

**ANSI/ASHRAE Standard 24-2009**  
**(Supersedes ANSI/ASHRAE Standard 24-2000 [RA 2005])**



# ASHRAE STANDARD

## Methods of Testing for Rating Liquid Coolers

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#### NOTE

**When addenda, interpretations, or errata to this standard have been approved, they can be downloaded free of charge from the ASHRAE Web site at <http://www.ashrae.org>.**

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## FOREWORD

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## 1. PURPOSE

This standard prescribes methods of testing for rating liquid coolers.

## 2. SCOPE

To attain this objective, this standard

- (a) classifies liquid coolers as to type,
- (b) lists and defines the terms suggested for rating liquid coolers, and
- (c) establishes methods of test that shall be used as a basis for obtaining ratings of liquid coolers.

## 3. DEFINITIONS

**liquid cooler:** a factory-made assembly of elements in which the heat is transferred from the liquid to the refrigerant, causing the refrigerant to evaporate and the liquid to be cooled.

**total refrigeration capacity (of the liquid cooler):** the product of the mass flow rate of refrigerant and the difference in enthalpy between the leaving and entering refrigerant, expressed in energy units per unit of time.

**net refrigeration capacity:** that portion of the total refrigeration capacity of a liquid cooler that produces useful cooling.

This is the product of the mass flow rate of liquid, specific heat of the liquid, and the difference between entering and leaving liquid temperatures, expressed in energy units per unit of time. It is represented also by the total refrigeration capacity less the heat leakage rate.

**temperature of flowing fluids:** the mixed mean stream temperature at a station perpendicular to the flow direction.

## 4. CLASSIFICATIONS

The classifications of liquid coolers, as covered by this standard, are:

- (a) Closed cooler, refrigerant in tubes
- (b) Closed cooler, refrigerant in shell

- (c) Open shell and tube
- (d) Tube-in-tube
- (e) Open tank and coil
- (f) Baudelot type

## 5. EXPRESSION OF TEST RESULTS

Test results shall be expressed in the following terms:

- (a) The net refrigeration capacity, W (Btu/h)
- (b) Temperature of leaving liquid, °C (°F)
- (c) Liquid mass flow rate, kg/s (lb<sub>m</sub>/h)
- (d) Description of liquid sufficient to obtain necessary physical properties
- (e) Liquid pressure drop through the cooler, kPa (psi)
- (f) Saturation temperature of refrigerant leaving liquid cooler, °C (°F)
- (g) Superheat of refrigerant leaving liquid cooler, °C (°F)
- (h) Temperature of refrigerant entering expansion device, °C (°F)
- (i) Refrigerant designation

## 6. TEST METHODS

### 6.1 Standard Test Methods

6.1.1 Tests shall consist of a primary test and a simultaneous confirming test at the conditions specified.

6.1.2 The specified conditions shall include the following:

- (a) Temperature of leaving liquid, °C (°F). Refer to ARI Standard 480<sup>1</sup> for temperature adjustment to allow for rating at desired liquid-side fouling factor.
- (b) Liquid flow rate, kg/s (lb<sub>m</sub>/h).
- (c) Necessary physical properties of liquid being cooled.
- (d) Either the net refrigeration capacity, W (Btu/h), or the saturation temperature, °C (°F), of the refrigerant leaving the liquid cooler.
- (e) Superheat of leaving refrigerant, °C (°F).
- (f) Temperature of refrigerant entering expansion device, °C (°F).
- (g) Refrigerant designation.

6.1.3 The resulting net refrigeration capacity of the confirming test (6.3) shall be within ±3.0% of the primary test, but the primary test shall govern for rating purposes.

### 6.2 Primary Test Method

6.2.1 The primary test shall consist of a measurement of the net refrigeration capacity produced in the cooler by determination of

- (a) heat removed from the liquid and
- (b) heat removed from the ambient air through the external surfaces of the cooler (heat leakage rate).

6.2.2 Obtain the net refrigeration capacity by determining the product of the following variables: mass flow rate of liquid, specific heat of the liquid, and difference between entering and leaving liquid temperatures.

6.2.3 Determine the mass flow rate of liquid by direct mass or volume measurement or liquid flowmeter.

6.2.4 Determine specific heat of the liquid using the average of the entering and leaving liquid temperatures and physical properties of the liquid.