Energy - Docket Optical System

From: Adams, Charlie [cadams@aosmith.com]
Sent: Monday, September 08, 2014 10:15 AM
To: Energy - Docket Optical System
Cc: Adams, Charlie; Frank Stanonik; Schuh, Darrell; Chisolm, David; Perez, Ralph; Stern, Jim; Wheeler, Kevin; Gary Klein
Subject: Comments regarding the draft proposed revision to Title 24 Standard concerning residential water heaters
Attachments: Tankless Water Wastage report - Australia.pdf

To Whom It May Concern:

AOS is the leading manufacturer of residential and commercial water heating equipment in the U.S.A, and has a substantial market presence in California.

We are opposed to the proposed draft revisions for water heater coverage in Title 24 and the associated draft CASE report. We believe that there are issues of Federal Preemption, and we especially believe that some erroneous assumptions were used in the economic analysis (for example, it does NOT take a plumber to drain a storage heater for routine maintenance – it takes a garden hose).
The Air-conditioning, Heating, and Refrigeration Institute (AHRI) is the trade association representing the water heater industry, and will be submitting detailed comments pointing out several concerns with the draft provisions and report. We strongly support those comments, and will not repeat them here.
However, one issue that should be of grave concern to California, and which may not have been fully appreciated by the CEC, is that in delivering the same number of gallons of hot water for a given use, by virtue of the way they operate tankless water heaters waste water when compared to storage water heaters.
Every time a tankless heater initiates a heating cycle (whenever there is a hot-water draw), it must go through a period lasting several seconds in which it must detect-water-flow, start-combustion-blower, prove-combustion-air, warm-up/start-ignition-means, light-burner, bring-heat-exchanger-up-to-temperature, and finally, heat-water-flowing-through-unit. This period is on the order of 10 – 20 seconds, depending on the model of heater, incoming water temperature, and other external conditions. Cold water is flowing through the heater during all of this period, every time the heater is told (by a water draw) to come on. As an illustration, if this period lasts 20 seconds and the water demand is 2 gpm, there is an extra usage of 2/3 gallons of water just getting to the hot water temperature that is usable. Even if the period is 10 seconds and the demand is 1 gpm, there is an extra 1/6 gallons of wastage. Multiply such wastage by the significant number of heating cycles per day that a large number of tankless heaters that were installed because of Title 24 would represent, and it is readily seen that that a drought-ridden California cannot afford to encourage/mandate this practice through its building standards.
Attached is a 2008 report published by the Australian government that addresses this problem in more detail.
Please let me know if there are any questions.
Regards,

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Australian Government
Department of the Environment, Water, Heritage and the Arts

Water Wastage of Instantaneous Gas Water Heaters

A report for the Water Efficiency Labelling and Standards (WELS) Scheme

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Disclaimer

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For more information contact: WELS@environment.gov.au

1. Summary

Eight instantaneous gas water heaters (IGWHs) were tested, including:

- a mechanical ignition type
- a number of electronic ignition types
- types designed for external mounting
- a type designed for internal mounting
- a range of capacities
- different (current) energy star ratings types.

These IGWHs were tested to determine the quantity of water which flowed through the test unit from the time the unit was turned on until the time the flow from its outlet reached an appropriate temperature differential relative to the final steady state temperature of the water.

Each of the test water heaters were installed in accordance with the manufacturers' instructions and instrumentation appropriately connected. A data logger was used to collate the data. The test procedure which was applied closely followed the test method specified in Australian Standard
AS 4552: *Gas fired water heaters for hot water supply and/or central heating*.

The quantity of water which flowed through the test unit until the water reached a steady state temperature was measured for a variety of water temperature settings, water pressures and water flow rates. The water which was wasted was determined from the data logger information using temperature differentials of 5°C and from the average steady state temperature as the reference criteria.

The study found:

a) Instantaneous gas water heaters wasted substantial quantities of water and there were significant differences between water heaters in respect to the quantity of water wastage – enough to warrant these products being considered for inclusion in the WELS program. Under some (normal) conditions it was found that at the 5°C and 1°C temperature differentials, 64.6 L and 93.1 L of water was wasted daily.

b) The set up and test procedure for ascertaining water wastage should be the same as that specified for determining gas consumption.

c) The quantity of water wasted should be determined independent of gas consumption determinations, until there is positive evidence that water wastage, as determined from theoretical calculations using gas consumption data and that determined directly are equivalent.

d) Water wastage should be determined using at least:

   i) the maximum water flow

   ii) the highest temperatures rises obtained without and with (if available) a remote temperature controller

   iii) the standardised pressure of 320 kPa

   iv) a reference temperature differential that is 90% of the steady state temperature.

   The reference differential should not exceed 5°C.

e) To account for additional quantities of water wasted by some heaters that have a heating profile which oscillates substantially (with ever decreasing amplitude) around the steady state temperature until the steady state is reached, the water which is wasted should be determined not from a point on the initial rise of the temperature curve but from a point on the curve that is equivalent to the reference differential temperature, immediately before the steady state temperature.

f) Although the quantity of water wasted from an instantaneous water heater would be more realistically determined from data taken from a distant draw-off point (e.g. a shower that is connected to the heater via typical plumbing), rather than taken from the heater outlet itself, it is suggested that water wastage should continue to be determined from the outlet of the heater, so as to maintain parity with storage water heater procedures.

   Not all of the water will actually be wasted, as some end-uses (such as for bathtub filling or washing machines) will retain and use initial, below-temperature flows. For the purposes of the study, all wastage is assumed to go to drain. In future, monitoring of actual end use patterns is recommended in order to establish data on actual percentages of start-up losses wasted to drain.

2. Principle

The principle of this study was to assess a broad range of gas instantaneous water heaters in terms of the water which would normally be wasted while waiting for the unit to heat the water to an appropriate temperature.

The study was also to closely follow the test method specified in Australian Standard AS 4552: *Gas fired water heaters for hot water supply and/or central heating.*

Further, the study not only intended to take into consideration measurement of the water wasted as determined from the outlet of the heater, but also as determined from a distant discharge at the end of a typical plumbing pipe run connected to the water heater. The discharge included a variable flow rate device, a fixed flow rate device (a shower having flow rate of 7.5-9.0 L/min which equates to a 3 star water rating) and an unrestricted opening.

3. Products

The products in this study were selected so as to cover:

- a mechanical ignition type
- an electronic ignition type
- types designed for external mounting
- a type designed for internal mounting
- a range of capacities
- different (current) energy star ratings.

Eight products were selected for the study and were independently purchased through retail outlets. The products comprised:

- one mechanical water heater having a capacity of 16 L/min
- seven electronic water heaters, including –
    - one unit having a capacity of 26 L/min and intended for internal installation
    - six units having capacities ranging from 16 L/min to 32 L/min and each intended for external installation.

One of these units had a current gas energy rating of 6 stars.

4. Testing

4.1 Set Up

Each of the test water heaters was visually examined for any obvious defects which could affect its performance. As no defects were observed, each unit was separately mounted, in accordance with the manufacturer's instructions, onto a support rig. All adjustable controls on each of the water heaters were checked to ensure that they were within the manufacturer's recommendations.

The plumbing and instrumentation for determining water wastage was as illustrated in Figure 1 below.

To ascertain the effects of typical plumbing and pipe runs on the amount of water wasted, the outlet of the heater was connected to a 4 metre length of DN[1] 20 pipe, followed by a 1 metre length of DN 15 pipe. The end of this pipe was:

- connected to a variable flow restriction device, which would allow the flow rate to be adjusted to a minimum that would just maintain burner operation

or

- connected to a fixed flow restricted outlet (a shower rose with a flow rate of 7.5-9.0 L/min, which is intended to represent a medium flow rate)

or

- unrestricted (so as to allow maximum flow).

A high speed data logger having a sampling period of 0.2 seconds was used to record each of the following parameters:

1. time in 0.2 sec intervals
2. air temperature in °C
3. heater inlet water pressure in kPa
4. heater inlet water temperature in °C
5. heater outlet water temperature in °C
6. water flow rate in L/min
7. cumulative water volume passing through the water heater in litres.

4.2. Methodology

The study primarily focussed on determining the amount of water which was wasted during the initial warm-up of a water heater from a cold start. The methodology used to obtain water wastage data closely followed the test procedure specified in Australian Standard AS 4552: *Gas fired water heaters for hot water supply and/or central heating*.

Although AS 4552 focuses on determining the thermal efficiency of water heaters, it was noted that the Standard is currently being revised to not only more accurately determine the thermal efficiency of water heaters, but also to enable the water wastage to be calculated. As details of revised test procedures were not available, this study adhered (as closely as required) to the test procedure in AS 4552.

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[1] DN refers to nominal diameter (Diametre Nominal) in metric units (millimetres).

Following set up of the water heater and test equipment, the testing procedure was as follows.

With the water heater turned off, water from the temperature controlled tank was allowed to flow through the heater.

The water pressure and flow rate were sequentially adjusted so the water pressure was:

a) 150 kPa

b) 320 kPa

c) 500 kPa

d) 750 to 1,000 kPa.

For each of the above pressures (or as considered appropriate), the flow rate was sequentially adjusted so that outlet from the heater was directed through the:

- i) variable flow restrictor
- ii) fixed flow restrictor

or

- iii) unrestricted outlet.

For the mechanical ignition units the burner and water tap settings were each sequentially set at minimum and then maximum.

For the electronic ignition units the temperature of the water heater was also sequentially set at:

1. the water heater default temperature (i.e. the water heater temperature that is preset on the unit if no remote temperature controller is fitted)
2. 37°C via a fitted temperature controller
3. 50°C via a fitted temperature controller
4. 60°C via a fitted temperature controller

or, where appropriate,

5. 75°C via a fitted temperature controller.

