HOT WATER ASSOCIATION SPECIFICATION

HWA 002:2015

Cylinders for Domestic Purposes – Heat Pumps

Specification of requirements and test methods for assessing the heat exchanger and hot water performance of cylinders designed for use with heat pumps

Version 1 : July 2015

Foreword

This publication (HWA 002:2015) has been prepared by industry experts as a new specification to cover the test requirements for cylinders to be heated by heat pumps. This is a generic test specification to be used alongside the constructional requirements of existing standards and specifications as listed below but where the typical 80^{o}C flow at 0.25 l/s provided by a fossil fuelled boiler is not appropriate.
This publication contains the relevant test data required to put additional labelling on the cylinder to indicate its likely performance when heated by a heat pump.

BS 1566	Vented Copper Cylinders
HWA 001	Vented Stainless steel Cylinders
EN 12897	Indirectly Heated Unvented Cylinders

1 Scope

This specification covers the test procedures for assessing the indirect heating performance of a heat exchanger in hot water cylinders designed for use under primary flow conditions more typical of heat pumps.
In many instances an additional heat exchanger for use with a traditional boiler may also be included in which case the “boiler” coil will be assessed and labelled under the conditions stated in the relevant standard (BS1566 , EN12879 or HWA 001).

2 Terms and Definitions

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

2.1 cylinder
cylindrical vessel for the heating and storage of hot water

2.2 nominal storage capacity (Gross capacity)
total volume of water, in litres, that can be stored in the cylinder including the volume of water in the internal primary heaters.

2.3 net storage capacity
total volume of secondary water, in litres, that can be stored in the cylinder, excluding the primary water in cylinders with internal indirect heat exchangers.

2.4 hot water capacity
maximum volume of water that can be heated by the heat sources as measured in Annex A
Where more than one heat exchanger is fitted then the hot water capacity relevant to each heat exchanger shall be required.

2.5 model range
cylinders which share the same common diameter, heat exchanger design (where applicable) and general overall configuration.

2.6 primary heater
heat exchanger/s for the transfer of heat from the primary water to the stored water.

2.7 primary water
water circulating through the primary heater .

2.9 reheat performance
primary heater performance measured in Kilowatts

3 Nominal storage capacity (Gross)

The nominal storage capacity of all cylinders shall be measured in accordance with A.3.1.1

4 Net storage capacity

The net storage capacity of all cylinders shall be measured in accordance with A.3.1.2

5 Heat exchanger hydraulic flow resistance test

The flow resistance of the heat exchanger shall be measured in accordance with A.6

6 Marking

6.1 Additional Data Label Information

In addition to the label information required by the relevant construction standards all cylinders shall have the following additional indelibly marked labelling clearly referring to its performance under this test specification . At the manufacturers option this may in done by means of a separate label :-

a) the hydraulic flow resistance of each primary heater in bars at the reheat test flow rate .
b) the reheat performance in kilowatts for each primary heater as determined in accordance with Annex A.
c) the volume of water heated by each primary heat exchanger as determined in accordance with Annex A.
d) for cylinders with additional primary heaters intended for solar use then the dedicated solar volume should be stated.

6.2 Additional Technical Information

a) In addition to the label information , the manufacturer shall make available to the purchaser, the hot water draw off characteristics in the form of a hot water draw off profile with outlet temperature plotted on the Y axis and draw off on the Y axis as described by Appendix A4 .
This information may be in the manufacturers technical literature and/or in any instruction or data sheet provided with the cylinder. See Example in Annex B

b) In addition to the label information , the manufacturer shall make available to the purchaser, the hydraulic flow resistance of the heat exchanger at at least the four flow rates as specified by A.6

This information may be in the manufacturers technical literature and/or in any instruction or data sheet provided with the cylinder.

Annex A

Type testing of cylinders for indirect hot water performance under heat pump primary flow conditions

A.1 General

This annex specifies the test requirements necessary to determine:

a) the volume of hot water heated by the coil on test.

b) the heating power of the primary heater in kW under the specific test conditions.

Where F_{pri} = Primary Flow rate in litres per second (l/s)

T_{pri} = Primary Flow temperature in Degrees C

Tc = Temperature in cylinder as measured at T2 (Fig A)

For this test F_{pri} = 0.42 l/s

T_{pri} = 55°C

Tc = 50 °C

A.2 Apparatus for performance of heat exchangers , Fig A1 is an example of the apparatus for unvented cylinders , Fig A2 is for vented cylinders.

1a ***Inlet control and expansion set*** for pressure mains connection connected to a cold water supply with a temperature not exceeding 10º C to ensure that an adequate flow (at least 0.25 l/s) is available from the cylinder.

1b ***Cold feed cistern*** connected to a cold water supply with a temperature not exceeding 10º C to ensure that an adequate flow (at least 0.25 l/s) is available from the cylinder.

2 ***Circulator*** , capable of maintaining a primary flow of (F_{pri} ± 0.01) l/s to the primary heater.

3 ***Primary Heat source*** , comprising a thermostatically controlled heat source capable of providing a primary flow temperature of (T_{pri} ± 2)º C at F_{pri} l/s to the inlet of the primary heater.

4 ***Weighing machine*** , fitted with a suitable container (with draining mechanism), capable of indicating the mass of hot water drawn off to an accuracy of ±1 %. If desired, an automatic system such as a data logger may be used to record the

temperature/draw off data. It is essential that any such equipment has an accuracy at least equal to that specified for the weighing machine and temperature sensor.

5 ***The Cylinder under test,*** *for clarity the cylinder is shown unlagged in Fig A2 , the test will normally be carried out on a factory insulated cylinder.*

FL1 , FL2 ***Flow meters,*** comprising a flow meter (FL1) calibrated for water at T_{pri}° C and accurate to ±0.01 l/s at a flow rate of 0.42 l/s. An optional second flow meter (FL2), calibrated for water at T_c °C at a flow rate of 0.25 l/s is used to speed up calibration of the test rig.

V1 , V2 ***Primary By-Pass Arrangement*** , employing two full flow lever operated, quarter turn spherical valves.

V3 , V4 ***Flow control valves*** , comprising two needle valves or similar devices for regulating the primary and secondary flows respectively.

V5 ***Outlet valve*** , A full flow lever operated, quarter turn spherical valve.

P1, P2 ***Pressure gauges*** , two pressure gauges or equivalent device/s such as a differential manometer capable of measuring the pressure drop across the primary heater to an accuracy of ±2 %.

T1, T2, T3 ***Temperature sensors*** , comprising three thermometers or thermocouple type devices capable of measuring the temperature of water to an accuracy of ±1° C. The temperature sensors shall be positioned as follows:

> **(T1)** in the primary flow pipe from the circulator to sense the primary water temperature immediately prior to the tee off to the by-pass arrangement;
>
> **(T2)** inside the cylinder either utilising the thermostat pocket intended for heat pump control use or, if no pocket fitted then at a position corresponding to its recommended position. If no recommendations are available then the position shall be 25 mm above the highest point of the heat exchanger coil.
>
> **(T3)** in the outlet pipe, no more than 150 mm downstream from the cylinder outlet, to sense the temperature of hot water leaving the cylinder;

Figure A1 Apparatus example for unvented cylinders

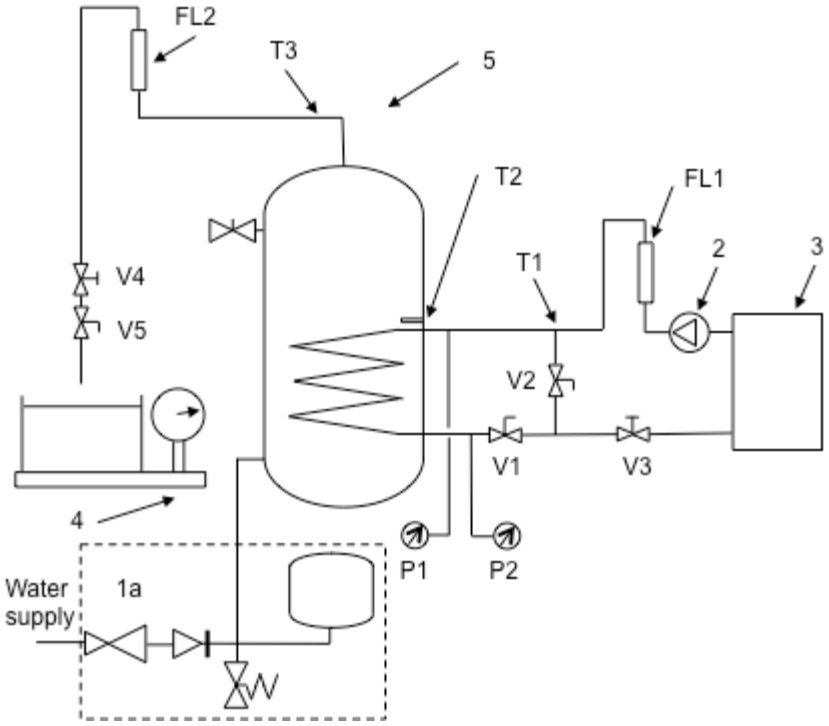
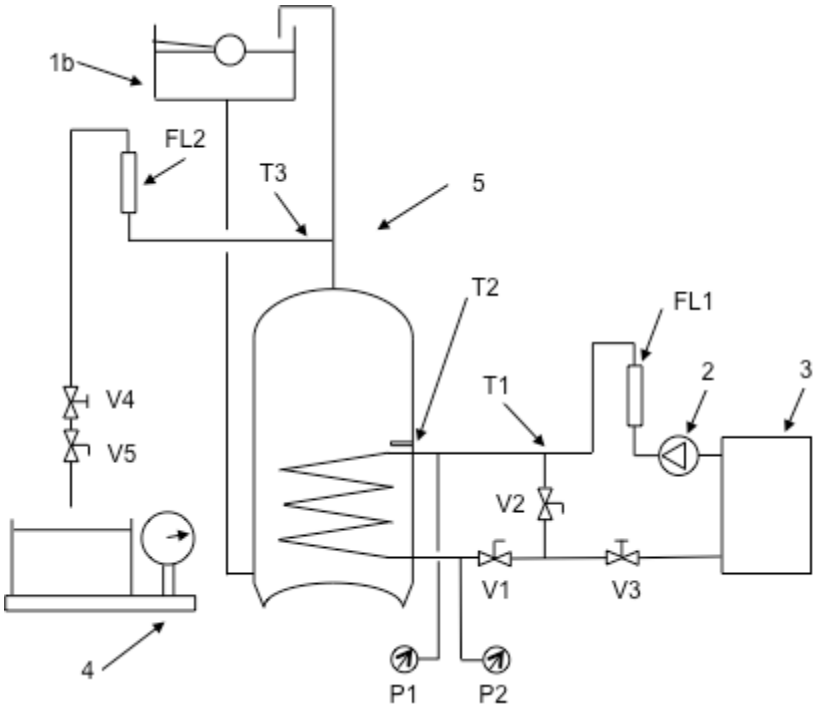


Figure A2 Apparatus example for vented cylinders



A.3 Procedure

A.3.1.1 Nominal (gross)_storage capacity

Weigh a cylinder without a primary heater (i.e equivalent direct) cylinder empty, using a weighing machine capable of indicating the mass to an accuracy of ±1 % and record the mass. Fill the cylinder with cold water until it emerges from the hot water draw off pipe and weigh the cylinder again, recording the mass. The difference in mass between the full cylinder and the empty cylinder in kilograms is deemed to be the nominal storage capacity in litres.

A.3.1.2 Net storage capacity

Weigh the empty cylinder complete with primary heater/s (if indirect) using a weighing machine capable of indicating the mass to an accuracy of ±1 % and record the mass. Fill the cylinder with cold water until it emerges from the hot water draw off pipe and weigh the cylinder again, recording the mass. The difference in mass between the full cylinder and the empty cylinder in kilograms is deemed to be the nominal storage capacity in litres.

A.3.2 Hot water performance

Set up the apparatus for testing as shown in Figure A.1

Fill the primary heater and associated primary circuit and expel all excess air.

Switch on the primary heater and allow the primary water to heat up to a flow temperature of T_{pri}º C, as measured at T1, with valves V1, V2 and V3 open and any excess air allowed to escape.

Close valve V2, leave valve V1 open and adjust valve V3 to give a primary flow rate of F_{pri} l/s through the primary heater as measured by flow meter FL1. Once this is achieved, open valve V2 and close valve V1.

Turn on the water supply to the cylinder, open valves V4 and V5 and expel any excess air from the system until water flows freely from the cylinder outlet.

With valve V5 fully open, adjust valve V4 to give a discharge flow rate of 0.25 l/s as measured either by flow meter FL2 or by timing the rate of increase in discharged water mass using a timer in conjunction with weighing machine . Once a flow rate of 0.25 l/s is achieved, close valve V5.

With valves V5 and V1 closed and V2 open, allow the primary heater to heat the primary water up to a flow temperature of T_{pri}º C.

Once stable primary conditions are established at T_{pri} °C and F_{pri} l/s, open valve V1 and then immediately close valve V2. Once the temperature of water at the thermostat position, as measured using temperature sensor T2, reaches 10º C start a timer for the reheat period. If necessary, adjust valve V3 to maintain a primary flow rate, as measured at FL1 of F_{pri} l/s.

A.3.2.1 Once the temperature of water measured using temperature sensor T2 reaches T_cº C disconnect the heat source by opening valve V2 and immediately closing valve V1. Note the time taken for the temperature to reach T_c °C and record this as the reheat time t. Allow the system to stabilize for three minutes.

Three minutes after closing valve V1 commence the draw off by opening valve V5. Measure the flow rate either by means of flow meter FL2 or by starting a timer as V5 is opened and using weighing machine W to record the mass. If necessary adjust valve V4 in order to maintain the 0.25 l/s flow rate.
Record the temperature of the water drawn off in 5 l increments at T3. Once the water temperature at T3 drops to below 40º C then at the end of the 5 l increment when this occurs, immediately close valve V5.

A.4 Hot water capacity of Indirect Cylinders

The hot water capacity is derived from the hot water draw off profile as determined by the volume of water drawn off at above 40°C, this is determined as follows .

The hot water draw off shall be plotted graphically with draw off in litres plotted in 5 l increments on the horizontal axis, and temperature at T3 on the vertical axis.
If automatic recording equipment was used, a continuous plot can be substituted for the manual 5 l incremental plot.
For the cylinder to be deemed as satisfying the requirements of this specification then at least 70 % of the net storage capacity (as measured in accordance with A.3.1.2) shall be drawn off as hot water at 40º C or above. The Hot Water capacity *Vh* is the volume drawn off before closing V5 as determined by reference to the graph of the draw off profile.

See Example in Annex B

A. 5 Reheat performance of Indirect Cylinders

The reheat performance *P*, expressed in kilowatts, is given by the equation:

$$P = \frac{(T_{av} - 10) \times Vh}{14.3 \times t}$$

Where

T_{av} is the average temperature of the water drawn off at 40º C or above, established from the graph of the draw off profile

Vh is the volume of water (in litres) drawn off at 40º C or above (Hot Water Capacity)

t is the reheat time in minutes

A.6 Hydraulic flow resistance of the heat exchanger

This test can be done using cold water at any temperature between 10°C and 20°C. Cold water shall be passed through the coil at flow rates of 10 l/m , 20 l/m , 30 l/m and 40 l/m . At each flow rate the pressure drop as determined by the difference between P1 and P2 shall be noted and the results recorded either in tabular or graphical format (see 6.2 b)

A.7 Cylinders with additional primary heaters

Where the cylinder has more than one primary heater then the hot water capacity reheat performance and pressure drop test shall be determined separately for each primary heater.

Annex B

Example of draw off profile – see 6.2 a)

In this example the hot water draw off volume is 110 litres