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Artificial climates in technical applications

Air temperature as a climatological quantity in controlled-atmosphere test installations

DIN 50011 Part 12

Klimate und ihre technische Anwendung; Klimaprüfeinrichtungen; Klimagröße: Lufttemperatur

Together with DIN 50011 Part 11, March 1982 edition, supersedes DIN 50011 Part 1, January 1978 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

1 Scope and field of application

This standard establishes concepts and specifies requirements relating to air temperature as a climatological quantity in setting up and operating controlled-atmosphere test installations. The choice of air temperature is determined by the purpose of the test installation.

2 Terminology

See DIN 50011 Part 11 for general terminology.

2.1 Types of test installation

The test installations referred to in this standard are generally described as chambers, but depending on size and construction, they may also be described as cabinets, chests, rooms, booths and plants.

2.1.1 Oven

A chamber for testing and conditioning test materials at temperatures ranging from ambient temperature to about 200 °C and in special cases, up to about 400 °C (cf. DIN 12880 Part 1).

2.1.2 Drying chamber

A chamber for drying materials and evaporating liquids at temperatures ranging from ambient temperature to about 150 °C and in special cases, in a partial vacuum.

2.1.3 Refrigeration chamber

A chamber for testing and conditioning at temperatures ranging from ambient temperature to about − 40 or − 70 °C and in special cases, at even lower temperatures.

2.1.4 Cooling chamber

A chamber for conditioning at temperatures ranging from ambient temperature to 2 °C.

2.1.5 Freezing chamber

A high performance chamber for freezing and conditioning for long periods at temperatures below 0 °C.

2.1.6 Constant-temperature chamber

A chamber used as a conditioning and working room with only slight variations in temperature over time.

2.1.7 Thermal test chamber

A test chamber with closely controlled variations in temperature from point to point and over time, at temperatures ranging from − 20, − 40 or − 70 °C (lower, in special cases) to 60, 100 or 180 °C (higher, in special cases) with specified rates of temperature change, the degree of temperature control achieved depending on the complexity of the application (cf. DIN 50011 Part 11).

2.1.8 Thermal-shock chamber

A chamber in which the rates of temperature change exceed 10 K/min for temperatures ranging from − 40 or − 70 °C (lower, in special cases) to 100 or 180 °C (higher, in special cases).

2.1.9 Incubating chamber

A chamber for biological applications at temperatures ranging from ambient temperature to 40 or 70 °C with only slight variations in temperature from point to point.

2.1.10 Sterilizer

A sterilizing chamber meeting hygienic requirements in the required temperature range (cf. DIN 58900 Part 1).

2.2 Systems and designs

2.2.1 Direct conditioning

In direct conditioning, the test room air is acted upon directly by air heaters and air coolers.

2.2.2 Indirect conditioning

In indirect conditioning, the test room air is acted upon continuously by a separate heat transfer medium (e.g. brine, oil, air).

2.2.3 Conditioning with recirculated air

Conditioning of the air intended for the test chamber in an air treatment room.

2.2.4 Conditioning of housing

The conditioning of the test chamber walls.

2.2.5 Direct heaters

Direct heaters are heating elements (generally electric heaters) installed in the air treatment room or mounted on the walls of the test chamber.

Continued on pages 2 to 7

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2.2.6 Direct coolers

Coolers (generally, coolant evaporators or cold-water coolers) which are installed in the air treatment room itself or mounted on the walls of the test chamber.

2.2.7 Indirect heat exchangers

Heat exchangers, installed in the air treatment room or mounted on the test chamber walls, employing a separate heat transfer medium (brine) for conditioning the test chamber air. They form part of the indirect conditioning systems, their large heat exchange surfaces enabling the temperature differential between them and the test room air to be kept small.

2.2.8 Fresh air

For the purposes of this standard, fresh air is air used to replace the air in the test chamber, usually filtered air drawn from the air in the installation room.

2.2.9 Natural ventilation

Natural ventilation is produced by convection in the test chamber.

2.2.10 Air circulation

Air circulation in the test chamber by means of fans (turbulent air in test chamber, or forced ventilation with recirculating air).

3 Requirements

Controlled-atmosphere test installations are subjected in service to high levels of stress and the structural materials used shall therefore be selected to ensure satisfactory operation for the given application.

3.1 Test chamber

3.1.1 Durability of test chamber

Due attention shall be paid by the operator to any chemical and physical effects the test material may have on the test installation. To prevent its being damaged, the mechanical load imposed on the test chamber shall be less than the permissible load specified by the manufacturer. The loadbearing capacity of the floor of the test chamber shall be specified.

3.1.2 Test chamber door or lid

The test chamber door or test chamber lid shall, when opened to introduce the test material, permit access to the entire useful space of a cabinet or chest. Walk-in chambers shall have doors with a clear opening of at least 800 mm × 1800 mm and shall be capable of being opened from the inside at any time.

3.1.3 Test chamber window

Test chamber windows shall be adequately thermally insulated for the operating temperature range (see subclause 3.1.10) and, if necessary, protected against condensation, e.g. by heating. The size of the windows shall be not less than 100 mm × 100 mm.

3.1.4 Test chamber ports

Test chamber ports for introducing power-supply, control and test leads into the test chamber or attaching them to the test material shall be capable of taking a thermally insulating seal. At least one port of sufficiently large cross section shall be provided for each test chamber.

3.1.5 Test chamber internals

Test chamber internals are, for example, adjustable gratings, trays or holding devices for securing the test material, and the power supply, control and test equipment (e.g. perforated metal sheets, wire mesh, bar gratings, etc.).

