Technical Note			TN-024
Test: 2.13			**Test no.:** All DHW tests
Assumption: Cold water supply pressure for DHW tests.			**Assumption no: 55**
Rev: 2	**Date: 17-11-2021**	**Author:** Ian Robinson	**Checked:** Gareth Jones

1. Introduction

This technical note aims to establish whether or not there is a need to increase the dynamic cold water pressure going into the HIU for the domestic hot water performance test. If there is a requirement to raise the pressure, should the pressure be lifted across all DHW tests or just for the peak output performance test?

2. Considerations

Water authorities across the UK are obliged to provide a minimum mains cold water pressure of 1 bar g at the entry point of the building. Manufacturers should take this into consideration as heat networks are likely to expand allowing more traditional dwellings to be heated by heat network as typically seen in the suburbs of the major cities. That said, currently the vast majority of HIUs are fitted within blocks of flats where cold water is boosted within the building.

Manufacturers have been consulted via MEHNA on the need to increase the dynamic test pressure and some showed concern that increased flow rates will lead to much higher pressure drops, which could make the rig the limiting factor for their test. Others raised concerns about raising incoming cold water pressures for the test could be seen as setting a president for over engineered system designs. During the discussions it was suggested that the test reports could (if necessary) solely log the pressure drop through the unit at different flow rates as a way of preventing over engineered boosted cold water systems.

If the HIU is capable of operating at 70kW DHW output, sufficient dynamic pressure will be required to overcome the pressure drop across the HIU and rig friction losses at a flow rate of around 25 litres per minute (assume a delta T of 40K i.e. $10^{O}C$ to $50^{O}C$) otherwise the test rig will be the limiting factor of the test.

If we consider the typical pressures associated with unvented cylinders, many are supplied with approved unvented kits containing a pressure reducing valve pre-set to around 3 bar g. Although cylinders are a different technology to HIUs, the application remains the same. So as the pressure drop through a cylinder is much less than that of an HIU it could be argued that a 3 bar g test pressure is not unreasonable for HIU applications.

The BESA listed HIU manufacturer's installation literature was reviewed and in almost all cases there was no mention of DHW pressure loss and very few even stated a minimum pressure requirement.

Taking this into account, a typical plate heat exchanger used in HIUs (E8-38) performance figures were reviewed. See Figure 1 and Figure 2 below. Here you can see the pressure drop increases from 15kPa at 10 l/min to 92kPa at 25 l/min:

Figure 1 Resistance at 10 l/min [1]

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SINGLE PHASE - DESIGN SWEP SSP G8 2021.1001.1.0
HEAT EXCHANGER: E8LASHx38/1P Date: 01/11/2021

SSP Alias: E8LASW-N

DUTY REQUIREMENTS		Side 1		Side 2
Fluid		Water		Water
Flow type			Counter-Current	
Circuit		Outer		Inner
Channel		Wide		Narrow
Heat load	kW		31,18	
Inlet temperature	°C	70,00		10,00
Outlet temperature	°C	40,00		55,00
Flow rate	l/min	15,12		10,00
Pressure drop (Design PD)	kPa	12,9 (30,00)		15,8 (15,00)
Thermal length		1,386		2,079

PLATE HEAT EXCHANGER		Side 1		Side 2
Total heat transfer area	m²		0,910	
Heat flux	kW/m²		34,3	
Mean temperature difference	K		21,64	
O.H.T.C. (available/required)	W/m²,°C		4600/1580	
Pressure drop - total*	kPa	12,9		15,8
- in ports	kPa	0,604		0,260
Port diameter (up/down)	mm	16,0/16,0		16,0/16,0
Number of channels per pass		19		18
Number of plates			38	
Oversurfacing	%		190	
Fouling factor	m²,°C/kW		0,404	
Reynolds number		710,3		333,2
Port velocity (up/down)	m/s	1,25/1,25		0,829/0,829
Channel velocity	m/s	0,165		0,115
Shear stress	Pa	24,3		30,7
Average wall temperature	°C	43,85		42,56
Largest wall temperature difference	K		2,41	
Min./Max. wall temperature	°C	25,49/62,75		23,09/61,54

Excluding pressure drop in connections.

NOTES

i An AHRI model might be possible. Please contact your local SWEP sales office for more information
i This is an asymmetric model. Side 1 refers to circuit F2-F4. Side 2 refers to circuit F1-F3.

