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Radiators, convectors and similar appliances – Calculation of thermal output and presentation of results

Radiateurs-convecteurs et appareils similaires – Calcul de la puissance thermique et présentation des résultats

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3150 was drawn up by Technical Committee ISO/TC 116, *Space heating appliances,* and circulated to the Member Bodies in September 1973.

It has been approved by the Member Bodies of the following countries :

Australia	France	South Africa, Rep. of
Belgium	Germany	Thailand
Bulgaria	Ireland	Turkey
Canada	Italy	United Kingdom
Czechoslovakia	Netherlands	Yugoslavia
Denmark	Norway	
Egypt, Arab Rep. of	Romania	

No Member Body expressed disapproval of the document.

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Radiators, convectors and similar appliances – Calculation of thermal output and presentation of results

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the method of calculating the thermal output of radiators, convectors and similar appliances and lists the particulars to be included in the test report.

It is applicable to tests carried out in accordance with ISO 3148, ISO 3149 and ISO . . .[1]

2 REFERENCES

ISO 3147, *Heat exchangers – Verification of thermal balance of water-fed or steam-fed primary circuits – Principles and test requirements.*

ISO 3148, *Radiators, convectors and similar appliances – Determination of thermal output – Test method using air-cooled closed booth.*

ISO 3149, *Radiators, convectors and similar appliances – Determination of thermal output – Test method using liquid-cooled closed booth.*

ISO . . ., *Radiators, convectors and similar appliances – Determination of thermal output – Test method using open booth.*[1]

3 CALCULATION OF THERMAL OUTPUT

The mean values obtained in the tests (see 4.5.1 and 4.5.2 of ISO 3148, 4.4.1 and 4.4.2 of ISO 3149 and 5.4.1 and 5.4.2 of ISO . . .) shall be used to calculate the thermal output.

To relate the output calculated in this way to the reference pressure conditions, multiply by the correction factor

$$1 + \frac{\beta \, \Delta p}{p_0}$$

where

β is a coefficient equal to 0,3 for radiators and 0,5 for convectors;

$\Delta p = p - p_0$

p being the mean atmospheric pressure during test;

p_0 being the reference atmospheric pressure (101,3 kPa, or 1 013 mbar);

provided that this correction factor is at least 1,01.

When the thermal output is measured at three points in the same fluid (three water temperatures or three steam temperatures), it shall be expressed in the form

$$\phi = B\,(t_{mean} - t_a)^n = B\,(\Delta t)^n$$

where

t_{mean} is the mean temperature of the primary fluid $= (t_e + t_s)/2$

t_e being the entry temperature of the primary fluid;

t_s being the exit temperature of the primary fluid;

t_a is the reference temperature of the air;

coefficients B and n are obtained by the method of least squares from the values of $\log \phi$ as a function of $\log (t_{mean} - t_a) \equiv \log \Delta t$, taking into account a weighting factor as described in the annex.

If, with steam, there is only a single measured value, the output shall only be indicated for the point at which the measurement was made.

4 TEST REPORT

4.1 Records of all the observations made at regular intervals throughout each test shall be kept in the laboratory files.

4.2 Only the arithmetical means shall be included in the table in the report relating to the corresponding test.

4.3 The test report shall include :

a) the precise reference of the test method

1) with regard to the primary circuit (see ISO 3147);

2) with regard to the test booth (dimensions);

1) In preparation.

b) the precise reference of the model subjected to the tests, as well as a brief description and one or more photographs enabling a clear idea to be formed of the construction. The model or the certified drawings shall be preserved by the laboratory for at least 10 years (unless the model is withdrawn from the market). The following details in particular shall be specified : the total height, the height between the centres, the depth, the total length or the length of one element, the number of elements, the mass and the water capacity, etc.;

c) any exemptions that may have been granted from the provisions of ISO 3147, ISO 3148, ISO 3149 and ISO . . ., and the reasons for such exemptions;

d) the table of mean values for each test, including all the measurements required for the calculation of output in accordance with ISO 3147.

If the test has been made with a temperature drop other than the specified values of either 20 ± 2 °C or 10 ± 2 °C (see ISO 3148, sub-clause 4.5.1 and ISO 3149, sub-clause 4.5.1), then the temperature drop employed shall be stated.

Any necessary corrections shall be incorporated in this calculation and the reasons for these corrections shall be stated;

e) for each test, a table of the values of the temperatures specified in ISO 3148, ISO 3149 and ISO . . . obtained in the air of the premises and on the internal surfaces of the walls (the table may, for example, be shown in the form of a perspective view);

f) in addition, where relevant, the following parameters :

1) the relative humidity of the air in the inner enclosure;

2) the temperature of the air in the outer enclosure;

3) the barometric pressure;

g) the straight line adjusted in accordance with the rule given in clause 3 for tests with water (and, where applicable, for tests with steam), including a graphical representation on logarithmic paper.

From this is deduced the nominal output for a difference Δt of 60 °C between the mean temperature of the heating fluid and the reference temperature of the air in the test booth.

NOTE — Only the complete facsimile reproduction (for publication) of the report is authorized. Publication of extracts is not allowed.

ANNEX

APPLICATION OF WEIGHTING FACTORS TO TEST RESULTS

The numerical values of the respective weightings that may have to be applied to the results of each test must be justified in accordance with the method chosen (see ISO 3147).

As far as the method given in clause 3 is concerned, the probable error is basically the error in the temperature difference $t_e - t_s$. Weightings $\overline{\omega}$ inversely proportional to these errors can therefore be used :

$$\phi = B\,(t_{mean} - t_a)^n = B\,(\Delta t)^n$$

The equation of the straight line regression is

$$\log \phi = \log B + n \log \Delta t$$

By applying the formulae for the method of least squares, the following values are obtained for log B and n :

$$\log B = \frac{\Sigma\,\overline{\omega} \log \phi \cdot \Sigma\,\overline{\omega}\,(\log \Delta t)^2 - \Sigma\,\overline{\omega} \log \Delta t \cdot \Sigma\,\overline{\omega} \log \Delta t \log \phi}{\Sigma\,\overline{\omega} \cdot \Sigma\,\overline{\omega}\,(\log \Delta t)^2 - (\Sigma\,\overline{\omega} \log \Delta t)^2}$$

$$n = \frac{\Sigma\,\overline{\omega} \cdot \Sigma\,\overline{\omega} \log \Delta t \log \phi - \Sigma\,\overline{\omega} \log \Delta t \cdot \Sigma\,\overline{\omega} \log \phi}{\Sigma\,\overline{\omega} \cdot \Sigma\,\overline{\omega}\,(\log \Delta t)^2 - (\Sigma\,\overline{\omega} \log \Delta t)^2}$$

For example, assuming the determination of three experimental points in conditions such that the probable errors would be 1 %, 1,5 % and 2,5 %, the weightings $\overline{\omega}$ adopted would then be proportional respectively to the ratios 1/1, 1/1,5, 1/2,5 or in whole numbers 30, 20 and 12.

We have

$$\Sigma\,\overline{\omega} = 62$$

$$\Sigma\,\overline{\omega} \log \phi = 30 \log \phi_1 + 20 \log \phi_2 + 12 \log \phi_3$$

ϕ_1, ϕ_2 and ϕ_3 being values corresponding to Δt_1, Δt_2 and Δt_3 such that

$$\frac{\Delta t_1}{30} \neq \frac{\Delta t_2}{20} \neq \frac{\Delta t_3}{12}$$

$$\Sigma\,\overline{\omega} \log \Delta t = 30 \log \Delta t_1 + 20 \log \Delta t_2 + 12 \log \Delta t_3$$