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Industrial electroheat equipment - Test methods for electroslag remelting furnaces

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IEC 60779: Industrial electroheat equipment - Test methods for electroslag remelting furnaces

Note d'introduction

Ce projet a été établi par l'EM 28.

Introductory note

This draft has been prepared by MT 28.

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	**Parallel IEC CDV/CENELEC Enquiry**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL ELECTROHEAT EQUIPMENT – TEST METHODS FOR ELECTROSLAG REMELTING FURNACES

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60779 has been prepared by IEC technical committee 27: Industrial electroheating equipment.

This second edition cancels and replaces the first edition published in 1983 and constitutes a technical revision.

Significant technical changes with respect to the previous edition are additional technical tests described in 5.1, 5.2, 5.3, 5.9, 5.10, 5.11, 5.13, 5.14 and 5.15.

The text of this standard is based on the following documents:

FDIS	Report on voting
27/XXX/FDIS	27/XXX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until _____. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INDUSTRIAL ELECTROHEAT EQUIPMENT – TEST METHODS FOR ELECTROSLAG REMELTING FURNACES

1 Scope and object

This International Standard applies to industrial electroslag remelting furnaces, the rated capacity of which is equal to or greater than 50 kg.

This Standard is applicable to industrial electroslag remelting furnaces having one or more electrodes, and having different melting power supplies such as alternating current, direct current or low-frequency current.

The object of this publication is the standardization of electroslag remelting furnace test conditions and methods to determine the main parameters and technical characteristics.

This Standard does not cover all possible test methods which may be carried out for the technical and economic assessment of furnace.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition applies. For undated references, the latest edition of the referenced documents (including any amendments) applies.

IEC 60050-841: XXXX [1], *International Electrotechnical Vocabulary - Part 841: Industrial electroheat*

IEC 60398: 1999, *Industrial electroheating installations - General test methods*

IEC 60676: 2002, *Industrial electroheating equipment - Test methods for direct arc furnaces*

3 Terms and definitions

For the purpose of this standard, the definitions given in IEC 60050-841, IEC 60676 and the following apply.

3.1
electroslag remelting furnace
remelting furnace in which the charge, usually a consumable electrode, is remelted by direct resistance heating of an electrical conductive molten slag

NOTE The slag is contained in a mould (crucible).

3.2
electroheat installation with an electro–slag remelting furnace
complete assembly of electroheat equipment and electrical and mechanical accessories necessary for operation and utilization of an electroslag remelting furnace

NOTE The electrical equipment comprises, in particular, the conductors and switchgear in the power, control and regulating circuits, and the melting power supply(ies), when the device has its own melting power supply(ies).

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[1] To be published.

3.3
power of an electroheat installation
apparent power S (in kVA) or active power P (in kW) measured at the input of the supply line

3.4
power factor of an electroheat installation (cosφ)
ratio of the active power to the apparent power measured at the input of the supply line

3.5
mould (crucible) of an electroslag remelting furnace
water-cooled non-consumable container which shapes the ingot to be produced by the electroslag remelting process and which contains the molten slag

3.6
secondary electrical circuit of an electroslag remelting furnace
electrical circuit which is closed by the melting power supply may include:

a) output terminals of melting power supply;
b) high-current feeder (busbars and/or cables);
c) bus switches, if required;
d) electrode clamp;
e) electrode stub;
f) consumable electrode or electrodes (depending on the connection system);
g) conductive molten slag (not included in the short-circuit test);
h) remelted ingot (not included in the case of the furnace with more than two electrodes);
i) base plate (depending on the connection system)

3.7
consumable electrode
solid part(s) in contact with the molten slag which carries the electrical current necessary for the melting operation and is constituted of the material necessary for the formation of the ingot

3.8
on-load voltage of an electroslag remelting furnace
a) voltage which can be measured between the following two points (not applicable for the furnace with two electrodes corresponding to single-phase a.c. power supply):
   – the base plate,
   – the electrode clamping device(s) bringing the melting electrical current to the consumable electrode(s) or stub(s)

NOTE See Figure 1, points C.

b) for the furnace with two electrodes corresponding to single-phase a.c. power supply, the voltage measured between the two electrode clamping devices

3.9
rated furnace frequency f_n (Hz)
if the furnace is built for a frequency range, f_n is the value corresponding to the rated furnace current

3.10
rated furnace current I_n at nominal frequency f_n
maximum current for continuous operation for which the furnace is designed

3.11
rated values of an electroslag remelting furnace
rated values, including rated furnace current I_n, rated furnace power P_n, and rated furnace frequency f_n, for which the furnace is designed

3.12
continuous operation of a furnace
operation during which the solid ingot is produced and solidified and the consumable electrode is progressively added during the whole process

3.13
steady state of an electroslag remelting furnace
state of a furnace in which, in continuous operation, electrical and thermal parameters have reached relatively constant values

3.14
melting rate of consumable electrode V_m (kg/min)
quantity of remelted consumable electrode(s) measured in kilograms within a unit time (min)

3.15
specific energy consumption e (kWh/kg)
ratio of the total amount of electric energy (kWh) measured at the input of the supply line, which is consumed by an electroheat installation for melting the charge in normal operating conditions agreed upon between the manufacturer and user, to the weight of the ingot produced (kg)

3.16
water-cooled base plate of an electroslag remelting furnace
water-cooled plate which is installed at the bottom of mould to contain liquid metal and slag at the beginning of melting in any case, and connected to the cable(s) or busbar(s) to make sure that the current flow through the secondary electrical circuit in the case of the furnace operation with one consumable electrode

3.17
furnace high-voltage switch
high-voltage switch for switching on and off, under load, the furnace transformer, in accordance with operating requirements [IEC 60676, 3.8]

3.18
electroslag remelting furnace transformer
transformer supplying an electroslag remelting furnace

3.19
electrode clamp
metallic, water cooled equipment for holding an electrode and supplying the current to the electrode.

