RESEARCH AND TESTING CENTER FOR THERMAL SOLAR SYSTEMS
Institute for Thermodynamics and Thermal Engineering
University of Stuttgart

in cooperation with

Store Test Report
Hot water store
Determination of the standing heat loss according to AS/NZS 4692.1:2005

Test Report No.: 15STO293

Stuttgart, September 10th, 2015

Claimant:	Stiebel Eltron GmbH & Co. KG Dr.-Stiebel-Strasse 33 37603 Holzminden / Germany

Manufacturer:	Stiebel Eltron GmbH & Co. KG
Type:	WWK 222 H
Construction Year:	2015

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1 Technical data[1]

Manufacturer: Stiebel Eltron GmbH & Co. KG	Type: WWK 222 H		Weight (empty): 120 kg
Year: 2015	Serial No.: 9047/500007	Nominal volume: 220 liters	Design: upright steel tank with integrated air-to-water heat pump
Performance index acc. DIN 4708: no reference	Test acc. to DIN 4753: no reference		
Corrosion protection:			enameled with anode
Max operation pressure:			8.0 bar
Max operation temperature:			65 °C
Thermal insulation: Polyurethane foam			Top: 70 mm Mantle: 70 mm Bottom: 30 mm
Heat exchangers in the store:			no internal heat exchangers except the condenser of the heat pump

[1] as stated by the manufacturer

2 Design

Connections

	Type	Application
C1	OT 1“	cold water (inlet)
C2	OT 1“	hot water (outlet)
C3	IT ¾“	one temperature / pressure relief valve
C4	OT ¾“	condenser drainage

IT = inside thread OT = outside thread

3 Test results

The measurement of the standing heat loss was performed according to AS/NZS 4692.1:2005. To reach a core temperature of 75°C ± 1 K the store was charged via an internal electrical heater (rated input: 1.8 kW) designed to heat the water from the bottom 10% of the tank volume. The store temperature was measured via 6 thermocouples in the store. The ambient temperature was measured via 3 Pt100 resistance thermometers around the store in different heights (bottom / middle / top). Table 1 shows the obtained results for 7 temperature control cycles after a stabilisation time of 50,8 h. The abbreviations are according to AS/NZS 4692.1:2005.

Table 1: Results of standing heat loss measurement according to AS/NZS 4692.1:2005 for 7 temperature control cycles

Cycle [-]	El_{in} [kWh]	T_t [°C]	T_a [°C]	t [h]	T_H [°C]	E_2 [kWh]	E_1 [kWh]	UA [kWh/(h·K)]	$Q_{loss,55}$ [kWh/24h]
1	0.493	74.41	20.38	7.170	75.41	19.246	19.228	0.001226	1.618
2	0.468	74.44	20.23	7.480	75.33	19.224	19.246	0.001208	1.595
3	0.475	74.37	20.20	7.260	75.28	19.213	19.224	0.001236	1.632
4	0.449	74.37	20.30	7.068	75.24	19.202	19.213	0.001204	1.589
5	0.446	74.34	20.32	6.854	75.20	19.192	19.202	0.001232	1.626
6	0.434	74.32	20.27	6.787	75.14	19.176	19.192	0.001227	1.620
7	0.381	74.31	20.37	6.571	74.94	19.125	19.176	0.001219	1.609

with:

El_{in} Electrical energy input over temperature control cycle according to AS/NZS 4692.1:2005, C4 [kWh]

T_t Average store temperature of all sensors over temperature control cycle [°C]

T_a Average ambient temperature over temperature control cycle [°C]

t Duration of temperature control cycle [h]

T_H Average store temperature at cut-out according to AS/NZS 4692.1:2005, B.3.3.2 [°C]

E_2 Thermal energy in the store at the end of the temperature control cycle [kWh]

E_1 Thermal energy in the store at the beginning of the temperature control cycle [kWh]

UA Heat loss rate per unit temperature difference [kWh/(h·K)]

$Q_{loss,55}$ Standing heat loss per 24 h for a 55 K temperature difference [kWh/24h]

The heat loss rate per unit temperature difference UA is calculated according to AS/NZS 4692.1:2005, C4(2):

$UA = (El_{in} - (E_2 - E_1)) / ((T_t - T_a) \cdot t)$ [kWh/(h·K)]

The standing heat loss per 24 h for a 55 K temperature difference is calculated according to AS/NZS 4692.1:2005, C4(3):

$Q_{loss,55} = UA \cdot 55 \cdot 24$ [kWh/24h]

The thermal energy in the store is calculated according to AS/NZS 4692.1:2005, C4(4):

$E = (\rho \cdot V \cdot c_p \cdot 0.001 + Y \cdot c_m) \cdot T_H / 3\,600\,000$ [kWh]

with:

V	Static capacity of the store [litres]: 219.9 l[2]
c_p	Specific heat capacity of water: 4186 J/(kg·K)[3]
Y	Mass of metal in direct contact with hot water: 45.542 kg[4]
c_m	Specific heat capacity of steel: 470 J/(kg·K)[3]
ρ	Density of water at 75 °C: 974.84 kg/m[3]

Average standing loss over 7 temperature control cycles: **1.613 kWh/24h**

Slope of the linear regression through the instantaneous heat loss values $Q_{loss,55}$: 0.009% (thermal equilibrium according to AS/NZS 4692.1:2005, C4 is reached).

