SLOVENSKI STANDARD
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Učinkovitost gospodinjskih električnih akumulacijskih grelnikov vode in preskusne metode

Efficiency of domestic electrical storage water heaters and testing methods

Wirkungsgrad von elektrischen Warmwasserspeichern für den Hausgebrauch

Efficacité des chauffe-eau électriques à accumulation

Ta slovenski standard je istoveten z: **EN 50440:2015**

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91.140.65 Oprema za ogrevanje vode Water heating equipment

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Efficiency of domestic electrical storage water heaters and testing methods

Efficacité des chauffe-eau électriques à accumulation et méthodes associées

Effizienz von elektrischen Warmwasserspeichern für den Hausgebrauch

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Content

European foreword

This document (EN 50440:2015) has been prepared by CLC/TC 59X "Performance of household and similar electrical appliances".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-10-05
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2018-10-05

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1 Scope

This European Standard specifies methods for measuring the performance of electric storage water heaters for the production of sanitary hot water for household and similar use.

The object is to state and define the principal performance characteristics of electric storage water heaters and to describe the test methods for measuring these characteristics.

NOTE 1 This standard does not apply to;

- storage water heaters that use electricity as a secondary source of heating the water;
- storage water heaters that do not use a tank to storage hot water;
- electric storage water heaters that do not meet the minimum (or maximum) output performance of the smallest (or biggest) load profile, as defined in Table 4.

NOTE 2 This standard does not specify performance or safety requirements. For safety requirements see EN 60335-1 in conjunction with EN 60335-2-21.

2 Normative references

Not applicable.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
storage water heater
water heater that uses electric heating elements as the means of heating water for long-term storage in a thermally insulated container and provided with a device to control the water temperature

3.2
primary function
to heat water for the production of hot water for household and similar needs

3.3
energized storage water heater
storage water heater that is designed to supply hot water and energised for 24 h per day

3.4
off-peak storage water heater
storage water heater that is designed to supply hot water whilst only being supplied with electrical energy at off-peak/low tariff periods

Note 1 to entry: The off-peak storage water heater is required to fulfil the requirements of the tapping pattern between 7:00h and 22:00h without external energy supply, e.g. to enable operation at off-peak/low-tariff periods and/or to operate in conditions of insecurity of energy supply. A product qualifies as “off-peak” if it is only energized for a maximum of 8 consecutive hours anywhere between 22:00h and 7:00h during the test with the 24h tapping pattern.

3.5
load profile
means the output performance (in terms of flow-rates, temperatures, tapping pattern, etc.) of a storage water heater when fulfilling its primary function under specific ambient conditions (see Tables 3 and 4), as declared by the manufacturer

3.6
energy efficiency
means the ratio between the delivered energy in the sanitary hot water for its load profile and the consumed electrical energy

3.7
storage volume
rated quantity of water stored in the appliance

Note 1 to entry: This is declared in litres.

3.8
smart control
device that automatically adapts the water heating process to individual usage conditions with the aim of reducing energy consumption

3.9
out of the box-mode
standard operating condition, setting or mode set by the manufacturer at factory level, to be active immediately after the appliance installation, suitable for normal use by the end-user according to the water tapping pattern for which the product has been designed and placed on the market

