STANDARD

ANSI/ASHRAE Standard 143-2015
(Supersedes ANSI/ASHRAE Standard 143-2007)

Method of Test for Rating Indirect Evaporative Coolers

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NOTE

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FOREWORD

First published in 2000, ASHRAE Standard 143 provides procedures for testing indirect evaporative cooling devices under laboratory conditions to obtain rating information. As an ASHRAE method-of-test standard, it is intended to offer recommended practices and accurate measurement procedures.

In this new 2015 edition, references have been updated and the reporting forms have been moved to the informative appendices.

1. PURPOSE

This standard provides test procedures and calculations for establishing the cooling capacities and power requirements for indirect evaporative cooling equipment.

2. SCOPE

2.1 This standard covers testing under steady-state conditions for rating of indirect evaporative coolers that

a. sensibly cool a primary airstream through heat exchangers by the evaporation of water into a secondary airstream and
b. are self-contained or are components of packaged systems.

2.2 This standard does not cover

a. devices that use mechanical refrigeration or thermal storage to cool the primary airstream, the secondary airstream, or the water provided for evaporation; or
b. devices that dry the primary or secondary airstream.

3. DEFINITIONS

adiabatic saturation: evaporating water into air without external gain or loss of heat. Sensible heat in both air and water becomes latent heat in entrained vapor, and temperatures fall and equalize.

air density: the mass per unit volume of the air.

application rating: a rating based on tests performed at application rating conditions (other than standard rating conditions).

component indirect evaporative cooler (IEC module): an indirect evaporative cooling device consisting of an indirect evaporative cooling heat exchanger, a means of delivering and distributing water to the wet passages of the heat exchanger, a basin for collecting water, a recirculating water pump, and the piping that connects the basin and the water distribution system. (See Figure 3.)

cooling effectiveness: the primary air dry-bulb temperature reduction divided by the primary air entering dry-bulb temperature less the entering secondary wet-bulb temperature.

determination: a complete set of measurements for a particular point of operation of an IECU. The measurements shall be sufficient to determine all IECU performance variables as defined in this standard.

energy factor: the ratio of the total kinetic energy of the flow to the kinetic energy corresponding to the average velocity.

evaporative cooling: cooling that evaporates water to cool air by one of two methods: (1) direct, which is adiabatic and humidifies the air, and (2) indirect, which is nonadiabatic and cools the air being treated.

fan: a device for moving air that utilizes a power-driven rotating impeller. A fan shall have at least one inlet opening and at least one outlet opening. The openings may or may not have elements for connection to ductwork.

fan motor power: the electric power required to drive the fan and any elements in the drive train that are considered a part of the fan.

fan speed: the rotative speed of the impeller. If a fan has more than one impeller, fan speeds are the rotative speeds of each impeller.

free delivery: the point of operation where the external static pressure is zero.

IECU: a term created for use in this document that refers to a packaged, semipackaged, or component indirect evaporative cooling unit. The term *cooling unit* is also used interchangeably throughout this document for evaporative cooling unit or evaporative cooler.

IECU air boundaries: indirect evaporative cooling unit inlet and outlet boundaries are defined as the interface between the cooling unit and the remainder of the system and are at a plane perpendicular to the airstream where it enters or leaves the indirect evaporative cooling unit. Various appurtenances, such as filter media assemblies, inlet boxes, inlet vanes, inlet cones, silencers, screens, rain hoods, dampers, discharge cones, and eaves, may be included as part of the cooling unit between the inlet and outlet boundaries.

IECU air density: the density of the air corresponding to the total pressure and dry- and wet-bulb temperatures at the cooling unit inlet.

IECU inlet area: the gross inside area measured in the plane(s) of the inlet connection(s). For converging inlets without connection elements, the inlet area shall be considered to be where a plane, perpendicular to the airstream, first meets the bell mouth or cone.

IECU input power boundary: the interface of the wiring entering electrically powered equipment. Drive or coupling losses are included as part of the input power.

IECU outlet area: the gross inside area measured in the plane(s) of the outlet opening(s).

IECU total power: the sum of the power in watts supplied to the electrical components of the indirect evaporative cooler tested. This includes fan motors, pump motors, and other devices needed to produce the cooling effect. The power to control devices such as thermostats, transformers providing

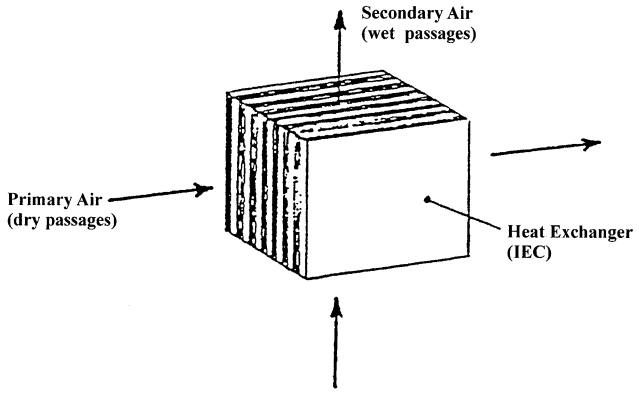

FIGURE 1 Integrated air-to-air heat exchanger.

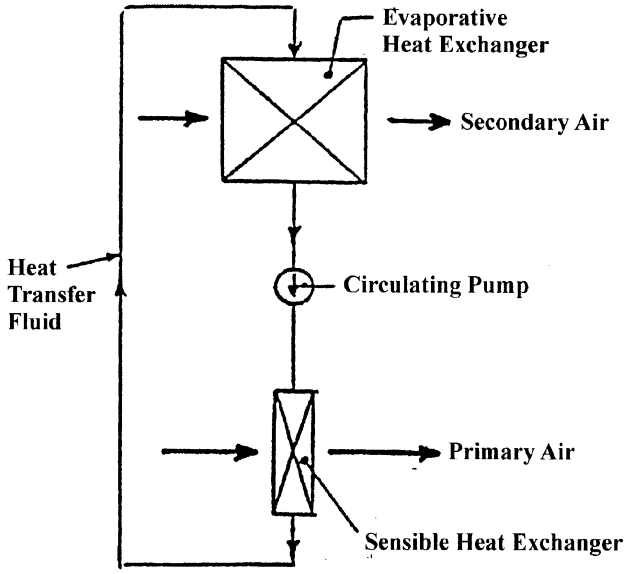

FIGURE 2 Nonintegrated sensible and evaporative heat exchanger.

low voltage to control mechanisms, and freeze protection devices need not be included in total power.

IECU total pressure: the difference between the total pressure at the cooling unit outlet and the total pressure at the cooling unit inlet.

IECU velocity pressure: the pressure corresponding to the average velocity at the cooling unit outlet.

indirect evaporative cooler (IEC): a heat and mass transfer device used to sensibly cool a primary airstream, without addition of moisture, by means of an evaporatively cooled secondary airstream. Since the secondary air provides wet-bulb depression, it represents a heat sink to the primary air.

indirect evaporative cooler with integrated heat exchanger: an indirect evaporative cooling device with integrated primary (dry) and secondary (wet) air passages in a single sensible and evaporative heat exchanger. (See Figure 1.)

indirect evaporative cooler with nonintegrated heat exchanger: an indirect evaporative cooling device with a separate primary (dry) sensible heat exchanger and a separate secondary (wet) evaporative heat exchanger. The recirculating fluid between these two heat exchangers is used to transfer heat from the primary to the secondary airstream. (See Figure 2.)

packaged indirect evaporative cooler (packaged IECU): an indirect evaporative cooler with integrated or nonintegrated primary and secondary air passages and provided with both primary and secondary air-moving devices. This device also includes the entire water distribution, collection, and recirculation system with pump and piping. This type may have provisions for installation of other heat and mass transfer devices, such as a direct evaporative cooler and auxiliary heating and cooling coils. These additional devices are not covered by this standard. (See Figure 7.)

point of operation: the relative position on the cooling unit characteristic curve corresponding to a particular flow rate. It is controlled during a test by adjusting a throttling device, by changing flow nozzles or the fan characteristic, or by any combination of these.

pressure: force per unit area. This corresponds to the energy per unit volume of fluid.

pressure, absolute: the value of a pressure when the datum pressure is absolute zero. It is always positive.

pressure, barometric: the absolute pressure exerted by the atmosphere.

pressure, differential: the change in total pressure due to friction and velocity.

pressure, gauge: the value of a pressure when the datum pressure is the barometric pressure at the point of measurement. It may be negative or positive.