3.1.6 Test chamber lighting

Test chamber lighting shall illuminate the test chamber adequately without adversely affecting the view of the test material.

3.1.7 Test chamber drains

Test chamber drains shall be provided for cleaning the test chamber and for removing liquids, e.g. condensate. They shall be capable of being closed.

3.1.8 Test chamber sealing

Doors and ports shall be appropriately sealed (single sealing, double sealing, door frame heating). Depending on the requirements to be met by the test installation, an internal and/or an external vapour barrier shall be provided.

3.1.9 Pressure equalization ports

If differential pressures are likely to occur between the test chamber and the installation room, equalization ports shall be provided, preventing, however, constant introduction of fresh air.

3.1.10 Thermal insulation

The walls, doors and lids of the test installation shall be insulated so that the temperature of the outside walls does not fall beneath the dewpoint and the installation room is not exposed to heat. The outside wall temperature of the test installation shall, on average, be not more than 15 °C above or below the air temperature in the installation room. The temperature of metal parts which can be touched shall not exceed 60 °C.

3.2 Measurement and regulation of air temperature

3.2.1 Temperature sensors

The temperature in the chamber shall be continuously registered by means of one or more sensors, best arranged outside the useful space.

Expansion thermometers, thermocouples or, preferably, Pt 100 resistance thermometers as specified in DIN 43760 shall be used as temperature sensors.

Note. In order to detect variations, the control sensors and those used for recording the temperature shall function independently of each other.

3.2.2 Temperature indication

The temperature measured shall be indicated with adequate resolution. The indication may be analog and/or digital.

3.2.3 Temperature recording

The temperature measured shall be recorded in analog and/or digital form using chart recorders or printers. If required, the temperature shall be recorded and stored with the aid of an external data system.

3.2.4 Temperature control

The temperature control equipment shall ensure that, in the useful space, the variations in temperature over

time do not exceed the agreed specified limits for the entire temperature range. The controller shall indicate whether the heating and cooling systems are on or off. If required, the controller shall be suitable for entering the set point via electronic programmers or computers.

The set point adjuster shall set the air temperature to the required value, the operator taking due account of any deviations as specified in DIN 50011 Part 11. The resolution of the set point adjuster shall be equal to or less than the deviation over time specified by the manufacturer.

3.3 Parameters of test installations

3.3.1 Temperature range

It shall be possible to achieve and control any given temperature within the agreed temperature range provided that the ambient conditions are as specified, the test chamber is empty and sealed and the test chamber lighting is switched off. The temperature range for the test chamber after introduction of the test material, or in the event that the test material gives off or absorbs additional heat, or when fresh air is supplied, shall be subject to special agreement.

3.3.2 Range of temperature change

The rate of temperature change (see DIN 50011 Part 11 for definition) shall be specified in accordance with the requirements (cf. subclause 5.2.4).

Note. The rate of temperature change is generally in increments of 1 K/min, but less than 0,5 K/min in the case of walk-in test chambers. Constant-temperature test installations shall have a rate of temperature change of about 0,1 K/min.

3.3.3 Thermal loading of test chamber

The thermal loading of the test chamber indicates the maximum heat load (cooling load) to which the test installation can be subjected at one or more agreed temperatures. It reduces the rate of temperature change on cooling and increases the variations from point to point. When the test installation is switched off or is faulty, any thermal loading due to the test material shall be terminated by the operator.

3.3.4 Continuous operation in cooling mode

If fresh air containing moisture is used, or if the test material gives off water, then the cooling installation is liable to ice up during continuous operation. Where the above conditions apply, manufacturer and operator shall agree on the duration and method of continuous operation. At the lowest temperature, the cooling installation shall be capable of at least 24 h continuous operation without defrosting being necessary. Where automatic defrosting, e.g. by temporarily increasing the temperature in the useful space, is used to achieve continuous operation, the defrost water shall be drained off so as to prevent the test material and test chamber walls from becoming wet or icing over.

3.3.5 Accuracy classes

The accuracy classes shown in table 1 indicate the sums of the short-term variations over time and from point to point in the useful space without taking account of the setting deviation, and correspond to the maximum variations of the preferred temperatures as specified in DIN 50013.

Depending on the temperature range and size of useful space chosen, the same test installation may be assigned to different accuracy classes. In general, however, the accuracy class is specified only for one temperature range and for one size of useful space, on the assumption that the test chamber is empty.

3.3.6 Movement of air

To maintain the accuracy classes, adequate movement of air in the useful space is required. In the centre of the useful space, the air speed is generally less than 1 m/s. The air speed values shall be agreed separately by way of test specifications; if necessary, the test material shall be screened.

3.4 Safety devices

3.4.1 Safeguarding the test installation

Given correct implementation in accordance with the operating manual, the safety devices shall safeguard the test installation against operator errors and supply failure (power, water).

Note. The following devices are necessary for safeguarding the equipment:

temperature controller and/or temperature limiter for the test chamber heating;

safety controls for the cooling circuit;

safety controls for the heat transfer medium circuit;

safety controls for the electrical components.

3.4.2 Protection of test material

The test material shall be protected against excess temperature during and after operation of the test installation by means of an adjustable temperature limiter or temperature controller. When the test installation is inoperative due to an interruption in supply, the test

Table 1. **Accuracy classes**

Accuracy class	0,5	1	2	5
Sum of variations, in °C	± 0,5	± 1	± 2	± 5
Maximum variation over time, in °C	± 0,3	± 0,5	± 1	± 3
To be used for	special tests, verification, calibration	testing with limited temperature variations	normal tests	simple conditioning and testing at extreme temperatures