PHYSICAL PROPERTIES		Side 1		Side 2
Reference temperature	°C	55,00		32,50
Dynamic viscosity	cP	0,504		0,757
Dynamic viscosity - wall	cP	0,609		0,623
Density	kg/m³	985,7		994,9
Heat capacity	kJ/kg,°C	4,183		4,178
Thermal conductivity	W/m,°C	0,6492		0,6194
Film coefficient	W/m²,°C	9510		10500

TOTALS		Side 1		Side 2
Total weight empty (no connections)*	kg		2,55	
Total weight filled (no connections)*	kg		3,36	
Hold-up volume (Inner Circuit)	dm³		0,37	
Hold-up volume (Outer Circuit)	dm³		0,46	

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Figure 2 Resistance at 25 l/min [1]

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SINGLE PHASE - RATING SWEP SSP G8 2021.1001.1.0
HEAT EXCHANGER: E8LASHx38/1P Date: 01/11/2021

SSP Alias: E8LASW-N

DUTY REQUIREMENTS		Side 1		Side 2
Fluid		Water		Water
Flow type			Counter-Current	
Circuit		Outer		Inner
Channel		Wide		Narrow
Heat load	kW		77,94	
Inlet temperature	°C	70,00		10,00
Outlet temperature	°C	40,00		55,00
Flow rate	l/min	37,81		25,00
Thermal length		1,386		2,079

PLATE HEAT EXCHANGER		Side 1		Side 2
Total heat transfer area	m²		0,910	
Heat flux	kW/m²		85,6	
Mean temperature difference	K		21,64	
O.H.T.C. (available/required)	W/m²,°C		8210/3960	
Pressure drop - total*	kPa	71,7		92,1
- in ports	kPa	3,78		1,62
Port diameter (up/down)	mm	16,0/16,0		16,0/16,0
Number of channels per pass		19		18
Number of plates			38	
Oversurfacing	%		108	
Fouling factor	m²,°C/kW		0,128	
Reynolds number		1776		833,0
Port velocity (up/down)	m/s	3,13/3,13		2,07/2,07
Channel velocity	m/s	0,413		0,288
Shear stress	Pa	134		179
Average wall temperature	°C	44,32		42,02
Largest wall temperature difference	K		3,73	
Min./Max. wall temperature	°C	25,81/62,91		22,09/61,04

Excluding pressure drop in connections.

NOTES

i An AHRI model might be possible. Please contact your local SWEP sales office for more information
i This is an asymmetric model. Side 1 refers to circuit F2-F4. Side 2 refers to circuit F1-F3.

PHYSICAL PROPERTIES		Side 1		Side 2
Reference temperature	°C	55,00		32,50
Dynamic viscosity	cP	0,504		0,757
Dynamic viscosity - wall	cP	0,604		0,630
Density	kg/m³	985,7		994,9
Heat capacity	kJ/kg,°C	4,183		4,178
Thermal conductivity	W/m,°C	0,6492		0,6194
Film coefficient	W/m²,°C	17400		20400

TOTALS		Side 1		Side 2
Total weight empty (no connections)*	kg		2,55	
Total weight filled (no connections)*	kg		3,36	
Hold-up volume (Inner Circuit)	dm³		0,37	
Hold-up volume (Outer Circuit)	dm³		0,46	
Port size F1/P1	mm		16	