4 Symbols and Units

Table 1 – Symbols

Symbol	Unit	Description
η_{elecwh}	[%]	Energy efficiency of a storage water heater.
Q_{ref}	[kWh]	Reference energy for the 24 h tapping pattern for the load profile of the water heater.
Q_{elec}	[kWh]	Electricity consumption with the relevant 24 h tapping pattern.
θ'_p	[°C]	mean water temperature for the determination of θ_p, measured at the outlet
f	[l/min]	Minimum flow rate which hot water is contributing to the reference energy as specified in Table 4.
T_m	[°C]	The water temperature at which hot water starts contributing to the reference energy as specified in table 4
T_p	[°C]	Minimum water temperature to be achieved during water draw off as specified in Table 4
$Q_{testelec}$	[kWh]	Measured electricity consumption over 24 h test (step 4).
Q_{H2O}	[kWh]	Useful energy content of the hot water of n drawn-offs
$V_{water}^{full-drawing}$	[litres]	Sum of quantity of hot water totally delivered during the tapping period.
V_{40_exp}	[litres]	Measured volume delivered at the mean water temperature.
V_{40}	[litres]	Mixed water quantity delivered at 40 °C.
C_{act}	[litres]	Actual capacity of Water Heater
m_{act}	[kg]	Actual weight of water contained inside the tank of the Water Heater
smart		Presence or not of smart control (value shall be 0 or 1).
SCF		Efficiency gain by smart control function.

5 Calculation of the electrical energy efficiency (η_{elecwh})

The electrical energy efficiency (η_{elecwh}) of a storage water heater is the ratio between the delivered energy in the hot water for the tapping pattern of its load profile and the consumed energy. The consumed energy is the result of the test of the water heater with adjustments for:

– ***smart control*** that can reduce the energy consumption

The electrical energy efficiency of a storage water heater shall be calculated as Formula 1:

$$\eta_{elecwh} = \frac{Q_{ref}}{Q_{elec}(1 - SCF \cdot smart)} \quad (1)$$

where:

Q_{ref} is the delivered energy for the 24 h tapping pattern for the load profile of the water heater, in kWh;

Q_{elec} is the consumption of electric energy with the relevant 24 h tapping pattern, in kWh;

smart indicates the presence of **smart control** and is yes = 1, no = 0;

NOTE SCF=0 in case no **smart control** is detected during testing (9.2).

6 Measured parameters

The parameters below shall be established following the measurement methods described in following Clauses 7 and 9:

a) electricity consumption [kWh/d];

b) electrical energy efficiency [%];

c) storage volume [litre].

7 General conditions for measurements

Measurements shall be carried out with a supply of:

Table 2 – Electricity

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Uncertainty of measurement (accuracy)	Notes
Electricity					
Power	W			± 2 %	
energy	kWh			± 2 %	
voltage, *test-period > 48 h*	V	230/ 400	± 4 %	± 0,5 %	
voltage, *test-period < 48 h*	V	230/ 400	± 2 %	± 0,5 %	
electric current	A			± 0,5 %	
frequency	Hz	50	± 1 %		

Table 3 gives additional test conditions and tolerances for test outputs (i.e. thermal energy).

Table 3 – Test conditions and outputs. Set values and tolerances

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Permissible deviations of individual measured values	Uncertainty of measurement (accuracy)	Notes
Time						
Time	s				± 0,1 s	
Maximum interval between samples (during the deliver of hot water)	s	3				
Maximum interval between samples (during the no-deliver of hot water)	s	60				
Sanitary water						
cold water temperature	°C/ K	10 °C	+/- 1 K	+/- 1 K	+/- 0,5 K*	
cold water pressure	MPa	0,3 MPa			± 5 %	
hot water temperature	°C/ K	pattern			+/- 0,5 K*	a, b
volume flowrate	l / min	pattern			± 1 %	
volume measurements	l				± 0,5 %	
thermal energy	kWh	pattern	± 2 % (overall)	± 2 % (or ±10Wh)	± 2 % (or ±10Wh)	c
Ambient air						
Temperature	°C/ K	20 °C	± 1 K		± 1 K	

a To be measured by "rapid response thermometer", meaning an instrument that registers within 1 s. at least 90% of the final temperature rise from 15 to 100 °C when the sensor is plunged in still water.

b Thermocouple with a maximum diameter of 0,5mm, centred in stream, directly at outlet

c Apart from the maximum deviation a correction factor Qref/QH2O is applied, whereby Qref is taken from Table 4 and QH2O is the energy content of the useful water actually delivered during the test. "Useful water" is water with a temperature higher than a threshold value Tm for tappings in a profile specified in Table 4.