The data logger was then activated, followed by the activation of the water heater, and then water at the specified outlet temperature setting, flow rate, and supply pressure was allowed to pass through the heater.

For each set of conditions indicated above, the unit was operated until a steady outlet water temperature was achieved (typically 2–3 minutes).

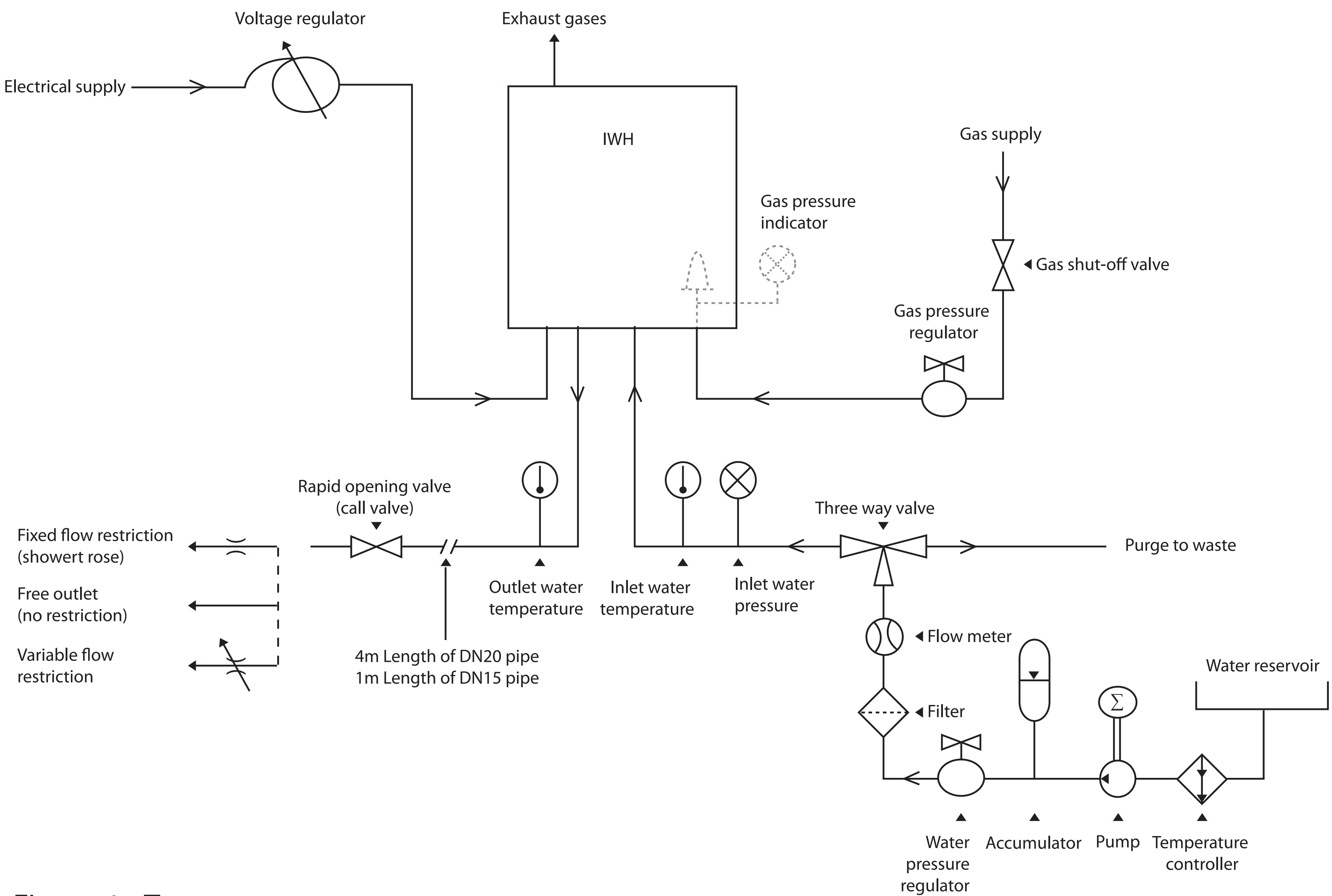


Figure 1 - Test set-up

5. Test results

5.1 Water heating profile graphs

The water heating profiles obtained for the test units in this study form three shapes.

1. A form which, within a short time period, indicates an initial sharp rise in outlet water temperature up to a point that is marginally below the steady state temperature, and then over a longer period of time the temperature rises gradually until a steady state is reached (see Figures 2 and 3 below).
2. A form which, within a short time period, indicates an initial sharp rise in outlet water temperature up to a point that marginally exceeds the steady state temperature, and then over a longer period of time the temperature either falls gradually until steady state is reached, or the temperature oscillates to below the steady state temperature then above the steady state temperature and so on (with ever decreasing amplitude) until a steady state is reached (see Figures 4 and 5 below).
3. A form where, within a short time period, there is an initial sharp rise in output water temperature up to a point that substantially exceeds the steady state temperature, and then over a longer period of time the temperature either falls gradually until steady state is reached, or the temperature oscillates to below the steady state temperature then above the steady state temperature and so on (with ever decreasing amplitude) until a steady state is reached (see Figure 6 below).

Depending on the heating profile of the water heater, the criteria selected for determining the water wastage can produce significantly different results. Clearly, an important reference is the steady state temperature, and the water wastage needs to be determined with reference to that temperature.

AS 4552 specifies an outlet water reference temperature that is:

a) 90% of the steady state temperature, for determining the heating capacity of a water heater, and

b) a temperature rise of 45°C, for determining the annual gas consumption of a water heater.

Although it was possible to use a reference temperature which was 90% of the steady state temperature for this study, it was not always possible to attain a temperature rise of 45°C because of the need to determine water wastage at lower temperature settings. As such, a 45°C rise in temperature could not be used as a reference temperature.

Since the object of this study was to gather diverse water wastage data, it was decided for simplicity to use reference temperatures that were differentials of five degrees ($t_{\Delta 5}$) and one degree ($t_{\Delta 1}$) from the steady state temperature.

FIGURE 2 – WATER HEATING PROFILE (Example 1)

TEST UNIT A – (320 kPa Min *Min* MED)

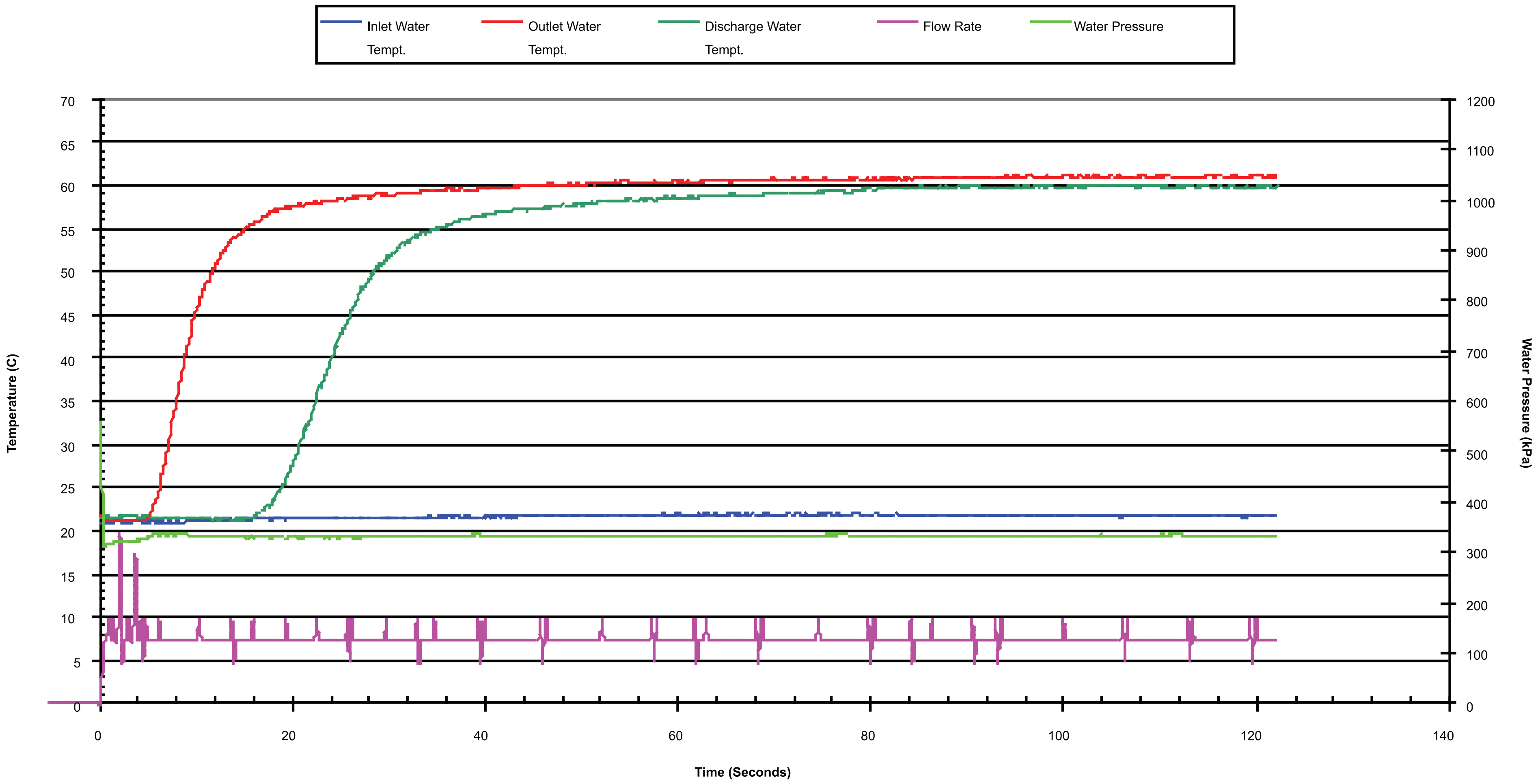


FIGURE 3 – WATER HEATING PROFILE (Detail of Example 1)