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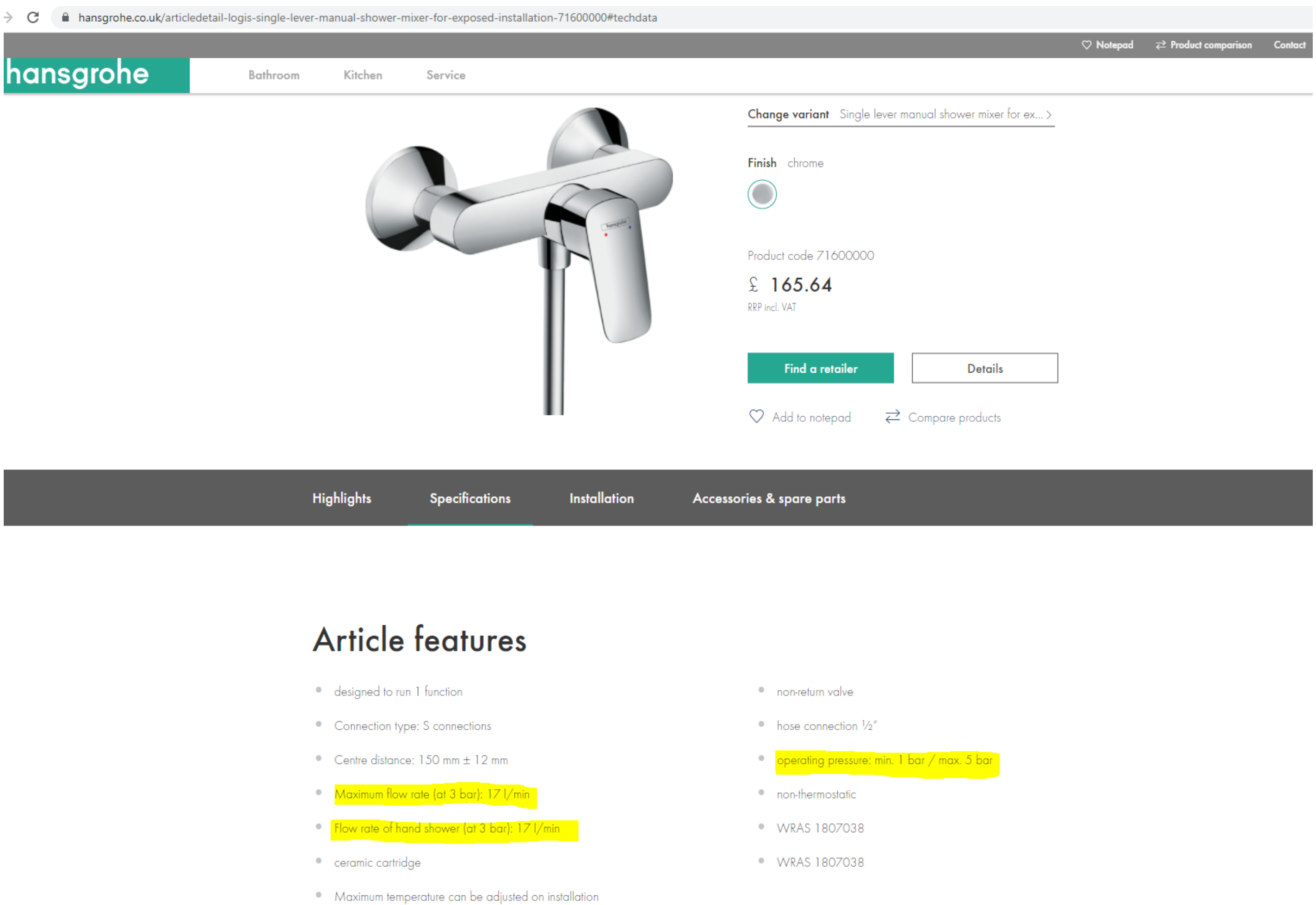
If we also consider mixer showers on the market as shown in Figure 3, there is a minimum pressure requirement of 1 bar. This means that once the incoming pressure has overcome the resistance through the HIU and downstream pipework, it has to have this pressure available at the shower mixer for it to operate correctly. As such, many installations need to be designed to these higher pressures.

Figure 3 Typical mixer shower pressure requirement [2]



3. Conclusions

The above performance reports clearly demonstrate that the resistance through the plate heat exchanger alone will be close to 100kPa (1 bar g) at 70kW. In addition to the resistance through the heat exchanger there is additional resistance to overcome through pipework, bends and fittings, hydroblocks (in some designs), cold water filters, flow meters / sensors etc within the HIU and also the downstream test rig equipment.

Although 1.5 bar g pressure may be an acceptable pressure for many products that are to be tested, there may be a number for whom DHW performance would be hampered by the capabilities of the test rig at 1.5 bar g.

As 1.5 bar g test pressure is acceptable for the lower flow rates, it could be argued that there is then a requirement for two pressure settings. One for the low flow tests 2a, 2b, 3a, 3c and one for the new performance test if it goes ahead. However, this gives the test lab more instruments to adjust during the tests. As such, it is recommended that all of these tests are carried out at a setting of 3 bar g, as this would negate this extra work.

4. Recommendation

It is recommended that the dynamic DHW test pressure is increased to 3 bar g across all hot water tests. However, to try to prevent designers overengineering the boosted mains systems, it is recommended that only the pressure drop across ΔP_3 (See Figure 4) should be logged and reported against the corresponding flow rate in the form of a graph as seen in Figure 5.