3.20
cooling-water flow rate (m^3/h)
addition of the following flow rates:

a) flow rate of water to cool mould and base plate;

b) flow rate of water to cool secondary electrical circuit line;

c) flow rate of water to cool the furnace transformer;

d) flow rate of water to cool the other elements of the furnace

[IEC 60676, 3.25]

4 Type of tests and general conditions of their performance

4.1 Type of tests

The tests shall be made under operating conditions including the composition of electroslag agreed upon between the manufacturer and the user.

For the assessment of an electroheat installation containing an electroslag remelting furnace, the following tests are recommended to be performed in the following order:

a) measurement of effective stroke of electrode ram motion (see 5.1);

b) measurement of the speed of the electrode motion (see 5.2);

c) measurement of time interval for exchange of two electrodes (see 5.3);

d) measurement of open circuit secondary voltage of the electroheat installation (see 5.4);

e) measurement of electrical parameters of the secondary circuit of the electroheat installation (see 5.5);

f) measurement of active power, reactive power and power factor of the electroheat installation (see 5.6);

g) measurement of temperature of components which are subjected to strong magnetic field and/or radiated or converted heat (see 5.7);

h) measurement of temperature rise of the cooling water (see 5.8);

i) measurement of cooling-water flow rate and heat losses (see 5.9);

j) measurement of intensity of magnetic field at or near an electroslag remelting furnace (see 5.10);

k) measurement of melting rate of consumable electrode(s) (see 5.11);

l) measurement of specific energy consumption (see 5.12);

m) measurement of vacuum parameters for a vacuum electroslag remelting furnace (see 5.13);

n) measurement of pressure in the chamber of a pressurized electroslag remelting furnace (see 5.14);

o) measurement of gas composition for an electroslag remelting furnace working under inert gas atmosphere (see 5.15).

4.2 General conditions of test performance

Performance of the tests shall be in accordance with the specification of IEC 60398.

The furnace shall be prepared for tests and put into operation at the user's site, in accordance with the service instructions and requirements for safe working.

5 Recommendations on technical tests

5.1 Measurement of effective stroke of electrode ram motion

The effective stroke of electrode ram motion is the distance between the upper limited position and lower limited position of electrode ram where the motion stops.

The measurement shall be made with meter ruler when the main power of the furnace is off.

5.2 Measurement of the speed of the electrode motion

The measurement shall be made with manual control of the moving system of the electrode in two directions under the condition that the furnace is equipped with the electrode(s) of the largest weight and length allowed by the designer.

NOTE The measurement may be made by another method, for example, using electric signal control.

The measurement of the speed of motion shall be carried out by means of a stop-watch (or electronic time-base control), noting the distance covered by the electrode arm relative to its fixed support.

5.3 Measurement of time interval for exchanging electrodes

The purpose of this test is to check if the time interval for exchanging electrodes meets the requirements agreed between the manufacturer and user when the furnace is equipped with two sets of electrode feed drive systems.

The time to be measured with a stop-watch is the time interval from the moment when the secondary current becomes zero after the first electrode has melted and pulled out in molten slag to the moment when the next electrode is dipped into the slag pool and the secondary current flows in the circuit is

5.4 Measurement of open circuit secondary voltage of the electroheat installation

This test shall be carried out across the melting power supply terminals (points B in Figure 1).

If the installation is provided with a regulation system the minimum and the maximum open-circuit secondary voltages shall be measured.

5.5 Measurement of electrical parameters of the secondary circuit of the electroheat installation

5.5.1 General

The purpose of this test is to check if the characteristics of the secondary circuit of the furnace meet the requirements agreed between manufacturer and user.

5.5.2 Carrying out a short-circuit test (not applicable for d.c. electroslag remelting furnaces)

This test shall be carried out under the following conditions. The furnace shall be equipped with the electrode(s) of the largest weight and length allowed by the designer. The electrical and magnetic properties of the electrode material shall be defined beforehand. The electrode(s) shall be brought into electrical contact with the base plate.

The voltage supply shall be set at its minimum.

The voltage shall progressively be increased until the rated current of the furnace is achieved.

The tests are carried out at least twice. For every test, the following electrical parameters shall be measured or calculated:

a) Active power P_2 on the secondary side of furnace transformer – measured with wattmeters in kilowatts;

   If in some cases it is difficult to measure P_2, the active power P_1 shall be measured on the primary side of furnace transformer with wattmeters in kilowatts, and then P_2 calculated as:

$$P_2 = P_1 - P_{CuT} \quad (1)$$

b) I_2, U_2 on the secondary side of furnace transformer – measured with ammeters in kiloamperes and voltmeters in volts, respectively;

c) Calculation of the following secondary values: