IS 3315 (1994): Evaporative Air Coolers (desert coolers)
[MED 3: Mechanical Engineering]

IS 3315 : 1994
(Reaffirmed 2009)

भारतीय मानक

वाष्पशील वायु शीतलन यंत्र (डेजर्ट कूलर) — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

EVAPORATIVE AIR COOLERS (DESERT COOLERS) — SPECIFICATION

(Second Revision)

UDC 621.565 : 697.973

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

July **1994** **Price Group 4**

Refrigeration and Air Conditioning Sectional Committee, HMD 03

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Heavy Mechanical Engineering Division Council.

This standard was first published in 1956 and revised in 1974. In first revision equipment and method of test for air flow rating of air coolers were included. In this revision following important changes have been incorporated:

a) Minimum cooling efficiency and maximum power consumption requirements have been specified.

b) Detailed material clause has been given. Use of various materials/parts conforming to relevant Indian Standards have been specified. Plastic body has been permitted.

c) Additional safety requirements have been incorporated.

d) Standard conditions for testing of coolers have been simplified.

The specified power consumption shall be reviewed after one year.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values *(revised)*'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

AMENDMENT NO. 2 MARCH 2007
TO
IS 3315 : 1994 EVAPORATIVE AIR COOLERS (DESERT COOLERS) — SPECIFICATION

(Second Revision)

(Page 1, *clause* **2***)* — Substitute the following for the existing:

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All the standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
277:2003	Galvanized steel sheets (plain and corrugated) — Specification *(sixth revision)*
302 (Part 1): 1979	Safety of household and similar electrical appliances: Part 1 General requirements *(fifth revision)*
694 : 1990	PVC insulated cables for working voltages up to and including 1 100 V (*third revision)*
2312:1967	Propeller type ac ventilating fans (*first revision)*
9968 (Part 1): 1988	Elastomer insulated cables: Part 1 For working voltages up to and including 1 100 V *(first revision)*
11951 : 1987	Specification for pump-set for desert coolers

(Page 1, *clause* **5.1,** *second line)* — Substitute 'Grade of coating 275' *for* the words 'Grade 350'.

(Pages 1, *clause* **5.1**, *third and sixth line)* — Substitute 'IS 277' *for* 'IS 277 : 1992'.

[*Pages* 2 *and* 4, *clauses* **5.4.3** *and* **8.5.1**(e)] — Substitute 'IS 2312' *for* 'IS 2312: 1967'.

(Page 2, *clause* **5.5.1**) — Substitute 'IS 11951' *for* 'IS 11951 : 1987'.

(Page 3, *clauses* **7.1, 7.2, 8.3.2, 8.3.3, 8.3.4, 8.3.5** *and* **8.3.6**) — Substitute 'IS 302 : Part 1 *for* 'IS 302-l(1979)'.

Amend No. 2 to IS 3315:1994

(Page 3, *clause* **7.3**) — Substitute 'IS 694' *for* 'IS 694 : 1990' and 'IS 9968 : (Part 1)' *for* 'IS 9968 (Part 1) : 1988' respectively.

(Page 4, *clause* **8.5.1)** — Substitute 'IS 302 : Part 1' '*for* 'IS 302-1(1979)'.

(ME 03)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 1 MAY 2004
TO
IS 3315:1994 EVAPORATIVE AIR COOLERS (DESERT COOLERS) — SPECIFICATION

(Second Revision)

(*Second cover page, Foreword*) — Insert the following before last paragraph:

'A scheme of labelling environmentally friendly products with ECO logo known as ECO-Mark has been introduced at the instance of Ministry of Environment and Forests (MEF), Government of India. The ECO-Mark would be administered by the Bureau of Indian Standards (BIS) under the *Bureau of Indian Standards Act,* 1986 as per Resolution No. 71 dated 21 February 1991 and No. 425 dated 28 October 1992 published in the Gazette of India. The Ministry of Environment and Forests, Government of India, issued a notification dated 17 May 1996 [GSR 214(E)] for ECO labelling of evaporative air coolers (desert coolers). These ECO labelling criteria relevant to evaporative air coolers (desert coolers) have been incorporated in this Indian Standard.'

(*Page* 1, *clause* **3.1.5**) — Substitute nomenclature for dry bulb temperature of inlet air as 'T_{db}' *for* 'T_{db}'

(*Page* 4, *clause* **8.5.3**) — Insert the following clauses after **8.5.3** and renumber subsequent clause:

'9 ADDITIONAL REQUIREMENTS FOR ECO- MARK

9.1 The evaporative air cooler (desert cooler) shall conform to the requirements for quality, safety and performance prescribed in **5** to **8**.

9.2 The manufacturer shall produce the consent clearance as per the provisions of *Water (Prevention and Control of Pollution) Act,* 1974, *Water (Prevention and Control of Pollution) Cess Act,* 1977 and *Air (Prevention and Control of Pollution) Act,* 1981 along with the authorization, if required under the *Environment (Protection) Act,* 1986 to BIS while applying for ECO-Mark.

9.3 Noise Level

For ECO-Mark the evaporative air cooler shall conform to the noise levels as notified under the *Environment (Protection) Act,* 1986 from time to time.

9.4 Instructions

The evaporative air cooler shall be sold along with instructions for proper use so as to maximize product performance, minimize wastage and method of safe disposal of used product.

9.5 Energy Consumption

The power consumption shall be at least 5 percent less than those specified in **6.2.**

9.6 Packing

The evaporative air cooler shall be packed in such packages, which are made of recyclable or biodegradable materials.'

(ME 03)

Indian Standard

EVAPORATIVE AIR COOLERS (DESERT COOLERS) — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This standard covers the air capacity, constructional features, performance requirements and methods of testing for evaporative air coolers.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
277 : 1992	Galvanized steel sheet (plain and corrugated) *(fifth revision)*
302-1 (1979)	Safety of household and similar electrical appliances: Part 1 General requirements *(fifth revision)*
9968 (Part 1): 1988	Elastomer-insulated cables : Part 1 For working voltages up to and including 1100 V *(first revision)*
694 : 1990	PVC insulated cables for working voltages up to and including 1 100 V *(third revision)*
2312: 1967	Propeller type ac ventilating fans *(first revision)*
11951 : 1987	Pump-set for desert cooler

3 DEFINITIONS

3.1 For the purpose of this standard, the following definitions shall apply.

3.1.1 *Evaporative Air Cooler*

A device which cools air by evaporation of water.

3.1.2 *Evaporative Air Cooling*

It involves the process of evaporating water into air stream. Air is cpoled by direct contact with water through a wetted surface. The heat and mass transfer process between the air and water lowers the air dry bulb temperature at constant wet bulb temperature.

3.1.3 *Temperature (Dry Bulb)*

The temperature of air read on a thermometer placed in such a way as to avoid errors due to radiation.

3.1.4 *Temperature (Wet Bulb)*

The steady temperature finally given by a thermometer having its bulb covered with gauze or muslin moistened with distilled water and placed in air with relative velicity of not less than 2.5 m/s.

3.1.5 *Cooling Efficiency*

The extent to which the leaving air dry bulb temperature approaches the wet bulb temperature of entering air is expressed as cooling efficiency. It is expressed as:

$$= \frac{T_{db} - T_{db'}}{T_{db} - T_{wb}} \times 100$$

where

T_{db}' = dry bulb temperature of inlet air.
T_{db}' = dry bulb temperature of outlet air.
T_{wb} = wet bulb temperature of inlet air.

3.1.6 *Zero Static Pressure*

It is the pressure at the outlet of air cooler made equal to the static pressure at the inlet of the air cooler.

4 MINIMUM AIR CAPACITY

The minimum air capacities of the evaporative air coolers based on the delivery of air at 'Zero' static pressure shall be as under:

750, 1 000, 1 260, 1 500, 1 800, 2 000, 2 500, 3 000, 4 000, 5 000, 6 000 and 8 000 m^3/h

NOTE — Other capacities may also be supplied as per agreement between the manufacturer and the purchaser.

5 MANUFACTURE AND CONSTRUCTION

5.1 Body

To ensure rigidity and life, the body shall be made out of galvanized steel sheet with Grade 350 minimum conforming to IS 277 : 1992. The sump tank shall be manufactured from a sheet of nominal 1 mm thickness and rest of the cabinet from a sheet of nominal 0.8 mm thickness with the tolerance as given in IS 277 : 1992.

For plastic body the manufacturer shall declare the properties-such as weathering, ageing, colour fastness due to exposure to sun light, resistance to heat flammability, etc. The thickness of body and extent of fire retardant used shall be declared. Body shall be subjected to drop test by dropping the body from a height of 3 m. The body shall not be damaged in the drop test. The manufacturer shall get the plastics used by them tested from CIPET

(Central Institute of Plastics Engineering Technology) and get a certificate for its suitability for coolers.

NOTE — Since sufficient data were not available test requirements of plastics materials not specified. As soon as details are available same would be considered for inclusion in the specification.

5.1.1 The design and assembly of the equipment shall be such that vibration does not cause rattling and loosening of parts.

5.1.2 Parts which require service and replacement shall be interchangeable and readily accessible.

5.1.3 The body should be so designed that during normal working of unit water shall not blow off, leak or drip from air cooler.

5.1.4 *Grill*

The front grill shall be made of non-corrosive material with an arrangement for adjusting horizontal and vertical directional flow of air.

5.1.5 *Water Feeding Arrangement*

Suitable water feeding arrangement shall be provided from the back side as well as front side.

5.1.6 *Size of Fan Opening (Not Grill Opening)*

This circular opening shall be more than fan sweep but shall be not exceeding more than 25 mm.

5.2 Filter Pads

Filter pads shall be made of wood wool or any other substitute placed in non-corrosive wire mesh and tightened at places with side panels to avoid sagging.

5.3 Sump Tank Capacities

Sump tanks for evaporative air coolers which do not need to be connected to continuous water supply shall have the following minimum capacities according to different nominal capacities of air coolers:

Minimum Capacities m^3/h	*Sump Tank Capacity* l
750	15
1 000	20
1 200	24
1 500	30
1 800	36
2 000	40
2 500	50
3 000	60
4 000	80
5 000	100
6 000	120
8 000	160

NOTE — Air coolers having minimum capacities up to 2 000 m^3/h shall be regarded as portable.

5.3.1 Each cooler shall be provided with an accessible drain on left or right side. The drain cock and drain cock cap shall be of brass material.

5.4 Fan

5.4.1 The fan shall be well balanced. The blade and blade carriers shall be securely fixed so that they do not get loose in operation. The metallic parts shall be powder coated or suitably protected against corrosion.

5.4.2 The bearing used shall be such as to ensure quiet running, good service and shall be self-lubricating to reduce lubricating frequency. The provision for lubrication shall be made. The fan shall have resilient mounting so as to reduce noise and vibration.

5.4.3 The fan shall be tested as per IS 2312 : 1967 except air delivery and power consumption.

5.5 Pump Set

5.5.1 Pump set used in evaporative air coolers shall conform to IS 11951 : 1987.

6 PERFORMANCE REQUIREMENTS

6.1 The overall design of the aircooler shall be such that reasonably silent performance is obtained. It is recommended that noise level should not be more than 65 dBA at 1 m distance from the desert cooler. This is for the guidance of the manufacturers.

6.2 The air cooler shall satisfy the following requirements under the standard rating conditions specified in **9**:

a) The air delivery shall be not less than the declared minimum capacity.

b) The cooling efficiency shall be not less than 65 percent.

c) Power consumption — The power consumption at zero static pressure shall not exceed the following values:

Minimum Capacities m^3/h	*Power Consumption* W
750	95
1 000	125
1 200	150
1 500	185
1 800	210
2 000	225
2 500	240
3 000	250
4 000	280
5 000	350
6 000	400
8 000	500

7 ELECTRICAL EQUIPMENT

7.1 Wiring

Electrical wiring and connection shall conform to the requirements given in IS 302-1 (1979). All electrical joints shall be electrically and mechanically secure. Where any cable, passes through metal holes, the metal edges, shall be fitted with agromet of suitable insulating material, so as to protect the cable from damage and possible earthing.

7.2 The metal casing of the electrical components, metal frame or chassis of cooler cabinet and all exposed metallic parts, likely to become live, shall be provided with earthing facilities in accordance with the requirement given in IS 302-1 (1979). One 'ON' and 'OFF' switch shall be provided with each evaporative cooler. Provision shall be made to run fan and pump set separately.

7.3 A three-core-cable conforming to IS 694 : 1990 or IS 9968 (Part 1): 1988 of minimum 2 m length shall be provided with each unit.

8 TEST

8.1 Classification of Tests

Test shall be classified into following three groups:

a) Production routine tests,

b) Type tests, and

c) Acceptance tests.

8.1.1 *Production Routine Tests*

These shall consist of routine tests that would be conducted on every assembled unit by a manufacturer.

8.1.2 *Type Tests*

The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components, and shall be carried out by a recognised testing authority (may be the manufacturer if approved by the purchaser). Once a cooler has undergone type tests, any major or minor alterations, which the manufacturer, intends to make, shall be reported to the testing authority and further type tests shall be carried out in accordance with the procedure laid down in this standard *(see* **8.5**).

8.1.3 *Acceptance Tests*

If the purchaser desires any of the production routine tests to be repeated at the time of purchase, then where agreed to between the purchaser and the manufacturer, these tests may be carried out at the manufacturer's works, or alternatively, the tests may be repeated at place specified by the purchaser provided that all the arrangements for tests are made by the purchaser at specified place.

Air delivery and power consumption of one evaporative air cooler out of every 100 air coolers or less of any lot would be checked at zero static pressure test conditions if required by the purchaser.

8.2 Sample for Tests

8.2.1 *Type Tests*

Two coolers shall be sent along with manufacturers detailed instructions to recognized testing authority for the purpose of type tests. The sample shall be picked up at random from stock or routine factory production.

8.2.2 *Acceptance Tests*

The number of samples shall be agreed to between the manufacturer and the purchaser.

8.3 Production Routine Tests

8.3.1 *General Running Tests*

Each unit shall be given a run to ensure vibration free and through running of all the parts.

8.3.2 *Protection Against Electric Shock*

Each unit shall be tested for protection against electric shock as per **8** of IS 302-1 (1979).

8.3.3 *High Voltage Tests*

Each unit shall be tested for high voltage test as per **16.4** of IS 302-1 (1979).

8.3.4 *Insulation Resistance Test*

Each unit shall be tested for insulation resistance test as per **16.3** of IS 302-1 (1979). This test shall be performed after high voltage test.

8.3.5 *Leakage Current*

Each unit shall be tested for leakage current as per **13** of IS 302-1 (1979).

8.3.6 *Earthing Connections Tests*

Each unit shall be tested for earthing connection as per **27** of IS 302-1 (1979).

8.3.7 *Finish*

All surface assembly of the cooler shall be of corrosion resisting material or shall be suitably and durably protected against corrosion.

8.3.8 *Power Consumption Test*

Each unit of a given lot shall be tested for power consumption test at free air flow conditions. This power consumption figure would not exceed the value arrived at by subtracting differential 'D' from the maximum permissible power consumption at zero static pressure test conditions as given in **6.2**(c). Differential 'D' would be the difference between the actual power consumption observed at zero static pressure test conditions of an air cooler selected at random from the given lot and the actual power consumption of the same air cooler at free air flow conditions. If more than one air coolers are tested at

zero static pressure conditions, then maximum observed differential would be subtracted from maximum permissible wattage at zero static pressure test conditions, tor arriving at acceptable value of power input for air coolers at free air flow conditions.

8.4 Rating

8.4.1 *Rating Voltage*

The rated voltage shall be 230 or 240 volts.

8.4.2 *Rated Frequency*

The rated frequency of cooler shall be standard frequency of 50 Hz.

8.5 Type Tests

8.5.1 Besides all the production and routine tests outlined in **8.3** the type test shall comprise the following:

a) Verification of marking as specified in **7** of IS 302-1 (1979).

b) Cooling efficiency test as specified in **9.4.**

c) Air delivery test as specified in **9.4**.

d) Power consumption test as specified in **6.2.**

e) All tests as defined in IS 2312 : 1967 except air delivery and power consumption tests.

8.5.2 *Cooling Efficiency and Air Delivery Test*

Under stable operating conditions laid down in **9.5**, at least five readings shall be taken at equal intervals of not less than 15 minutes. The arithmetical averages of these readings shall be adopted as final values to calculate:

a) cooling efficiency, and

b) air delivery.

8.5.3 *Power Consumption*

The power consumption shall not exceed the values specified in **6.2** and tested in accordance with **8.4** at zero static pressure conditions.

9 GENERAL TEST CONDITIONS

9.1 Unless otherwise specified the tests shall be made on the air cooler installed as for normal use, with the accessories, grills, etc, if any, in their normal position in accordance with the manufacturer's instructions.

9.2 Standard Ratings

9.2.1 Cooling efficiency test may be conducted at any ambient temperature. The relative humidity of inlet air to the air cooler shall be maintained at any value between 25 percent and 55 percent. During the test relative humidity shall not vary more than ± 5 percent.

9.2.2 Air delivery test may be conducted at any ambient temperature prevailing at the time of test.

9.2.3 The evaporating medium shall be dry during the air tlow test.

9.2.4 The appliance shall be complete with all components and accessories necessary for an actual installation in place.

9.2.5 The evaporation medium and components for cooling efficiency and air flow test will remain identical.

9.3 The static pressure difference between the air delivered by the air cooler at the outlet of the air cooler in the mixing chamber and the ambient conditions of inlet air cooler in the test room shall be adjusted to give zero static pressure with the help of exhaust fan and damper.

9.4 The air cooler shall be operated to give maximum (a) cooling efficiency, and (b) air delivery, in a manner not contrary to the manufacturer's operating instructions.

9.5 Stable Operating Conditions

The air cooler shall be operated under conditions specified in **9.1** to **9.4** with air flow and temperature measuring apparatus *(see* **11)** attached to it, for a reasonable time to establish thermal equilibrium. Stable operating condition is deemed to be reached when during an interval of 15 minutes the temperature measured at the same position does not vary by more than 0.5°C. Stable operating conditions are deemed to maintain when the dry bulb temperature at the outlet of the mixing chamber remains within 1.5°C of the average value adopted as given in **8.5.2.** The test shall be continued until at least five successive readings within the permissible range are obtained.

9.6 The voltage supply to the air cooler shall be adjusted within ± 2 percent of the motor rated voltage.

10 ACCURACY OF INSTRUMENTS

10.1 The accuracy of the manometers shall be within ± 0.5 mm of water gauge.

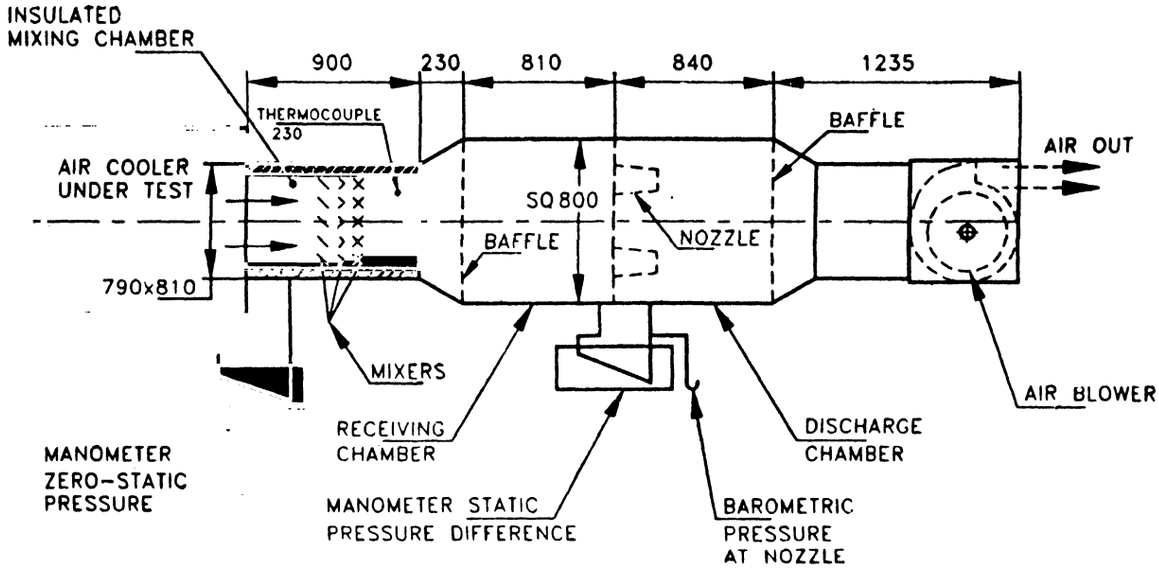
10.2 The accuracy of the temperature measuring instruments shall be within ± 0.1°C.

10.3 Electrical measurements shall be made with instruments having accuracy within ± 0.5 percent of the quantity measured.

10.4 The smallest division on the scale of any instrument shall not exceed twice the specified accuracy for it

11 AIR FLOW AND TEMPERATURE MEASURING APPARATUS

11.1 Temperature and flow rate of air delivered by the air cooler are determined as per Fig. 1. The air cooler takes in air at ambient conditions specified in **9.2**. The air leaving cooler first passes through a mixing device to eliminate non-uniformity. The dry bulb temperature shall be measured at the outlet of the mixing device for calculating cooling efficiency of the cooler. Flow rate is determined by measuring the pressure drop across one or more nozzles of the type shown in Fig. 2.



All dimensions in millimetres.

FIG. 1 TYPICAL AIR FLOW AND TEMPERATURE MEASURING APPARATUS

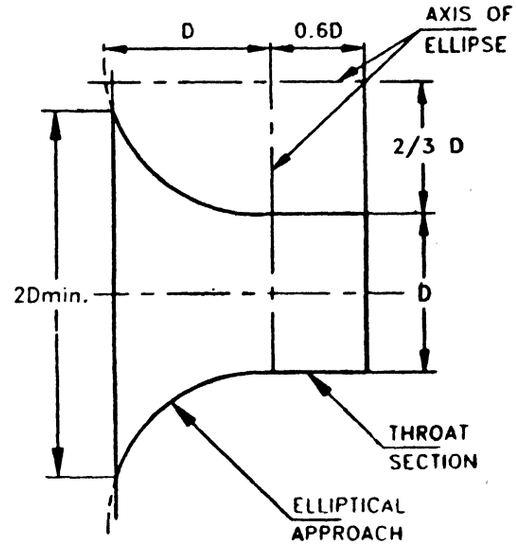


FIG. 2 AIR FLOW MEASUREMENT NOZZLE

11.2 The inlet air dry bulb temperatures shall be measured at the approximate geometrical centre of the intake surface area of the air cooler at a distance of not less than 25 cm from the cooler. The temperature measurements shall be taken on all sides of the air intake to the air cooler. The air intake surfaces of the air cooler shall not be exposed to radiant heat or direct air draught. The distance from air intake surface to the next obstruction shall not be less than 1 m. The air cooler shall be placed on a stand at least 50 cm from ground level or on the trolley stand supplied, if any, by the manufacturer.

11.3 Outlet or outlets of the air cooler shall be connected to a mixing chamber. The mixing chamber shall contain deflectors or vanes to mix air stream. The mixing chamber shall be well insulated so that heat leakage shall be reduced to a minimum. The mixing chamber shall be connected to one wall of the receiving chamber. The temperature measurements are made at the outlet of mixing chambers. The thermometers are so placed so as to ensure the flow of well mixed air over them to measure average temperature. To establish zero static pressure, at the outlet of the air cooler in mixing chamber, with respect to inlet air to the air cooler in the test room, a manometer shall have one side connected to one or more static pressure connections located flush with the inner surface of the mixing chamber. The other side of the manometer is open to inlet air ambient conditions. The static pressure connections shall be located so as not to be affected by air flow.

11.4 One or more nozzles shall be fitted into the wall at the outlet side of receiving chamber, discharging air into discharge chamber. The size and arrangement of the receiving chamber shall be sufficient to provide uniform approach velocity to the nozzle(s). To accomplish this purpose, suitable diffusion baffles may be installed in the receiving chamber, at a distance of not less than 1.5 throat diameter of nozzle from the nozzle inlet.