TEST UNIT A – (320 kPa Min *Min* MED)

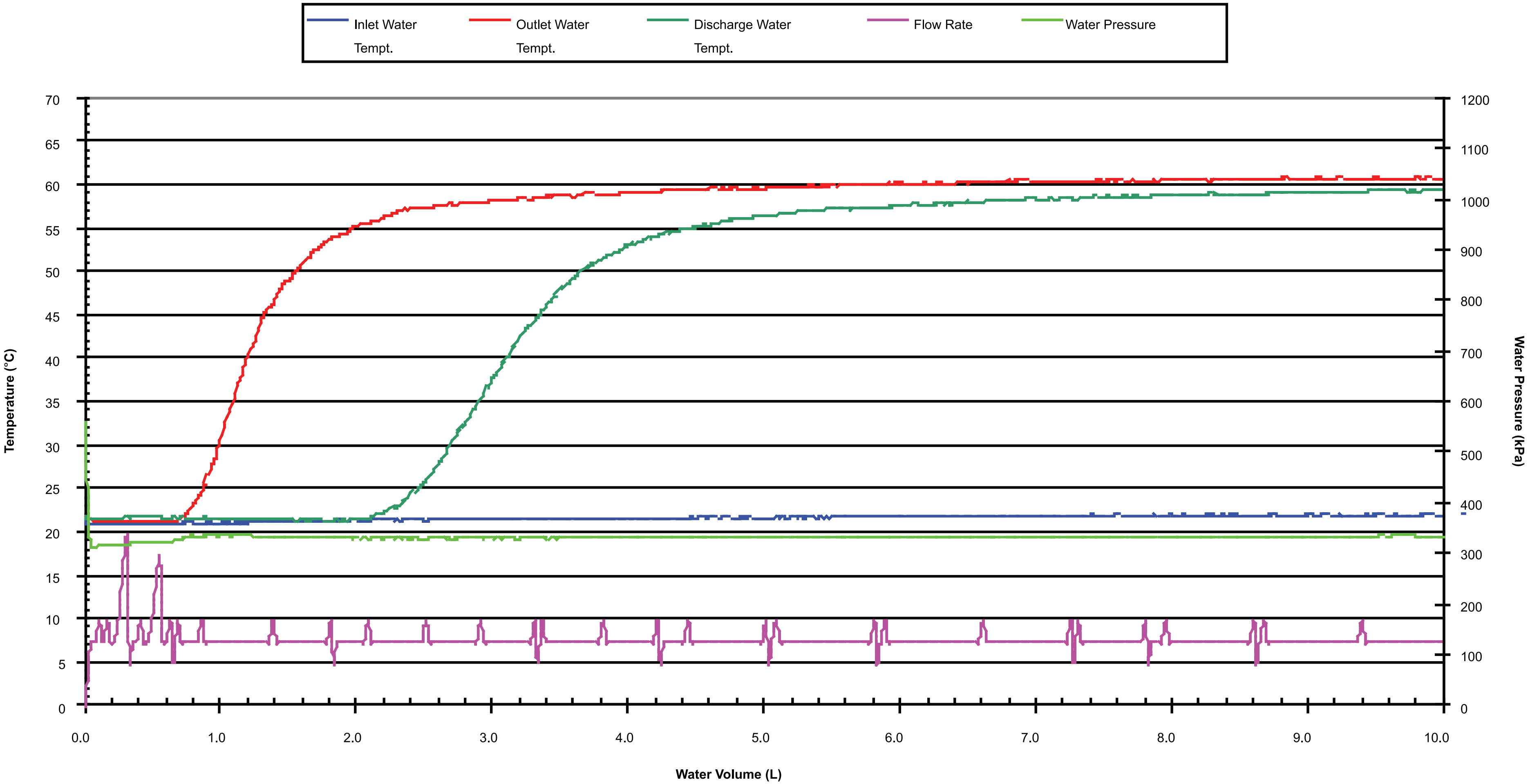


FIGURE 4 – WATER HEATING PROFILE (Example 2)

TEST UNIT B – (320 kPa, 60°C, FR_{MED})

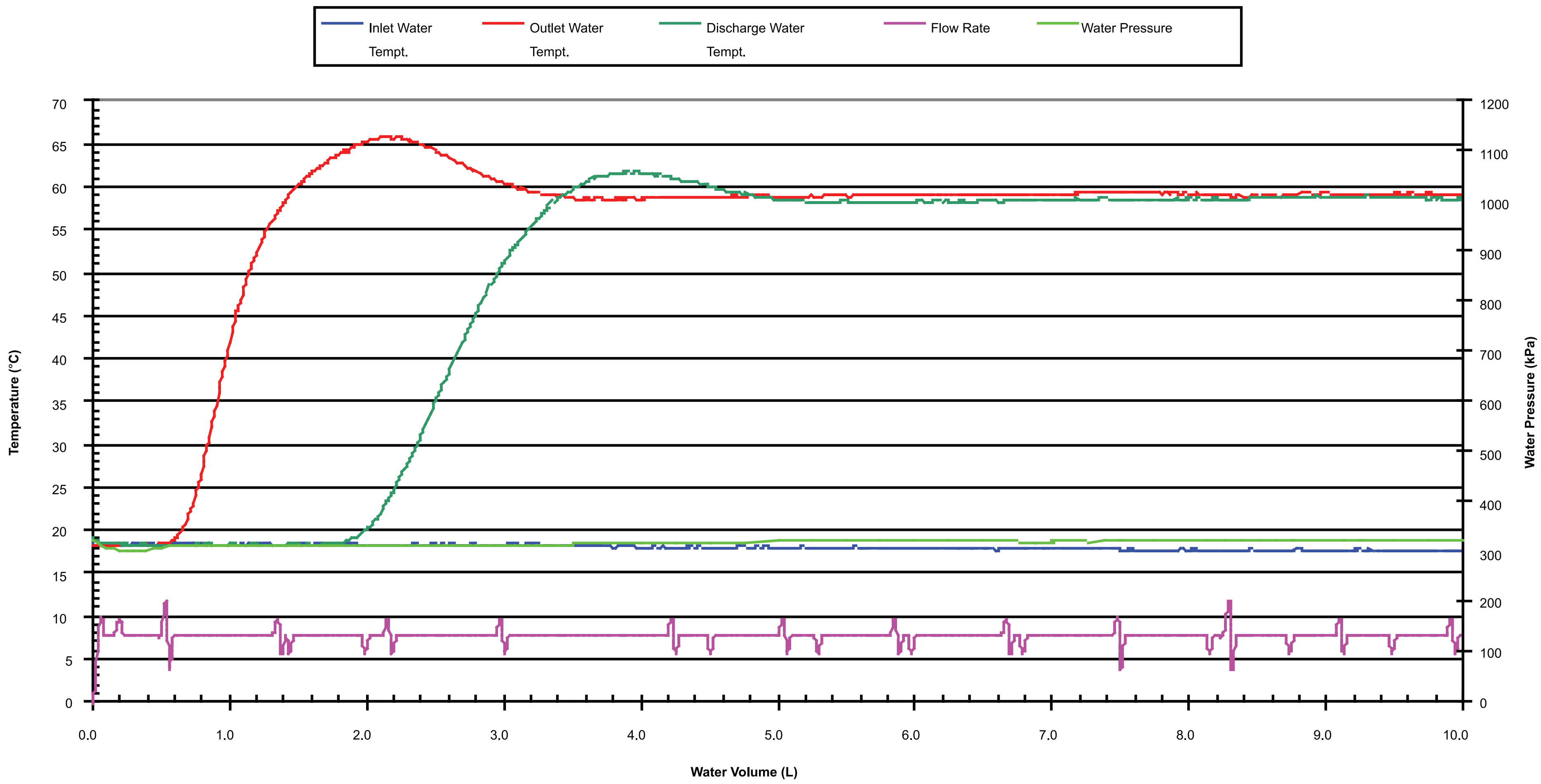


FIGURE 5 – WATER HEATING PROFILE (Example 3)

TEST UNIT E – (320 kPa, 60°C, FR_{MIN})

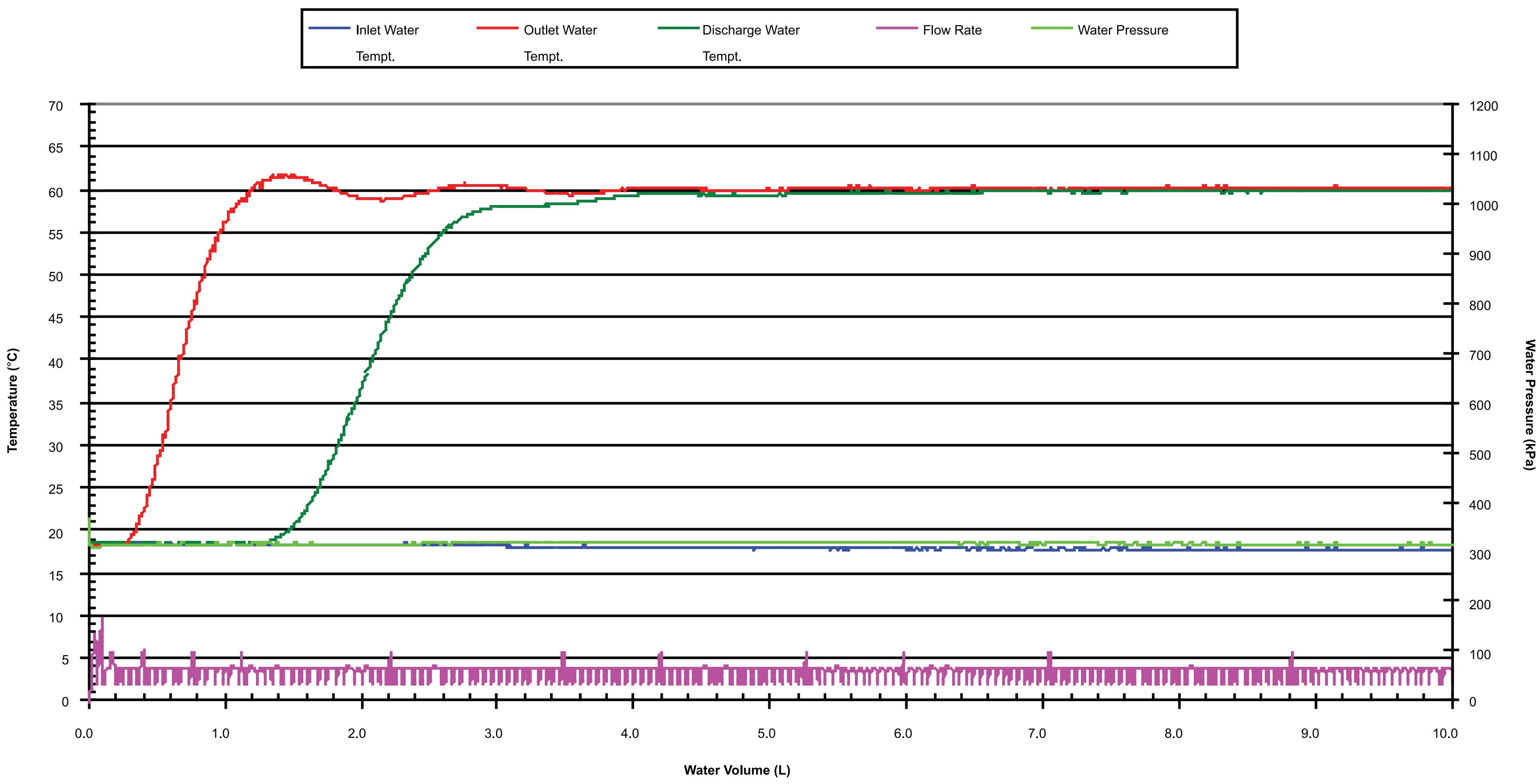
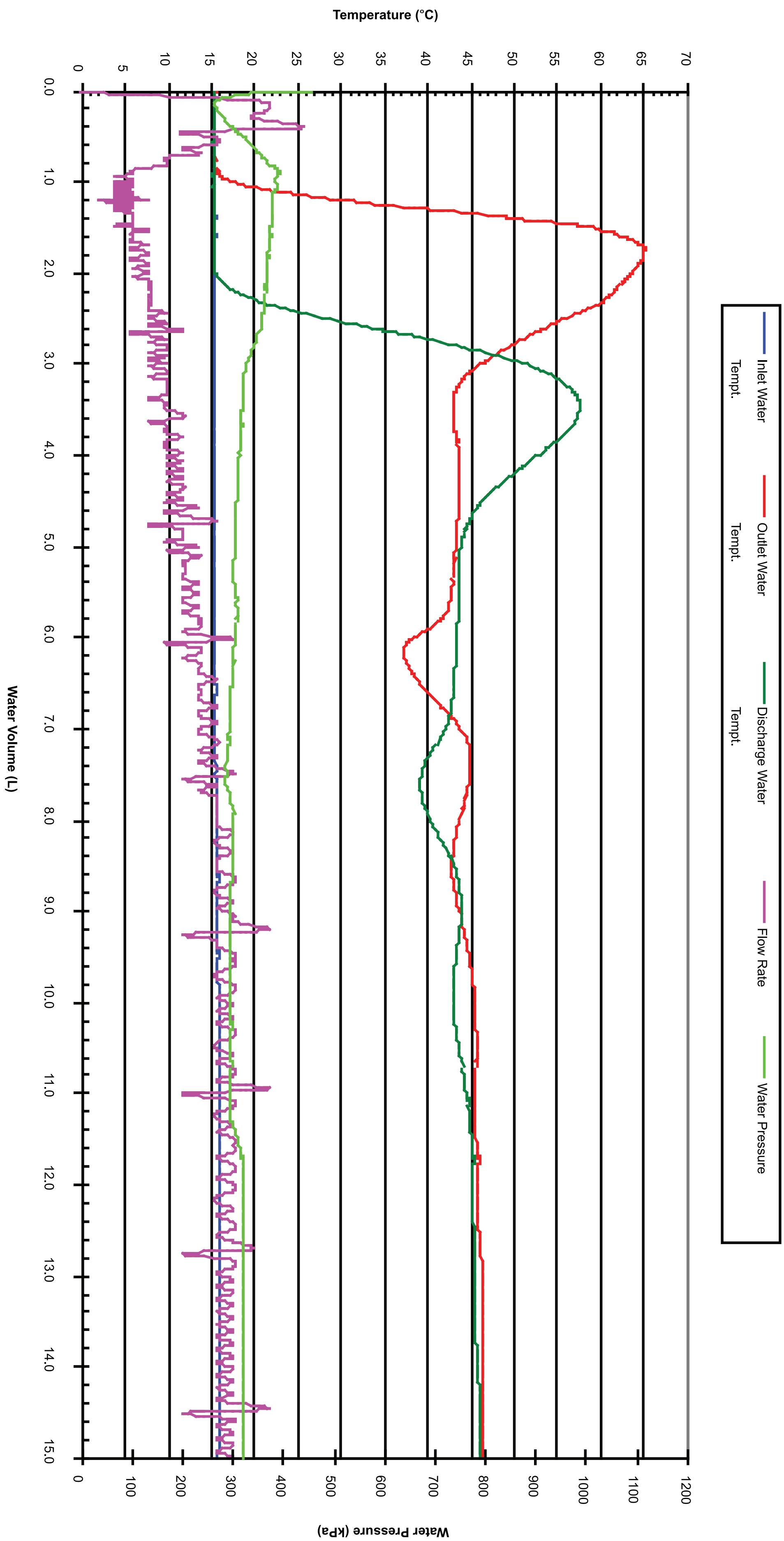


FIGURE 6 – WATER HEATING PROFILE (Example 4)

TEST UNIT D – (320 kPa, Default°C, FR_{MAX})



5.2 Water wastage tables

The water wastage values in Tables 1 to 10 are all determined relative to first occurrence of temperature differentials of 5°C (i.e. $t_{\Delta 5}$) and 1°C (i.e. $t_{\Delta 1}$) from the average steady state temperature achieved by that test product. In other words, the water wastage was the volume of water which flowed through the unit from the time the burner of the unit was activated until the temperature of the water (as recorded by the data logger) reached, on the first occurrence, the temperature differentials of 5°C and 1°C from the average steady state temperature.

Even where a test product had a water heating profile similar to that illustrated in Figure 6, the water wastage in the Tables reflect what was determined at the first occurrence of temperature differentials and not at the second (or even) third occurrence of the temperature differentials.

If taken from these subsequent points, the water wastage would have been substantially greater than that indicated in the Tables.

Table 1 indicates the average water wasted (as determined at the outlet and, in some cases, at the draw-off discharge point) for each of the products at temperature differentials of 5°C (i.e. $t_{\Delta 5}$) and 1°C (i.e. $t_{\Delta 1}$) for all tests in the appropriate tables for that product.

Table 1 also indicates a maximum quantity of water wasted that for some test settings was notably greater (by a factor of about 2 or more) than that determined for most other test settings applied to that product.

Table 2 is similar to Table 1 but it indicates the average water wasted at the outlet (and in some cases, at the draw-off discharge point) for each of the test products as determined on a daily basis, which for AS 4552 gas energy determinations is equal to 19 draw-offs.

As can be observed from Tables 1 and 2, the amount of water wasted by water heaters is substantial and varied, and as such meet the criteria for these products to be included into the WELS scheme.

It should also be noted that the actual spread of data in Tables 1 and 2 within each product and between the products is even greater than that indicated. This is because the values in these tables are the average values calculated using data obtained under all pressure, flow rate and temperature rise conditions. More accurate values can be obtained by comparing specific data in the appropriate Tables.

It should also be noted that the quantity of water wasted, as determined from a draw-off discharge, was about 1.4 to 2.7 times greater than that determined at the outlet of the product.

Clearly, plumbing from the water heater to a draw-off point has a major effect on the true quantity of water wasted.

Table 1 Water wasted per test

Water heater	Water wasted			
	At outlet		At discharge	
	$t_{\Delta 5}$ (L)	$t_{\Delta 1}$ (L)	$t_{\Delta 5}$ (L)	$t_{\Delta 1}$ (L)
Test Unit A	2.1	4.4 (max 8.0)		
Test Unit B	1.2	1.4 (max 9.7)	3.2	3.4 (max 11.6)
Test Unit C	2.5	3.4	3.9	4.9
Test Unit D	1.3	1.4 (max 5.6)		
Test Unit E	2.2	3.3		
Test Unit F	1.4	2.3		
Test Unit G	2.0	2.8		
Test Unit H	2.0	2.4		

Table 2 Water wasted daily

Water heater	Water wasted			
	At outlet		At discharge	
	$t_{\Delta 5}$ (L)	$t_{\Delta 1}$ (L)	$t_{\Delta 5}$ (L)	$t_{\Delta 1}$ (L)
Test Unit A	39.9	83.6 (max 152.0)		
Test Unit B	22.8	26.6 (max 184.3)	60.8	64.6 (max 220.4)
Test Unit C	47.5	64.6	74.1	93.1
Test Unit D	24.7	26.6 (max 106.4)		
Test Unit E	41.8	62.7		
Test Unit F	26.6	43.7		
Test Unit G	38.0	53.2		
Test Unit H	38.0	45.6		

Tables 3 to 10 indicate each of the parameter settings (i.e. pressure, flow rate, temperature/burner and water tap) and the test results obtained for each of the products.

A description of the parameters referenced in the Tables is as follows:

Burner setting	The burner setting on the test product which was adjusted to either: • minimum gas flow that that would just maintain burner operation or • maximum gas flow.
Tap setting	The tap setting on the test product which was adjusted to either: • minimum water flow that just enabled the product to continue to perform or • maximum water flow.
Pressure	The water pressure at the inlet of the water heater.
Flow rate MIN	The flow rate through a variable flow restriction at the discharge end of the water heater, which is adjusted to a minimum flow that would just maintain burner operation.
Flow rate MED	The flow rate through a fixed flow restriction which was a shower rose having a flow rate of 7.5-9.0 L/min, at the discharge end of the water heater.
Flow rate MAX	The flow rate through an unrestricted opening at the discharge end of the water heater.
T_{OUT}	The average steady state temperature of the water (in °C), at the outlet of the water heater or at the discharge.
T_{IN}	The average temperature of the water (in °C), at the inlet of the water heater.
T_{DIFF}	The difference in temperature between T_{OUT} and T_{IN}.
$WW_{\Delta 1}$	The quantity of water which flows from the water heater (in litres) from the time the unit's heater is activated to the time of the first occurrence of a temperature differential of 1°C from the average steady state temperature.
$WW_{\Delta 5}$	The quantity of water which flows from the water heater (in litres) from the time the unit's heater is activated to the time of the first occurrence of a temperature differential of 5°C from the average steady state temperature.
$t_{\Delta 1}$	The time period (in seconds), from the time the unit's heater is activated to the time of the first occurrence of a temperature differential of 1°C from the average steady state temperature.
$t_{\Delta 5}$	The time period (in seconds), from the time the unit's heater is activated to the time of the first occurrence of a temperature differential of 5°C from the average steady state temperature.
FRAV	The average flow rate of water (in litres per minute) through the water heater from the time the unit's heater is activated to at least the time the water from the heater attains a steady state temperature.

The data collected by the data logger is extensive and not all of this data is indicated in the Tables.

All data collected by the data logger will be retained for future reference, such as for recalculating the water wastage if different criteria are proposed other than that used in this study.

Further, it should be noted that the data logger collected gas consumption data for a number of test products. As such, it should be possible to calculate the water wastage using the energy method that may be proposed in the revised AS 4552, in order to correlate that determination with the water wastage determined in this study.

6. Conclusions and recommendations

a) Even though the data in Tables 1 and 2 indicate average quantities of water wasted for each of the units when subjected to a variety of temperatures, pressures and flow rate settings, from Table 3 it is particularly clear that:

   i) instantaneous gas water heaters waste substantial quantities of water

   ii) there are significant differences in water wastage from different water heaters.

   Specific data in Tables 3 to 10 indicate even greater water wastages. For example, Table 5 indicates wastages of 3.4 L at $t_{\Delta 5}$ and 4.9 L at $t_{\Delta 5}$. This translates to being 64.6 L and 93.1 L of water wasted daily.

   In view of the large quantities of water which are wasted and the range of wastage between different products, it is proposed that gas instantaneous water heaters be considered for inclusion into the WELS program.

b) While it is recommended that the set up and test procedure for determining water wastage should be the same as that for determining gas consumption, it is not recommended that the actual water wastage determination at this stage be calculated from the gas consumption determinations. This is because the gas consumption determination is ascertained from data obtained after the water temperature from the heater attains steady state conditions whereas the water that is run to waste occurs before (i.e. while waiting for) the water temperature from the heater attains steady state conditions. Unless such an anomaly can be reconciled, any proposed theoretical calculation of water wastage using the gas consumption data would need to be corroborated with the direct water wastage determination.

c) It is recommended that the reference temperature differential from the steady state temperature which is selected for determining water wastage should preferably be the same as that specified in the revised method for determining gas consumption, when this is published. Preferably, to maintain proportionality, the reference temperature differential should be a percentage of the steady state temperature. The current AS 4552 uses 90% of the steady state temperature for determining the heat capacity of a water heater and this percentage is recommended for determining water wastage. The reference differential should not exceed 5°C.

d) It is recommended that water wastage be determined from a point on the heating profile curve that is equivalent to the reference differential temperature immediately before the steady state temperature and not from a point on the initial temperature rise. This procedure would not affect the determination of water wastage results obtained from products that had heating profile curves shown in Figures 2 to 5. However, it would take account of the additional water that would be wasted by products which had a heating profile curve similar to that indicated in Figure 6, where the initial temperature rise substantially exceeds the steady state temperature and then oscillates around the steady state temperature for a protracted period before reaching steady state. In other words, the procedure would take account of water that is at a temperature higher than that required (and could cause scalding) which is just as unusable as water that is too cold.

e) As is evident from the data in Tables 3 to 10:

- o The time taken for the water to attain a steady state temperature reduces (for the same water pressure and target temperature) as the flow rate increases.

  However, as is also evident from the same tables, although the time period is reduced the quantity of water wastage increases as the flow rate increases.

  Since user behaviour would tend to turn a tap or shower on fully to minimise waiting time (and thereby increase water wastage) water heaters should include determinations of water wastage at full flow. It is recommended that water wastage determinations be at conducted at maximum water flow.

- o As the difference in water temperatures at the outlet and the inlet (i.e. T_{DIFF} in Tables 3 to 10) increases, the water wastage also increases. As such, water wastage determinations should include determinations at the higher temperatures. It is therefore recommended that water wastage determinations should include determinations at default temperature where no remote temperature controller is available, or the default temperature or 50°C (whichever is the greater) for units where a remote temperature controller is available.

f) Good reasons exist why water wastage should be determined from the end of a draw-off discharge that is connected to the water heater via typical plumbing. These include not only that the arrangement more closely represents an in-use situation but plumbing has a dampening affect on water temperature as it absorbs some of the heat energy from the heated water. Such dampening is advantageous for products which have heating profiles such as that indicated in Figure 6, as it would reduce the risk of serious scalding. However, as indicated in Tables 1 and 2, water wastage values from a connected discharge are substantially greater than those determined directly from the water heater outlet.

If it was suggested that the water wastage for instantaneous gas water heaters be determined relative to a distant draw-off discharge, and it was argued such a determination would not disadvantage any manufacturers/suppliers because all would need to comply to the same requirements, there would be substantial resistance to such an approach. This would primarily be because manufacturers and suppliers of instantaneous gas water heaters would consider such an approach as being a disadvantage when such water wastage figures are compared with those of storage water heaters.

Therefore, it is recommended that unless there is parity between the test procedure of instantaneous water heaters and storage water heaters the determination of water wastage from instantaneous gas water heaters should be, at this time, from the outlet of the water heater.

Water wastage – instantaneous gas water heaters

Table 3 – Test unit A (p. 1/4)

Pressure (kPa)	Flow rate setting	Burner setting							
		Min				Max			
		Tap setting							
		Min		Max		Min		Max	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min			T_{out} = 50.3°C T_{in} = 21.7°C T_{diff} = 28.6°C $WW_{\Delta 5}$ = 1.4 L $t_{\Delta 5}$ = 19.5 sec $WW_{\Delta 1}$ = 6.0 L $t_{\Delta 1}$ = 82.5 sec FR_{AV} = 4.4 L/min				T_{out} = 52.2°C T_{in} = 22.3°C T_{diff} = 29.9°C $WW_{\Delta 5}$ = 1.5 L $t_{\Delta 5}$ = 19 sec $WW_{\Delta 1}$ = 4.6 L $t_{\Delta 1}$ = 61 sec FR_{AV} = 4.3 L/min	
	Med	T_{out} = 63.8°C T_{in} = 20.9°C T_{diff} = 42.7°C $WW_{\Delta 5}$ = 2.2 L $t_{\Delta 5}$ = 18 sec $WW_{\Delta 1}$ = 7.3 L $t_{\Delta 1}$ = 61 sec FR_{AV} = 7.1 L/min		T_{out} = 47.4°C T_{in} = 21.8°C T_{diff} = 25.6°C $WW_{\Delta 5}$ = 1.7 L $t_{\Delta 5}$ = 15 sec $WW_{\Delta 1}$ = 4.1 L $t_{\Delta 1}$ = 35 sec FR_{AV} = 6.9 L/min		T_{out} = 76.8°C T_{in} = 21.3°C T_{diff} = 55.5°C $WW_{\Delta 5}$ = 2.3 L $t_{\Delta 5}$ = 19 sec $WW_{\Delta 1}$ = 4.8 L $t_{\Delta 1}$ = 41 sec FR_{AV} = 7.0 L/min		T_{out} = 47.8°C T_{in} = 21.4°C T_{diff} = 26.4°C $WW_{\Delta 5}$ = 1.6 L $t_{\Delta 5}$ = 14 sec $WW_{\Delta 1}$ = 5.6 L $t_{\Delta 1}$ = 47 sec FR_{AV} = 7.2 L/min	
	Max	T_{out} = 63.0°C T_{in} = 21.4°C T_{diff} = 41.6°C $WW_{\Delta 5}$ = 2.1 L $t_{\Delta 5}$ = 16 sec $WW_{\Delta 1}$ = 5.2 L $t_{\Delta 1}$ = 41 sec FR_{AV} = 7.3 L/min		T_{out} = 45.4°C T_{in} = 20.6°C T_{diff} = 24.8°C $WW_{\Delta 5}$ = 2.0 L $t_{\Delta 5}$ = 10 sec $WW_{\Delta 1}$ = 3.9 L $t_{\Delta 1}$ = 19 sec FR_{AV} = 12.0 L/min		T_{out} = 75.5°C T_{in} = 21.7°C T_{diff} = 53.8°C $WW_{\Delta 5}$ = 2.3 L $t_{\Delta 5}$ = 17 sec $WW_{\Delta 1}$ = 4.5 L $t_{\Delta 1}$ = 35 sec FR_{AV} = 7.3 L/min		T_{out} = 52.9°C T_{in} = 20.9°C T_{diff} = 32.0°C $WW_{\Delta 5}$ = 2.6 L $t_{\Delta 5}$ = 12 sec $WW_{\Delta 1}$ = 8.0 L $t_{\Delta 1}$ = 38 sec FR_{AV} = 11.6 L/min	

Water wastage – instantaneous gas water heaters

Table 3 – Test unit A (p. 2/4)

Pressure (kPa)	Flow rate setting	Burner setting							
		Min				Max			
		Tap setting							
		Min		Max		Min		Max	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 81.3°C T_{in} = 22.0°C T_{diff} = 59.4°C $WW_{\Delta 5}$ = 2.3 L $t_{\Delta 5}$ = 42.5 sec $WW_{\Delta 1}$ = 6.4 L $t_{\Delta 1}$ = 109 sec FR_{AV} = 3.6 L/min		T_{out} = 47.8°C T_{in} = 20.9°C T_{diff} = 26.9°C $WW_{\Delta 5}$ = 1.5 L $t_{\Delta 5}$ = 17 sec $WW_{\Delta 1}$ = 3.8 L $t_{\Delta 1}$ = 42 sec FR_{AV} = 5.2 L/min				T_{out} = 49.7°C T_{in} = 20.4°C T_{diff} = 29.3°C $WW_{\Delta 5}$ = 1.5 L $t_{\Delta 5}$ = 17 sec $WW_{\Delta 1}$ = 4.0 L $t_{\Delta 1}$ = 45 sec FR_{AV} = 5.1 L/min	
	Med	T_{out} = 61.0°C T_{in} = 21.9°C T_{diff} = 39.1°C $WW_{\Delta 5}$ = 2.2 L $t_{\Delta 5}$ = 16 sec $WW_{\Delta 1}$ = 5.4 L $t_{\Delta 1}$ = 43 sec FR_{AV} = 7.5 L/min		T_{out} = 48.6°C T_{in} = 21.6°C T_{diff} = 27.0°C $WW_{\Delta 5}$ = 2.4 L $t_{\Delta 5}$ = 17 sec $WW_{\Delta 1}$ = 4.4 L $t_{\Delta 1}$ = 32 sec FR_{AV} = 7.9 L/min		T_{out} = 74.3°C T_{in} = 21.9°C T_{diff} = 52.4°C $WW_{\Delta 5}$ = 2.7 L $t_{\Delta 5}$ = 20 sec $WW_{\Delta 1}$ = 4.6 L $t_{\Delta 1}$ = 35 sec FR_{AV} = 7.4 L/min		T_{out} = 51.0°C T_{in} = 21.3°C T_{diff} = 29.7°C $WW_{\Delta 5}$ = 1.8 L $t_{\Delta 5}$ = 13 sec $WW_{\Delta 1}$ = 4.6 L $t_{\Delta 1}$ = 35 sec FR_{AV} = 7.7 L/min	
	Max	T_{out} = 61.7°C T_{in} = 21.7°C T_{diff} = 40.0°C $WW_{\Delta 5}$ = 2.2 L $t_{\Delta 5}$ = 16 sec $WW_{\Delta 1}$ = 5.8 L $t_{\Delta 1}$ = 44 sec FR_{AV} = 7.4 L/min		T_{out} = 43.3°C T_{in} = 20.9°C T_{diff} = 22.4°C $WW_{\Delta 5}$ = 2.2 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 3.2 L $t_{\Delta 1}$ = 13 sec FR_{AV} = 13.4 L/min		T_{out} = 74.3°C T_{in} = 21.6°C T_{diff} = 52.7°C $WW_{\Delta 5}$ = 2.4 L $t_{\Delta 5}$ = 16 sec $WW_{\Delta 1}$ = 4.3 L $t_{\Delta 1}$ = 31 sec FR_{AV} = 7.4 L/min		T_{out} = 50.3°C T_{in} = 20.7°C T_{diff} = 29.6°C $WW_{\Delta 5}$ = 2.7 L $t_{\Delta 5}$ = 10 sec $WW_{\Delta 1}$ = 4.7 L $t_{\Delta 1}$ = 20 sec FR_{AV} = 13.4 L/min	

Water wastage – instantaneous gas water heaters

Table 3 – Test unit A (p. 3/4)

Pressure (kPa)	Flow rate setting	Burner setting							
		Min				Max			
		Tap setting							
		Min		Max		Min		Max	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min			T_{out} = 50.5°C T_{in} = 21.8°C T_{diff} = 28.7°C $WW_{\Delta 5}$ = 1.6 L $WW_{\Delta 1}$ = 4.0 L FR_{AV} = 4.3 L/min		T_{out} = 92.4°C T_{in} = 21.8°C T_{diff} = 70.6°C $WW_{\Delta 5}$ = 2.6 L $WW_{\Delta 1}$ = 6.2 L FR_{AV} = 4.2 L/min			
	Med	T_{out} = 50.2°C T_{in} = 17.4°C T_{diff} = 32.8°C $WW_{\Delta 5}$ = 2.1 L $WW_{\Delta 1}$ = 6.3 L FR_{AV} = 7.2 L/min				T_{out} = 70.0°C T_{in} = 16.4°C T_{diff} = 53.6°C $WW_{\Delta 5}$ = 2.5 L $WW_{\Delta 1}$ = 3.8 L FR_{AV} = 7.2 L/min		T_{out} = 46.8°C T_{in} = 16.5°C T_{diff} = 30.3°C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 3.3 L FR_{AV} = 7.5 L/min	
	Max	T_{out} = 48.6°C T_{in} = 16.6°C T_{diff} = 31.9°C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 2.6 L FR_{AV} = 7.4 L/min		T_{out} = 35.2°C T_{in} = 17.5°C T_{diff} = 17.8°C $WW_{\Delta 5}$ = 2.2 L $WW_{\Delta 1}$ = 4.0 L FR_{AV} = 13.5 L/min		T_{out} = 68.7°C T_{in} = 16.6°C T_{diff} = 52.1°C $WW_{\Delta 5}$ = 2.4 L $WW_{\Delta 1}$ = 4.0 L FR_{AV} = 7.4 L/min		T_{out} = 42.6°C T_{in} = 15.1°C T_{diff} = 27.5°C $WW_{\Delta 5}$ = 2.6 L $WW_{\Delta 1}$ = 3.8 L FR_{AV} = 14.3 L/min	

Water wastage – instantaneous gas water heaters

Table 3 – Test unit A (p. 4/4)

Pressure (kPa)	Flow rate setting	Burner setting: Min				Burner setting: Max			
		Tap setting: Min		Tap setting: Max		Tap setting: Min		Tap setting: Max	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
800	Min								
	Med	T_{out} = 48.8°C T_{in} = 17.3°C T_{diff} = 31.5°C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 3.5 L FR_{AV} = 7.4 L/min		T_{out} = 41.2°C T_{in} = 17.3°C T_{diff} = 23.8°C $WW_{\Delta 5}$ = 1.7 L $WW_{\Delta 1}$ = 3.4 L FR_{AV} = 7.9 L/min		T_{out} = 68.7°C T_{in} = 16.9°C T_{diff} = 51.8°C $WW_{\Delta 5}$ = 2.1 L $WW_{\Delta 1}$ = 3.2 L FR_{AV} = 7.4 L/min		T_{out} = 46.0°C T_{in} = 16.0°C T_{diff} = 30.0°C $WW_{\Delta 5}$ = 2.4 L $WW_{\Delta 1}$ = 3.1 L FR_{AV} = 7.6 L/min	
	Max	T_{out} = 47.5°C T_{in} = 16.6°C T_{diff} = 30.9°C $WW_{\Delta 5}$ = 2.2 L $WW_{\Delta 1}$ = 4.1 L FR_{AV} = 7.5 L/min		T_{out} = 32.5°C T_{in} = 15.6°C T_{diff} = 16.9°C $WW_{\Delta 5}$ = 2.2 L $WW_{\Delta 1}$ = 3.8 L FR_{AV} = 14.1 L/min		T_{out} = 68.6°C T_{in} = 17.0°C T_{diff} = 51.6°C $WW_{\Delta 5}$ = 2.4 L $WW_{\Delta 1}$ = 3.2 L FR_{AV} = 7.4 L/min		T_{out} = 43.2°C T_{in} = 15.9°C T_{diff} = 27.3°C $WW_{\Delta 5}$ = 2.6 L $WW_{\Delta 1}$ = 3.9 L FR_{AV} = 14.2 L/min	

Water wastage – instantaneous gas water heaters

Table 4 – Test unit B (p. 1/5)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min										
	Med										
	Max			T_{out} = 47.5°C T_{in} = 15.3°C T_{diff} = 32.2°C $WW_{\Delta 5}$ = 1.2 L $t_{\Delta 5}$ = 8 sec $WW_{\Delta 1}$ = 1.3 L $t_{\Delta 1}$ = 9 sec FR_{AV} = 8.6 L/min							

Water wastage – instantaneous gas water heaters

Table 4 – Test unit B (p. 2/5)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 37.1°C T_{in} = 16.6°C T_{diff} = 20.5°C $WW_{\Delta5}$ = 0.7 L $t_{\Delta5}$ = 12 sec $WW_{\Delta1}$ = 0.7 L $t_{\Delta1}$ = 13.5 sec FR_{AV} = 3.4 L/min	T_{out} = 36.7°C T_{in} = 16.6°C T_{diff} = 20.1°C $WW_{\Delta5}$ = 2.4 L $t_{\Delta5}$ = 43 sec $WW_{\Delta1}$ = 2.8 L $t_{\Delta1}$ = 50 sec FR_{AV} = 3.4 L/min	T_{out} = 47.3°C T_{in} = 18.1°C T_{diff} = 29.3°C $WW_{\Delta5}$ = 0.8 L $t_{\Delta5}$ = 13 sec $WW_{\Delta1}$ = 0.9 L $t_{\Delta1}$ = 15 sec FR_{AV} = 3.6 L/min		T_{out} = 49.8°C T_{in} = 15.8°C T_{diff} = 34.0°C $WW_{\Delta5}$ = 1.0 L $t_{\Delta5}$ = 18 sec $WW_{\Delta1}$ = 1.3 L $t_{\Delta1}$ = 24 sec FR_{AV} = 3.4 L/min		T_{out} = 59.3°C T_{in} = 17.5°C T_{diff} = 41.8°C $WW_{\Delta5}$ = 0.9 L $t_{\Delta5}$ = 17 sec $WW_{\Delta1}$ = 1.0 L $t_{\Delta1}$ = 19 sec FR_{AV} = 3.3 L/min		T_{out} = 73.4°C T_{in} = 14.6°C T_{diff} = 58.8°C $WW_{\Delta5}$ = 1.4 L $t_{\Delta5}$ = 25 sec $WW_{\Delta1}$ = 1.9 L $t_{\Delta1}$ = 35 sec FR_{AV} = 3.3 L/min	
	Med	T_{out} = 37.1°C T_{in} = 17.9°C T_{diff} = 19.2°C $WW_{\Delta5}$ = 1.1 L $t_{\Delta5}$ = 8 sec $WW_{\Delta1}$ = 1.4 L $t_{\Delta1}$ = 11 sec FR_{AV} = 7.5 L/min	T_{out} = 36.9°C T_{in} = 17.9°C T_{diff} = 19.0°C $WW_{\Delta5}$ = 2.9 L $t_{\Delta5}$ = 22 sec $WW_{\Delta1}$ = 3.5 L $t_{\Delta1}$ = 26 sec FR_{AV} = 7.5 L/min	T_{out} = 47.4°C T_{in} = 14.4°C T_{diff} = 33.0°C $WW_{\Delta5}$ = 1.1 L $t_{\Delta5}$ = 8 sec $WW_{\Delta1}$ = 1.2 L $t_{\Delta1}$ = 8.5 sec FR_{AV} = 8.2 L/min	T_{out} = 45.5°C T_{in} = 14.4°C T_{diff} = 31.1°C $WW_{\Delta5}$ = 3.3 L $t_{\Delta5}$ = 24 sec $WW_{\Delta1}$ = 9.1 L $t_{\Delta1}$ = 65.5 sec FR_{AV} = 8.2 L/min	T_{out} = 49.6°C T_{in} = 17.6°C T_{diff} = 32.0°C $WW_{\Delta5}$ = 1.4 L $t_{\Delta5}$ = 10.5 sec $WW_{\Delta1}$ = 2.1 L $t_{\Delta1}$ = 16 sec FR_{AV} = 7.7 L/min	T_{out} = 49.4°C T_{in} = 17.6°C T_{diff} = 31.8°C $WW_{\Delta5}$ = 3.5 L $t_{\Delta5}$ = 27 sec $WW_{\Delta1}$ = 4.5 L $t_{\Delta1}$ = 35 sec FR_{AV} = 7.7 L/min	T_{out} = 59.0°C T_{in} = 17.0°C T_{diff} = 42.0°C $WW_{\Delta5}$ = 1.2 L $t_{\Delta5}$ = 9 sec $WW_{\Delta1}$ = 1.4 L $t_{\Delta1}$ = 10 sec FR_{AV} = 7.7 L/min	T_{out} = 58.6°C T_{in} = 17.0°C T_{diff} = 41.5°C $WW_{\Delta5}$ = 3.1 L $t_{\Delta5}$ = 23.5 sec $WW_{\Delta1}$ = 3.3 L $t_{\Delta1}$ = 25 sec FR_{AV} = 7.7 L/min	T_{out} = 67.8°C T_{in} = 16.9°C T_{diff} = 50.9°C $WW_{\Delta5}$ = 2.3 L $t_{\Delta5}$ = 17 sec $WW_{\Delta1}$ = 9.7 L $t_{\Delta1}$ = 74 sec FR_{AV} = 7.7 L/min	T_{out} = 67.3°C T_{in} = 16.9°C T_{diff} = 50.4°C $WW_{\Delta5}$ = 4.7 L $t_{\Delta5}$ = 35 sec $WW_{\Delta1}$ = 11.6 L $t_{\Delta1}$ = 89 sec FR_{AV} = 7.7 L/min
	Max	T_{out} = 37.0°C T_{in} = 16.4°C T_{diff} = 20.6°C $WW_{\Delta5}$ = 1.2 L $t_{\Delta5}$ = 8 sec $WW_{\Delta1}$ = 1.7 L $t_{\Delta1}$ = 11 sec FR_{AV} = 9.2 L/min	T_{out} = 37.0°C T_{in} = 16.4°C T_{diff} = 20.6°C $WW_{\Delta5}$ = 2.8 L $t_{\Delta5}$ = 18 sec $WW_{\Delta1}$ = 3.6 L $t_{\Delta1}$ = 23 sec FR_{AV} = 9.2 L/min	T_{out} = 47.3°C T_{in} = 14.3°C T_{diff} = 33.0°C $WW_{\Delta5}$ = 1.1 L $t_{\Delta5}$ = 7.5 sec $WW_{\Delta1}$ = 1.2 L $t_{\Delta1}$ = 8.3 sec FR_{AV} = 8.3 L/min	T_{out} = 47.0°C T_{in} = 14.3°C T_{diff} = 32.7°C $WW_{\Delta5}$ = 2.7 L $t_{\Delta5}$ = 18.3 sec $WW_{\Delta1}$ = 2.9 L $t_{\Delta1}$ = 19.5 sec FR_{AV} = 8.3 L/min			T_{out} = 59.1°C T_{in} = 17.1°C T_{diff} = 42.0°C $WW_{\Delta5}$ = 1.7 L $t_{\Delta5}$ = 11 sec $WW_{\Delta1}$ = 2.8 L $t_{\Delta1}$ = 18 sec FR_{AV} = 9.4 L/min			

Water wastage – instantaneous gas water heaters

Table 4 – Test unit B (p. 3/5)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min			T_{out} = 47.5°C T_{in} = 16.0°C T_{diff} = 31.0°C $WW_{\Delta 5}$ = 0.9 L $WW_{\Delta 1}$ = 1.0 L FR_{AV} = 3.6 L/min							
	Med			T_{out} = 47.4°C T_{in} = 15.0°C T_{diff} = 32.4°C $WW_{\Delta 5}$ = 1.1 L $WW_{\Delta 1}$ = 1.2 L FR_{AV} = 8.1 L/min							
	Max			T_{out} = 47.3°C T_{in} = 15.0°C T_{diff} = 31.0°C $WW_{\Delta 5}$ = 1.2 L WW_{1} = 1.3 L FR_{AV} = 8.8 L/min							

Water wastage – instantaneous gas water heaters

Table 4 – Test unit B (p. 4/5)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37˚C		Default		50˚C		60˚C		75˚C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
800	Min										
	Med			T_{out} = 47.5˚C T_{in} = 13.4˚C T_{diff} = 34.1˚C $WW_{\Delta5}$ = 1.1 L $WW_{\Delta1}$ = 1.2 L FR_{AV} = 8.2 L/min							
	Max							T_{out} = 59.0˚C T_{in} = 16.3˚C T_{diff} = 47.2˚C $WW_{\Delta5}$ = 1.7 L $WW_{\Delta1}$ = 2.6 L FR_{AV} = 9.1 L/min			

Water wastage – instantaneous gas water heaters

Table 4 – Test unit B (p. 5/5)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
1000	Min										
	Med										
	Max			T_{out} = 47.3°C T_{in} = 14.7°C T_{diff} = 32.6°C $WW_{\Delta 5}$ = 1.1 L $WW_{\Delta 1}$ = 1.2 L FR_{AV} = 8.4 L/min							

