SLOVENSKI STANDARD
SIST EN 61308:1999

01-julij-1999

High-frequency dielectric heating installations - Test methods for the determination of power output (IEC 61308:1994)

High-frequency dielectric heating installations - Test methods for the determination of power output

Hochfrequente dielektrische Erwärmungsanlagen - Meßverfahren für die Bestimmung der Ausgangsleistung

Installations de chauffage diélectrique haute fréquence - Méthodes d'essais pour la détermination de la puissance de sortie

Ta slovenski standard je istoveten z: EN 61308:1996

ICS:

25.180.10 Elektriļ ne peļ i Electric furnaces

SIST EN 61308:1999 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61308

September 1996

ICS 25.180.10

Descriptors: Electroheating installation, industrial heating, dielectric heating, high frequency, output power, test method

English version

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Installations de chauffage diélectrique haute fréquence - Méthodes d'essais pour la détermination de la puissance de sortie (CEI 1308:1994)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 61308:1996 E

Foreword

The text of the International Standard IEC 1308:1994, prepared by IEC TC 27, Industrial electroheating equipment, was submitted to the formal vote and was approved by CENELEC as EN 61308 on 1996-07-02 without any modification.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-06-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-06-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annex A is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 1308:1994 was approved by CENELEC as a European Standard without any modification.

CONTENTS

HIGH-FREQUENCY DIELECTRIC HEATING INSTALLATIONS – TEST METHODS FOR THE DETERMINATION OF POWER OUTPUT

Section 1: General

1.1 Scope and object

This International Standard is applicable to industrial radio- or high-frequency dielectric heating installations used for the purpose of thermal applications such as heating, assembly by melting, melting and drying of partially conductive or non-conductive materials, such as plastics, wood, rubber, textiles, glass, ceramics, paper, foodstuffs, etc., in both normal and protective atmospheres, using, for example, inert gas or vacuum.

This standard relates to high-frequency dielectric heating installations in the frequency range 1 MHz to 300 MHz for power levels of 50 W and above. Comprising high-frequency generators and capacitors for the substance to be heated which, according to the requirements, may also contain the necessary mechanical devices.

The main purpose of this standard is to assist in compliance with the requirements set out in 6.4 of IEC 519-9, when testing electro-heating power sources. It is not primarily intended as a means of representing a potential high-frequency heating application for the requirement of the user. Due to the large variety of dielectric heating applications, any output power figures obtained as a result of these tests should not be taken as representing the amount of power that can be dissipated into a particular dielectric heating installation, but in certain instances the output power figures could be used as an indication of performance.

The amount of power required to heat a product will be dependent, for example, on the type of material, temperature and moisture and on the construction of the electrode system.

This standard relates to equipment normally operating under continuous rated conditions and where the output terminals are easily accessible.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(841): 1983, *International Electrotechnical Vocabulary (IEV) – Chapter 841: Industrial electroheating*

IEC 519-9: 1987, *Safety in electroheat installations – Part 9: Particular requirements for high-frequency dielectric heating installations*

1.3 Definitions

For the purpose of this International Standard, the basic definitions are defined in IEC 50(841), IEC 519-9 and supplemented by the following definition.

1.3.1 **high-frequency output power:** Maximum amount of power measured into the test load defined in this standard.

The high-frequency output power will be equal to, or greater than, the rated useful output power.

Section 2: Tests

2.1 Power output test loads

There are three different types of output power test loads for use in high-frequency dielectric heating installations. Only the principals are outlined. Detailed constructions shall conform to known engineering techniques.

2.1.1 *Calorimeter load*

A calorimeter load is used for applications determining the high-frequency output power where the load is assumed to be a combination of capacitance and resistance and for power measurements of about 1 kW and above.

2.1.2 *Matched resistive load*

A matched resistive load is used for applications determining the high-frequency output power where the load is required to be of a specific resistance and for power measurements of 50 W and above.

2.1.3 *Lamp load temperature method*

The lamp load temperature method is used for applications determining the high-frequency output power where neither of the above methods is suitable and for power measurements of 50 W to about 1 kW.

Section 3: Description of tests

3.1 Methods of test and measurements

Measuring devices should not be affected by high-frequency fields.

3.1.1 *Calorimeter load*

Typical examples are shown in figures 1a and 1b, but variations of these designs are acceptable. The measuring element is composed of glass, or a lower loss material and comprises two electrodes manufactured from a non-magnetic material such as copper, aluminium, etc.

The generator output terminals are connected to the two electrodes and water as the power absorbing medium flows through the element. The electrode spacing may be adjustable for load setting purposes. To achieve the correct impedance matching between the generator and the load, it may be necessary to use a tuning circuit, to extract the required output power.

A recommended water flow would be about 1 l/min per kW, but not less than 0,5 l/min per kW.

To avoid localized water temperature hot spots through the element, water shall be thoroughly mixed.

To avoid the formation of steam, which may lead to explosion, the water flow should be monitored, for instance, by means of flow interlocking switches.

The water inlet temperature shall not exceed 35 °C.

The water outlet temperature shall not exceed 60 °C.

The difference between the outlet temperature and the inlet temperature shall be at least 10 K in order to obtain results of an acceptable accuracy.

The specific conductivity of the water shall lie between 200 µS/cm and 600 µS/cm.

The measurement shall be carried out when the load is in thermal equilibrium.

The power output is calculated from the following equation:

$$P = \frac{4{,}1868 \times Q \times \Delta T}{60} \approx 0{,}07 \times Q \times \Delta T$$

where

P is the power output, in kW;

Q is the water flow rate, in l/min;

ΔT is the temperature difference, in kelvins, between water inlet and outlet temperatures.

NOTE – 1 cal = 4,1868 J.

The accuracy of power output measurement shall be within ±5 %.

3.1.2 *Matched resistive load*

The matched resistive load takes the form of a low reactance resistor which can be cooled by natural air convection, by forced air or by water. It is generally connected to the generator by a coaxial feeder at a characteristic impedance of 50 Ω. Other values of characteristic impedances are available and alternative feeders may be used.

The power is obtained by measuring the current or voltage at the resistor and the meter can indicate the power directly as I^2R or V^2/R. The matched resistor loads are commercially available at power levels from tens of watts to hundreds of kilowatts.

Typical accuracies are from ±2,5 % to ±5 % dependent on the particular design.

3.1.3 *Lamp load temperature method*

A typical example is shown in figure 2. A filament lamp h1 is connected to the generator output terminals. To achieve the correct impedance matching between the generator and the load, it may be necessary to use a tuning circuit to extract the required output power. The temperature of the lamp is measured with the generator switched on.

A similar filament lamp h2 is then connected across an adjustable mains supply voltage. The voltage is set to provide the same lamp temperatures as for h1. The voltage and current through the lamp h2 are measured and the product gives the power dissipated which will also be the high-frequency output power of the high-frequency generator.

For power levels greater than can be achieved for one lamp, several lamps can be used but problems may occur with non-uniform temperature levels for the various lamps. The difficulties increase with frequency and with the use of lamps with longer filaments. For frequencies above 30 MHz this method is not recommended, and above 100 MHz, practically not suitable.

In view of dielectric strength and better comparability, the lamps shall be operated at a maximum of 70 % of their rated voltage.

Typical temperature measuring devices could include photoelectric cells (see annex A) or pyrometers. The accuracy of power output measurement shall be within ±5 %.