*Together with the publication task it should be mentioned towards the Commission that this tolerance is hard or really not to be reached in practice.

All other installation requirements are made according to the manufacturer's instructions.

8 Reference conditions

Table 4 specifies the tapping patterns for the chosen Load Profile. Parameters in the table are:

a) *Load Profile* [XXS-4XL, in header row of table];
b) *h* hour [hh:mm] starting at 0:00 h;
c) Q_{tap} [kWh] useful energy content of water withdrawal to be achieved in the draw-off;
d) *f* [l/min] minimum flow rate to be reached during tapping;
e) T_m [°C] temperature from which counting of useful energy content starts;
f) T_p [°C] minimum (peak) temperature to be achieved during tapping;
g) Q_{ref} [kWh/d] daily (24 h) useful energy content of all water draw-offs, effectively the sum of all Q_{tap}.

For all tests a cold water temperature of (10 ± 2) °C shall be used.

As much as possible, the test method uses a 'black-box' approach, i.e. largely technology independent. This means amongst others that the laboratory uses the original appliance thermostat, in the position specified by manufacturer, and at the factory settings.

Table 4 –Load profile of water heater (reference test tapping patterns)

h	XXS				XS				S			
	Qtap	f	Tm	Tp	Qtap	f	Tm	Tp	Qtap	f	Tm	Tp
	kWh	l/min	°C	°C	kWh	l/min	°C	°C	kWh	l/min	°C	°C
07.00	**0,105**	2	25						**0,105**	**3**	**25**	
07.05												
07.15												
07.26												
07.30	**0,105**	2	25		**0,525**	**3**	**35**	-	**0,105**	**3**	**25**	
07.45												
08.01												
08.05												
08.15												
08.25												
08.30	**0,105**	2	25						**0,105**	3	25	
08.45												
09.00												
09.30	**0,105**	2	25						**0,105**	3	25	
10.00												
10.30												
11.00												
11.30	**0,105**	2	25						**0,105**	3	25	
11.45	**0,105**	2	25						**0,105**	3	25	
12.00	**0,105**	2	25									
12.30	**0,105**	2	25									
12.45	**0,105**	2	25		**0,525**	3	35	-	**0,315**	4	10	55
14.30												
15.00												
15.30												
16.00												
16.30												
17.00												
18.00	**0,105**	2	25						**0,105**	3	25	
18.15	**0,105**	2	25						**0,105**	3	40	
18.30	**0,105**	2	25									
19.00	**0,105**	2	25									
19.30	**0,105**	2	25									
20.00	**0,105**	2	25									
20.30					**1,050**	3	35	-	**0,420**	4	10	55
20.45	**0,105**	2	25									
20.46												
21.00	**0,105**	2	25									
21.15	**0,105**	2	25									
21.30									**0,525**	5	45	
21.35	**0,105**	2	25									
21.45	**0,105**	2	25									
Qref	**2,100**				**2,100**				**2,100**			

h	M				L				XL			
	Qtap	f	Tm	Tp	Qtap	f	Tm	Tp	Qtap	f	Tm	Tp
	kWh	l/min	°C	°C	kWh	l/min	°C	°C	kWh	l/min	°C	°C
07.00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
07.05	**1,400**	6	40		**1,400**	6	40					
07.15									**1,820**	6	40	
07.26									**0,105**	3	25	
07.30	**0,105**	3	25		**0,105**	3	25					
07.45					**0,105**	3	25		**4,420**	10	10	40
08.01	**0,105**	3	25						**0,105**	3	25	
08.05					**3,605**	10	10	40				
08.15	**0,105**	3	25						**0,105**	3	25	
08.25					**0,105**	3	25					
08.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
08.45	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
09.00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
09.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
10.00									**0,105**	3	25	
10.30	**0,105**	3	10	40	**0,105**	3	10	40	**0,105**	3	10	40
11.00									**0,105**	3	25	
11.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
11.45	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
12.00												
12.30												
12.45	**0,315**	4	10	55	**0,315**	4	10	55	**0,735**	4	10	55
14.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
15.00									**0,105**	3	25	
15.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
16.00									**0,105**	3	25	
16.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
17.00									**0,105**	3	25	
18.00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
18.15	**0,105**	3	40		**0,105**	3	40		**0,105**	3	40	
18.30	**0,105**	3	40		**0,105**	3	40		**0,105**	3	40	
19.00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
19.30												
20.00												
20.30	**0,735**	4	10	55	**0,735**	4	10	55	**0,735**	4	10	55
20.45												
20.46									**4,420**	10	10	40
21.00					**3,605**	10	10	40				
21.15	**0,105**	3	25						**0,105**	3	25	
21.30	**1,400**	6	40		**0,105**	3	25		**4,420**	10	10	40
21.35												
21.45												
Qref	**5,845**				**11,655**				**19,070**			

h	XXL				3XL				4XL			
	Qtap	f	Tm	Tp	Qtap	f	Tm	Tp	Qtap	f	Tm	Tp
	kWh	l/min	°C	°C	kWh	l/min	°C	°C	kWh	l/min	°C	°C
07.00	**0,105**	3	25		**11,2**	48	40		**22,4**	96	40	
07.05												
07.15	**1,820**	6	40									
07.26	**0,105**	3	25									
07.30												
07.45	**6,240**	16	10	40								
08.01	**0,105**	3	25		**5,04**	24	25		**10,08**	48	25	
08.05												
08.15	**0,105**	3	25									
08.25												
08.30	**0,105**	3	25									
08.45	**0,105**	3	25									
09.00	**0,105**	3	25		**1,68**	24	25		**3,36**	48	25	
09.30	**0,105**	3	25									
10.00	**0,105**	3	25									
10.30	**0,105**	3	10	40	**0,84**	24	10	40	**1,68**	48	10	40
11.00	**0,105**	3	25									
11.30	**0,105**	3	25									
11.45	**0,105**	3	25		**1,68**	24	25		**3,36**	48	25	
12.00												
12.30												
12.45	**0,735**	4	10	55	**2,52**	32	10	55	**5,04**	64	10	55
14.30	**0,105**	3	25									
15.00	**0,105**	3	25									
15.30	**0,105**	3	25		**2,52**	24	25		**5,04**	48	25	
16.00	**0,105**	3	25									
16.30	**0,105**	3	25									
17.00	**0,105**	3	25									
18.00	**0,105**	3	25									
18.15	**0,105**	3	40									
18.30	**0,105**	3	40		**3,36**	24	25		**6,72**	48	25	
19.00	**0,105**	3	25									
19.30												
20.00												
20.30	**0,735**	4	10	55	**5,88**	32	10	55	**11,76**	64	10	55
20.45												
20.46	**6,240**	16	10	40								
21.00												
21.15	**0,105**	3	25									
21.30	**6,240**	16	10	40	**12,04**	48	40		**24,08**	96	40	
21.35												
21.45												
Qref	**24,530**				**46,760**				**93,520**			

9 Test procedures

9.1 Standard Test Procedure

9.1.1 Introduction

The following subclauses describe the test procedure to establish the electricity consumption Q_{elec} during a 24 h test.

9.1.2 Installation

Install product in test environment according to manufacturer's instructions.

Designated floor-standing appliances are to be placed on a floor with low thermal leakage (e.g. 20 mm thick medium density fibreboard could be placed under the test object at a distance of 100 mm above the floor of the test room).

Wall-mounted products shall be mounted on a panel at least 150 mm from any structural wall with a free space of at least 250 mm above and below the product and at least 700 mm to the sides. Products designated to be built-in shall be mounted according to manufacturer's instructions.

Products with declared Load Profiles 3XL and/or 4XL may be tested on-site, provided test conditions are equivalent, possibly with correction factors, to the ones referenced here.