11.5 Nozzles shall be constructed in accordance with Fig. 2 and fitted into the wall separating receiving chamber from discharge chamber. The throat diameter of the nozzle(s) shall be such that the throat velocity is between 5 m/s and 35 m/s and the total nozzle area is less than 10 percent of the approach duct area. The distance from the centre of any nozzle to any of the four adjacent side walls, either in receiving chamber or in discharge chamber, shall be not less than 1.5 throat diameter of nozzles. The centre to centre distances between the nozzles shall be not less than three throat diameters. If nozzles of different diameters are in use, the distance between axes shall be based upon the average diameter. The dry bulb temperature and wet bulb temperature shall be measured at each nozzle separately. These temperature readings shall be used only for determining the density and specific volume of the air.

11.5.1 The nozzle coefficient of discharge may be determined with the help of Tables 1 and 2 or, preferably, the nozzle(s) may be calibrated.

Table 1 Flow Coefficients for Nozzles (C_d)

Reynolds Number R	Discharge Coefficient C_d
40 000	0.973
50 000	0.977
60 000	0.979
70 000	0.981
80 000	0.983
100 000	0.985
150 000	0.988
200 000	0.991
250 000	0.993
300 000 and above	0.994

Table 2 Factor (f) to Determine the Reynolds Number

Temperature	10	15	20	25	30	35	40	45	50
Factor, f	19.4	18.7	18.1	17.5	16.9	16.4	15.9	15.5	15.2

Reynolds number R for air may be determined from empirical equation :

$$R = f.V.D$$

where

f = a factor depending on temperature as given in Table 2,

V = velocity of air through nozzle in m/h declared nominal capacity divided by total area of nozzles in m^2, and

D = throat diameter of nozzle in m.

11.6 The air is discharge through nozzle(s) into the discharge chamber. The distance from nozzle to next obstruction in the discharge chamber shall not be less than five throat diameters unless suitable diffusion baffles are used. The distance from nozzle outlet to diffusion baffles in discharge chamber shall be not less than 2.6 throat diameters. If desired, the discharge chamber may be provided with an access door.

11.7 Diffusion baffles, used both in receiving chamber and discharge chamber shall have staggered pattern holes of diameter not more than 6 mm and free area between 45 percent to 55 percent of the duct area.

11.8 To measure the pressure drop across the nozzle(s) one or more manometers in parallel shall have one side connected to one or more static pressure connections located flush with the inner surface of the receiving chamber. The othersideof the manometer(s) shall be connected in a similar manner to one or more static pressure connections in the wall of the

discharge chamber. Static pressure connections shall be located so as not to be affected by air flow.

11.9 An exhaust fan/blower with speed regulator shall be connected to the discharge chamber with adjustable damper, to overcome the resistance of chambers, nozzle(s) and diffusion baffles. It shall be able to provide a zero static pressure at the outlet of the air cooler under test.

11.10 The temperature and air flow measuring apparatus shall be sealed reasonably air-tight to ensure that the air delivered by the air cooler is discharged into discharge chamber through nozzle(s) without leakage as far as possible.

12 CALCULATION OF AIR FLOW

12.1 Air volume flow rate through a single nozzle shall be determined as follows :

$$Q = K.\, C_d.\, A.\, \sqrt{\frac{p.v}{1+w}\left\{\frac{P_o}{P}\right\}}$$

where

Q = Volume flow of air in m^3/h,

K = 1.6×10^4 (a constant),

C_d = Nozzle coefficient,

A = Nozzle(s) area in m^2,

p = Static pressure difference across the nozzle(s in mm of water (velocity pressure in mm of water if pitot tube is used),

v = Specific volume of air and water vapour mixture in m^3/kg of dry air,

w = Specific humidity in kg/kg of dry air,

P_o = Standard barometric pressure — 760 mm of mercury, and

P = Barometric pressure at nozzle in mm of mercury.

12.2 Where the barometric pressure *(P)* deviates from the standard barometric pressure by not more than 25 mm of mercury, the factor *Po/P* may be considered equal to 1.0.

12.3 When more than one nozzle is in use, the total volume flow rate will be the sum of the volume flow rate *(Q)* of each nozzle calculated as directed in **12.1.**

12.4 An example for calculating air delivery of a cooler is given in Annex A for guidance.

13 GUARANTEE

13.1 The cooler shall be guaranteed free from defects in material and workmanship for one year from the date of purchase.

14 MARKING AND INFORMATION

14.1 Each unit shall have the following information on the name plate in a permanent and legible manner in a location where it is accessible and visible.

a) Name of the manufacturer;

b) Type or model number, serial number and year of manufacturing;

c) Minimum air capacity at zero static pressure;

d) Normal total current and voltage;

e) Power input;

f) Sump tank capacity; and

g) Cooling efficiency of the unit.

14.2 The manufacturer shall provide a manual containing necessary information for proper installation, operation and maintenance of the evaporative air cooler. In this manual suitability of coolers of different capacities for different sizes of rooms shall be indicated for the guidance of the users.

14.3 BIS Certification Marking

The product may also be marked with Standard Mark.

14.3.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Clause 12.4)

EXAMPLE FOR METHOD OF CALCULATION

An example for method of calculation for air delivery of an air cooler has been illustrated for clear understanding.

Suppose during a test on an air cooler, following readings were recorded.

Condition of the supply of air to the air cooler:

T_{db} = 39.8°C

T_{wb} = 25°C

Condition of the outlet air from the air cooler:

T_{db}' = 29°C

T_{wb} = 25°C

Differential pressure across nozzles = 10 mm water column

Number of nozzle = 5

Diameter of each nozzle = 0.132 m

Area of each nozzles = 0.013 685 m^2

Total area of 5 nozzles = 0.068 5 m^2

The declared capacity of the air cooler = 3 000m^3/h.

From psychrometric tables, at T_{db}' – 29°C and T_{wb} = 25°C

Specific volume of dry air at 29°C(v_a) = 0.855 7 m^3/kg

Specific volume of air mixture per kg of dry air at 29°C (v_s*) = 0.890 8 m^3/kg

Specific humidity of air per kg of dry air at 25°C (w_s*) = 0.020 09 kg/kg

Specific humidity of air per kg of dry air at 29°C (w_s) = 0.025 65

The humidity ratio,

$$w = \frac{(597.30 - 0.56\,T_{wb})\,w_{s*} - 0.24\,(T_{db'} - T_{wb})}{597.30 + 0.44\,T_{db'} - T_{wb}}$$

$$= \frac{(597.30 - 0.56 \times 25)\,0.020\,09 - 0.24\,(29 - 25)}{597.30 + (0.44 \times 29) - 25}$$

$$= \frac{(597.30 - 14)\,0.002\,09 - (0.24 \times 4)}{597.30 + 12.876 - 25}$$

$$= \frac{11.718\,497 - 0.96}{585.076}$$

$$= \frac{10.758\,497}{585.076}$$

= 0.018 4 kg/kg of dry air

The saturation ratio

$$\mu = \frac{w}{w_s} = \frac{0.018\,4}{0.025\,65}$$

= 0.717 348 9 0.717 35

Specific volume of air and water vapour mixture in m^3/kg of dry air,

$v = v_a + \mu\,(v_s* - v_a)$

= 0.855 7 + 0.717 35 (0.890 8 - 0.855 7)

= 0.855 7+ 0.717 35(0.035 1)

= 0.855 7 + 0.025 18

= 0.880 88 m^3/kg of dry air

Reynolds number R for air may be determined from equation :

$R = f.V.D$

where

f = a factor depending on temperature as given in Table 2.

V = velocity of air through nozzle in m/h and

D = throat diameter of nozzle in m

At T_{db}' -29°C (from Table 2)

f = 17

$$R = 17 \times \frac{3\,000}{0.068\,5} \times 0.132$$

R = 98 277.372

From Table 1 for R = 98 277.372,

Cd = 0.985

Air flow,

$$Q = K.\,C_d.\,A.\,\sqrt{\frac{p.v}{1+w}\left\{\frac{P_0}{P}\right\}}$$

$$= 1.6 \times 10^4 \times 0.985 \times 0.068\,5 \times \sqrt{\frac{10 \times 0.880\,88}{1 + 0.018\,4} \times 1}$$

$$= 1\,079.56 \times \sqrt{8.649\,646\,5}$$

= 1 079.56 × 2.941 03

= 3 175 m^3/h

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