTE

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FOREWORD

First published in 2003, Standard 41.10 prescribes methods for refrigerant mass flow-rate measurement using flowmeters. A companion standard, ASHRAE Standard 41.9-2010,^{A1} prescribes methods for refrigerant mass flow-rate measurement using calorimeters.

Selecting an appropriate refrigerant mass flowmeter can be a daunting task given the wide variety of operating principles, measurement precision, and costs of commercial products. Some meters can be used for either liquids or gases, while others can be used only for liquids or only for gases. Considerable pressure losses are inherent in some approaches, but the pressure losses in some other types of meters are very small and often negligible. Useful basic information can be found in textbooks that focus on measurement technology. Once a flowmeter has been selected, the user may need to consult with the meter manufacturer regarding installation specifics, operating, range limits, calibration limits, and other similar performance specifics in order to obtain the expected measurement accuracy.

This revision updates the 2008 edition of the standard. Revisions have been implemented to bring this standard into compliance with ASHRAE's mandatory language requirements. References have been updated, and an Informative Bibliography (Annex A) has been added. Other changes were made to improve readability.

1. PURPOSE

This standard prescribes methods for refrigerant mass flow-rate measurement using flowmeters.

2. SCOPE

This standard applies where the entire flow stream of the refrigerant both enters and exits the flowmeter as either a "vapor only" or a "liquid only" state.

3. DEFINITIONS

The following definitions apply to the terms used in this standard.

bubble-point temperature: a liquid-vapor equilibrium point for a pure liquid or for a multicomponent mixture of miscible, pure component liquids, in the absence of noncondensables, where the temperature of the mixture at a defined pressure is the minimum temperature required for a vapor bubble to form in the liquid.

error: the difference between the true value of the quantity measured and the observed value. All errors in experimental

data are classified as one of two types: systematic (fixed) errors or random (precision) errors. The terms *accuracy* and *precision* are often used to distinguish between systematic and random errors. A measurement with small systematic errors is said to be unbiased. A measurement with small random errors is said to have high precision. A measurement that is unbiased and precise is said to be accurate.

fixed error: same as systematic error.

flowmeter: a device employing a detecting element that determines the flow rate of a refrigerant in the gaseous or liquid phase within a closed conduit by measuring a response of the detecting element.

lubricant circulation rate: the ratio of the mass of lubricant circulating through a refrigerant system to the total mass of refrigerant and lubricant flowing through the system at a specified set of operating conditions.

precision error: same as random error.

random error: an error that causes readings to take random values on either side of a mean value. The random error is quantified based on how well an instrument reproduces subsequent readings for an unchanging input. Calibration does not correct random errors.

subcooling: at a defined pressure, the difference between a given liquid temperature and the bubble-point temperature.

steady-state test conditions: operation where at least three successive data points obtained at each set of specified conditions are neither successively increasing nor successively decreasing. To ensure conditions are stable, data readings shall be taken not less than 3 minutes apart and the test shall be continued until 3 successive readings are within the limits of tolerances specified in Section 5.1.

systematic error: an error that persists but is not due to chance. Calibration corrects systematic errors.

uncertainty: an estimated value for the error in a measurement, which may be the result of both systematic and random error. Because only random errors are treatable by statistical methods, and calibration only corrects systematic errors, uncertainty computed using this standard results from random errors.

unit under test: a compressor, condensing unit, or other apparatus for which refrigerant mass flow rates are measured using this standard.

4. CLASSIFICATIONS

4.1 Operating State—Gaseous or Liquid

4.1.1 Gaseous refrigerant flowmeters are restricted to applications where the entire flow stream of the refrigerant enters and exits as a vapor only state.

4.1.2 Liquid refrigerant flowmeters are restricted to applications where the entire flow stream of the refrigerant enters and exits as a liquid only state.