pressure, static: static pressure of a gas stream is the force per unit area measured by a manometer connected to a small hole in the duct wall or other boundary, the surface of which shall be parallel to the path of the stream. It is equivalent to the potential energy of a unit volume of the fluid and exists by virtue of the gas density and degree of compression alone.

pressure, total: the air pressure that exists by virtue of the degree of compression and the rate of motion. It is the algebraic sum of the velocity pressure and the static pressure at a point. Thus, if the air is at rest, the total pressure is equal the static pressure.

pressure, velocity: that portion of the air pressure that exists by virtue of motion only. It is always positive.

primary air: air supplied to a conditioned space.

pump or rotary device power: the electric power required to drive the pump or rotary device used to distribute water in the IECU.

rating: the assigned values of those performance characteristics, under stated rating conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer.

rating conditions: any set of operating conditions under which a single level of performance results, and which causes only that level of performance to occur.

rating standard: a standard that sets forth a method of interpreting the results of tests of individual units, at specified conditions, in relation to a product manufactured in quantity.

secondary air: air used to reject heat to an ambient environment or elsewhere.

semipackaged primary indirect evaporative cooler (semipackaged primary IEC): a component indirect evaporative cooler provided with a primary air-moving device, which delivers primary air. This device includes also the entire water distribution, collection, and recirculation system with pump and piping. (See Figure 6.)

semipackaged secondary indirect evaporative cooler (semipackaged secondary IEC): a component indirect evaporative cooler, with integrated or nonintegrated primary and secondary air passages, and provided with a secondary air-moving device, which delivers secondary air. This device also includes the entire water distribution, collection, and recirculation system with pump and piping. (See Figures 4 and 5.)

shall: the word *shall* is to be understood as mandatory.

standard air: dry air with a density of 0.075 lbm/ft^3 (1.204 kg/m^3), a specific heat of 0.24 Btu/lbm·°F (1.006 kJ/kg·K), a ratio of 1.400, and a viscosity of 1.22E-05 lbm/ft·s (1.82E-05 N·s/m^2). Air at 68°F (20°C), 0% relative humidity, and 29.92 in. Hg (101.325 kPa) has these properties, approximately.

standard rating: a rating based on tests performed at standard rating conditions.

standard rating conditions: rating conditions used as the basis of comparison of performance characteristics.

temperature, dry-bulb: the air temperature measured by a dry temperature sensor.

temperature, wet-bulb: the temperature measured by a temperature sensor covered by a water-moistened wick and exposed to air in motion. When properly measured, it is a close approximation of the temperature of adiabatic saturation.

test: a series of determinations for various points of operation.

testing standard: a standard setting forth methods of measuring capacity or other aspects of operation of a specific unit or system of a given class of equipment, together with a specification of instrumentation, procedure, and calculations.

wet-bulb depression: the difference between the dry-bulb and wet-bulb temperatures of an airstream.

4. SYMBOLS AND SUBSCRIPTS

4.1 Symbols

Symbol	Description	I-P Units	SI Units
A_e	Area of nozzle	ft^2	m^2
C	Nozzle discharge coefficient	Dimensionless	Dimensionless
D	Diameter and equivalent diameter	ft	m
P_{sx}	Static pressure at plane or station x	in. wg	Pa
P_{std}	Static pressure at standard air density	in. wg	Pa
p_b	Ambient barometer pressure	in. Hg	Pa
p_e	Saturated vapor pressure at t_{wx}	in. Hg	Pa
p_p	Partial vapor pressure	in. Hg	Pa
Q_P	Primary standard airflow rate	cfm	m/s
Q_S	Secondary standard airflow rate	cfm	m/s
Q_x	Volumetric airflow rate at plane x	cfm	m/s
q	Cooling capacity	m·Btu/h	kW
R	Gas constant	ft·lb/lb$_m$·°R	kJ/(kg·K)
Re	Reynolds number	Dimensionless	Dimensionless
t_{dx}	Dry-bulb temperature at plane or station x	°F	°C
t_{wx}	Wet-bulb temperature at plane or station x	°F	°C
V_x	Velocity at plane x	fpm	m/s
W	Total power	kW	kW
W_p	Power input to primary fan	kW	kW
W_s	Power input to secondary fan	kW	kW
W_c	Power input to recirculating water pump	kW	kW
W_a	Power input to appurtenances	kW	kW
Y	Nozzle expansion factor	Dimensionless	Dimensionless