[2] measured
[3] according to AS/NZS 4692.1:2005
[4] according to the manufacturer

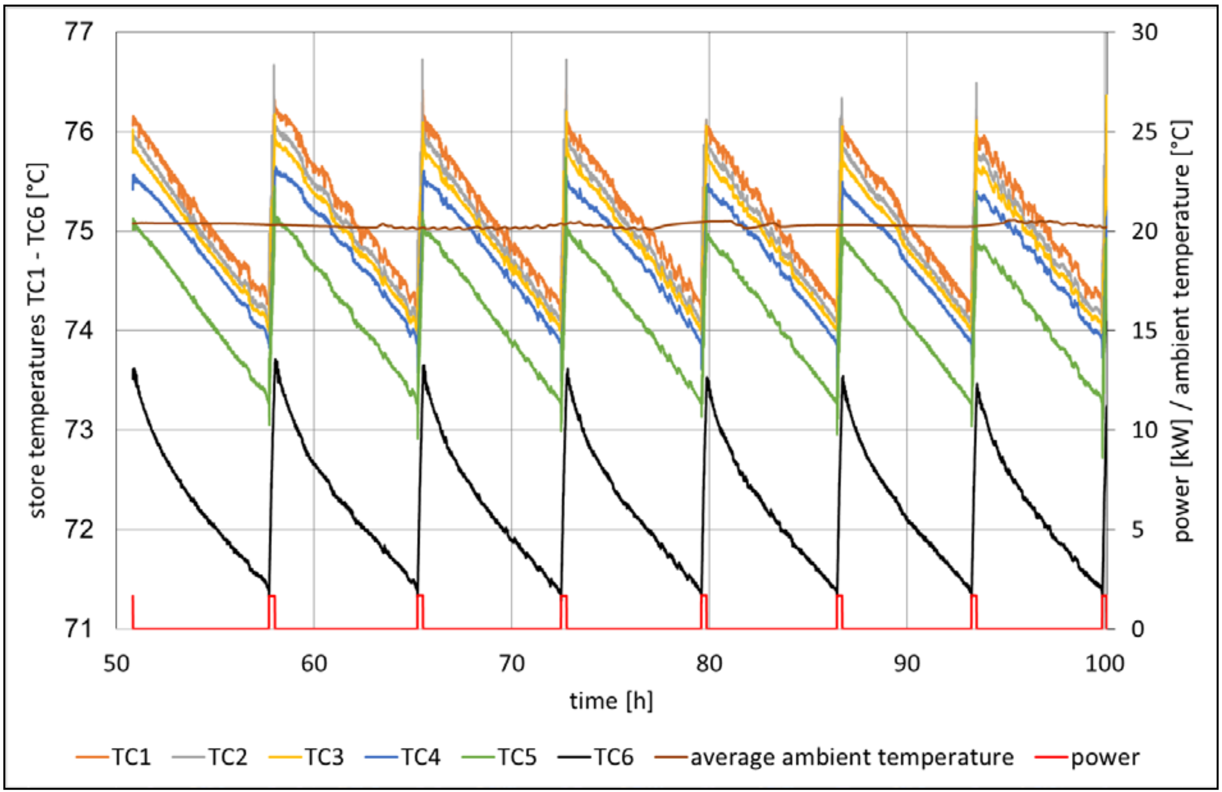

Figure 1: Temperatures and power over 7 temperature control cycles

4 Remarks

No special incidents

5 Measurement equipment

Number of test equipment	Description	Last calibration
04-021	Data logging system (Keithley)	January 2015
04-467	Data logging system (Agilent)	February 2015
99-126	Power meter (IME)	August 2015
01-664	PT100 (ambient temperature)	October 2014
01-028	PT100 (ambient temperature)	October 2014
01-640	PT100 (ambient temperature)	April 2015
none	Thermocouple TC1 – TC6 (store temperature)	August 2015

6 Test procedure

The measurement of the standing heat loss was performed according to AS/NZS 4692.1:2005 in a climate controlled room.

Water was used as a medium of heat store.

Arrival of test sample:	20.07.2015
Testing period:	26.08.2015 to 31.08.2015
Identification of test sample:	Adhesive label 15STO293
Test location	Stuttgart, Pfaffenwaldring 10, room 2.79
Test engineer:	Dipl.-Ing. S. Bachmann

Stuttgart, September 10th, 2015

Dr.-Ing. Harald Drück
- head of TZS -