If this is done there will be three benefits:

1) Only the pressure loss through the HIU will be logged and not the incoming mains pressure.

2) All BESA tested products will have usable data available for the designers to build into their design.

3) Direct comparisons of meaningful data can be made by the designer.

Figure 4 Test Rig [3]

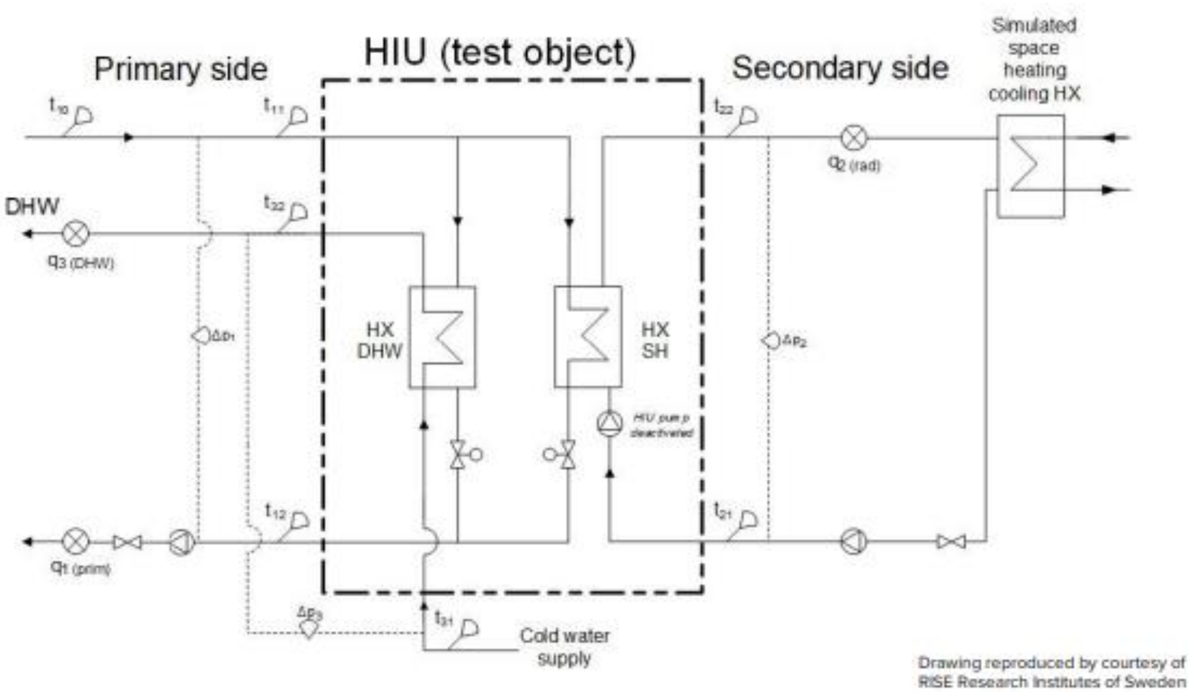
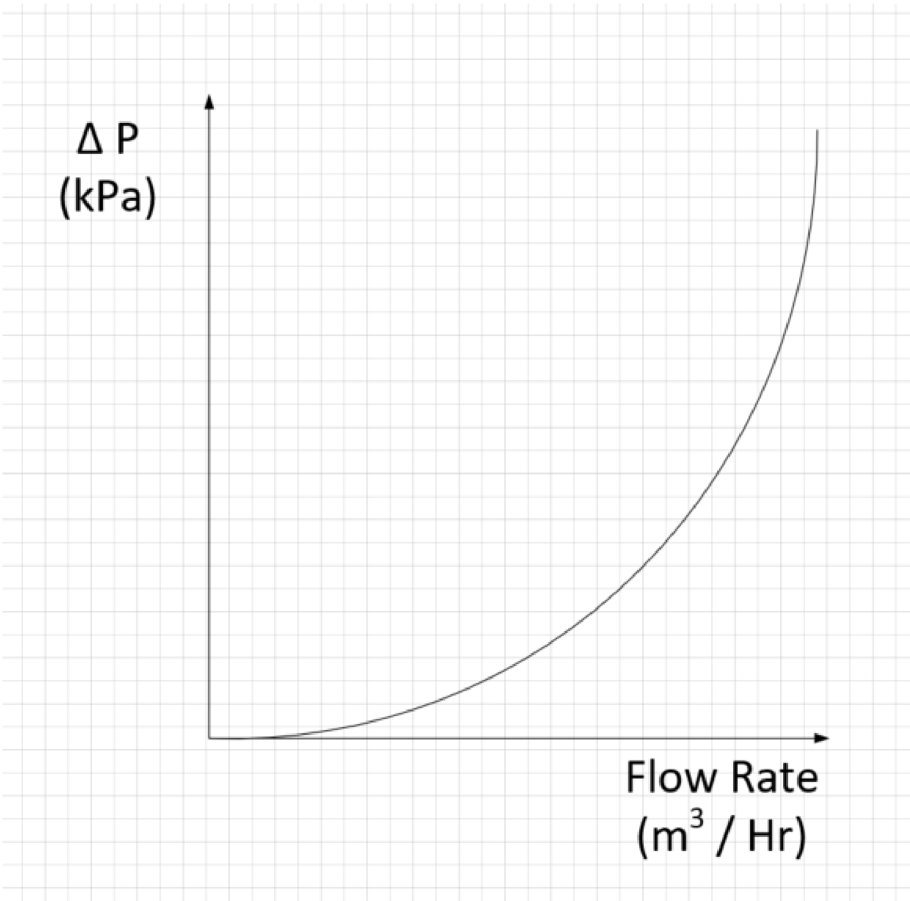
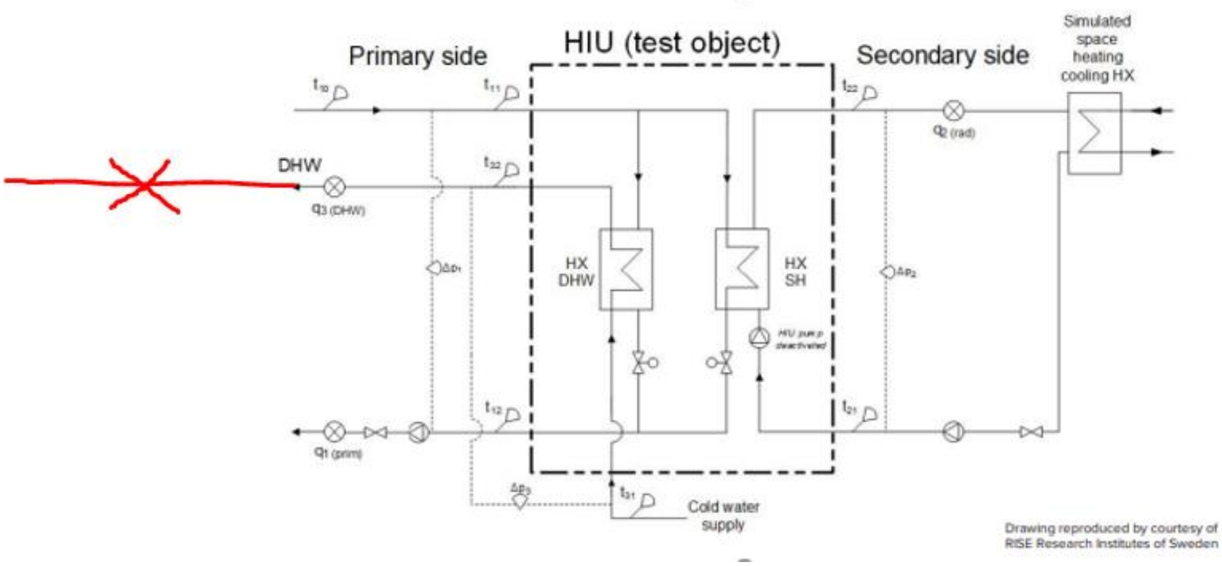


Figure 5 Proposed pressure loss graph



It is important that the regulating valve is positioned at the end of the line as shown below by the red X in Figure 6. If the adjustment valve is positioned in front of the HIU the pressure transducer that is positioned after the HIU will register a pressure close to atmospheric pressure and give a falsely low reading, resulting in an incorrect high pressure drop figure.

Figure 6 Position of flow adjustment valve



5. References

[1] SWEP plate sizing report

[2] Hansgrohe website https://www.hansgrohe.co.uk/articledetail-logis-single-lever-manual-shower-mixer-for-exposed-installation-71600000#techdata

[3] BESA HIU Test Regime Oct 2018