Water wastage – instantaneous gas water heaters

Table 5 – Test unit C (p. 1/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37˚C		Default		50˚C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min						
	Med						
	Max	T_{out} = 36.9˚C T_{in} = 15.0˚C T_{diff} = 21.9˚C $WW_{\Delta 5}$ = 2.2 L $WW_{\Delta 1}$ = 2.5 L FR_{AV} = 22.9 L/min		T_{out} = 54.7˚C T_{in} = 14.6˚C T_{diff} = 40.1˚C $WW_{\Delta 5}$ = 3.7 L $WW_{\Delta 1}$ = 5.3 L FR_{AV} = 14.3 L/min		T_{out} = 47.8˚C T_{in} = 15.8˚C T_{diff} = 32.0˚C $WW_{\Delta 5}$ = 2.4 L $WW_{\Delta 1}$ = 3.5 L FR_{AV} = 17.9 L/min	

Water wastage – instantaneous gas water heaters

Table 5 – Test unit C (p. 2/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 37.9°C T_{in} = 16.5°C T_{diff} = 21.4°C WWΔ5 = 1.8 L tΔ5 = 30.5 sec WWΔ1 = 2.4 L tΔ1 = 39 sec FRAV = 3.5 L/min	T_{out} = 37.7°C T_{in} = 16.5°C T_{diff} = 21.2°C WWΔ5 = 3.3 L tΔ5 = 57 sec WWΔ1 = 4.3 L tΔ1 = 73 sec FRAV = 3.5 L/min	T_{out} = 55.2°C T_{in} = 15.7°C T_{diff} = 39.5°C WWΔ5 = 2.0 L tΔ5 = 41.5 sec WWΔ1 = 2.3 L tΔ1 = 47 sec FRAV = 3.0 L/min	T_{out} = 55.2°C T_{in} = 15.7°C T_{diff} = 39.5°C WWΔ5 = 3.6 L tΔ5 = 74.5 sec WWΔ1 = 6.3 L tΔ1 = 130 sec FRAV = 3.0 L/min	T_{out} = 47.6°C T_{in} = 16.9°C T_{diff} = 30.7°C WWΔ5 = 1.8 L tΔ5 = 36 sec WWΔ1 = 2.2 L tΔ1 = 42.5 sec FRAV = 3.0 L/min	T_{out} = 47.4°C T_{in} = 16.9°C T_{diff} = 30.5°C WWΔ5 = 3.4 L tΔ5 = 66 sec WWΔ1 = 4.0 L tΔ1 = 78.5 sec FRAV = 3.0 L/min
	Med	T_{out} = 37.2°C T_{in} = 16.4°C T_{diff} = 20.8°C WWΔ5 = 1.8 L tΔ5 = 14 sec WWΔ1 = 2.6 L tΔ1 = 21 sec FRAV = 7.7 L/min	T_{out} = 35.8°C T_{in} = 16.4°C T_{diff} = 19.4°C WWΔ5 = 3.5 L tΔ5 = 27.5 sec WWΔ1 = 4.3 L tΔ1 = 33 sec FRAV = 7.7 L/min	T_{out} = 54.9°C T_{in} = 16.2°C T_{diff} = 38.7°C WWΔ5 = 2.2 L tΔ5 = 18 sec WWΔ1 = 2.8 L tΔ1 = 22 sec FRAV = 7.7 L/min	T_{out} = 50.0°C T_{in} = 16.2°C T_{diff} = 33.8°C WWΔ5 = 3.8 L tΔ5 = 29.5 sec WWΔ1 = 4.2 L tΔ1 = 33 sec FRAV = 7.7 L/min	T_{out} = 47.9°C T_{in} = 16.4°C T_{diff} = 31.5°C WWΔ5 = 2.1 L tΔ5 = 16 sec WWΔ1 = 2.8 L tΔ1 = 21.5 sec FRAV = 7.7 L/min	T_{out} = 45.1°C T_{in} = 16.4°C T_{diff} = 28.7°C WWΔ5 = 3.8 L tΔ5 = 29.5 sec WWΔ1 = 4.3 L tΔ1 = 33 sec FRAV = 7.7 L/min
	Max	T_{out} = 37.0°C T_{in} = 16.2°C T_{diff} = 20.8°C WWΔ5 = 2.3 L tΔ5 = 6.5 sec WWΔ1 = 2.6 L tΔ1 = 7.5 sec FRAV = 27.7 L/min	T_{out} = 36.9°C T_{in} = 16.2°C T_{diff} = 20.7°C WWΔ5 = 4.0 L tΔ5 = 11.5 sec WWΔ1 = 4.8 L tΔ1 = 13.5 sec FRAV = 27.7 L/min	T_{out} = 54.9°C T_{in} = 12.9°C T_{diff} = 42.0°C WWΔ5 = 3.4 L tΔ5 = 13.5 sec WWΔ1 = 4.9 L tΔ1 = 20 sec FRAV = 13.5 L/min	T_{out} = 55.0°C T_{in} = 12.9°C T_{diff} = 42.1°C WWΔ5 = 5.3 L tΔ5 = 22 sec WWΔ1 = 6.7 L tΔ1 = 28 sec FRAV = 13.5 L/min	T_{out} = 47.9°C T_{in} = 14.9°C T_{diff} = 33.0°C WWΔ5 = 2.5 L tΔ5 = 9 sec WWΔ1 = 3.4 L tΔ1 = 12.5 sec FRAV = 17.4 L/min	T_{out} = 47.7°C T_{in} = 14.9°C T_{diff} = 32.8°C WWΔ5 = 4.3 L tΔ5 = 16 sec WWΔ1 = 5.4 L tΔ1 = 20 sec FRAV = 17.4 L/min

Water wastage – instantaneous gas water heaters

Table 5 – Test unit C (p. 3/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min						
	Med						
	Max	T_{out} = 36.8°C T_{in} = 14.5°C T_{diff} = 22.3°C $WW_{\Delta 5}$ = 2.4 L $WW_{\Delta 1}$ = 2.8 L FR_{AV} = 26.3 L/min		T_{out} = 55.0°C T_{in} = 15.3°C T_{diff} = 39.7°C $WW_{\Delta 5}$ = 3.4 L $WW_{\Delta 1}$ = 5.0 L FR_{AV} = 14.5 L/min		T_{out} = 47.8°C T_{in} = 15.5°C T_{diff} = 32.3°C $WW_{\Delta 5}$ = 3.1 L $WW_{\Delta 1}$ = 4.9 L FR_{AV} = 18.1 L/min	

Water wastage – instantaneous gas water heaters

Table 5 – Test unit C (p. 4/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37˚C		Default		50˚C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
800	Min						
	Med						
	Max			T_{out} = 54.6˚C T_{in} = 14.7˚C T_{diff} = 39.9˚C $WW_{\Delta 5}$ = 3.0 L $WW_{\Delta 1}$ = 4.7 L FR_{AV} = 14.7 L/min			

Water wastage – instantaneous gas water heaters

Table 6 – Test unit D (p. 1/4)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min			T_{out} = 50.5°C T_{in} = 18.8°C T_{diff} = 31.7°C $WW_{\Delta 5}$ = 0.8 L $WW_{\Delta 1}$ = 0.8 L FR_{AV} = 3.3 L/min							
	Med										
	Max			T_{out} = 46.4°C T_{in} = 14.7°C T_{diff} = 31.7°C $WW_{\Delta 5}$ = 1.1 L $WW_{\Delta 1}$ = 1.2 L FR_{AV} = 15.9 L/min							

Water wastage – instantaneous gas water heaters

Table 6 – Test unit D (p. 2/4)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 37.8°C T_{in} = 14.4°C T_{diff} = 23.4°C $WW_{\Delta 5}$ = 0.7 L $t_{\Delta 5}$ = 12 sec $WW_{\Delta 1}$ = 0.7 L $t_{\Delta 1}$ = 12.5 sec FR_{AV} = 3.6 L/min				T_{out} = 49.8°C T_{in} = 14.5°C T_{diff} = 35.3°C $WW_{\Delta 5}$ = 0.9 L $t_{\Delta 5}$ = 15 sec $WW_{\Delta 1}$ = 1.2 L $t_{\Delta 1}$ = 20 sec FR_{AV} = 3.8 L/min		T_{out} = 59.0°C T_{in} = 14.1°C T_{diff} = 44.9°C $WW_{\Delta 5}$ = 0.9 L $t_{\Delta 5}$ = 16 sec $WW_{\Delta 1}$ = 1.0 L $t_{\Delta 1}$ = 18 sec FR_{AV} = 3.7 L/min		T_{out} = 73.4°C T_{in} = 14.4°C T_{diff} = 59.0°C $WW_{\Delta 5}$ = 1.5 L $t_{\Delta 5}$ = 25 sec $WW_{\Delta 1}$ = 2.1 L $t_{\Delta 1}$ = 35 sec FR_{AV} = 3.7 L/min	
	Med	T_{out} = 37.0°C T_{in} = 16.0°C T_{diff} = 21.0°C $WW_{\Delta 5}$ = 1.0 L $t_{\Delta 5}$ = 7 sec $WW_{\Delta 1}$ = 1.1 L $t_{\Delta 1}$ = 8 sec FR_{AV} = 7.7 L/min		T_{out} = 46.4°C T_{n} = 15.6°C T_{diff} = 30.8°C $WW_{\Delta 5}$ = 1.0 L $t_{\Delta 5}$ = 8 sec $WW_{\Delta 1}$ = 1.0 L $t_{\Delta 1}$ = 9 sec FR_{AV} = 7.8 L/min		T_{out} = 49.5°C T_{in} = 17.2°C T_{diff} = 32.3°C $WW_{\Delta 5}$ = 1.2 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 1.4 L $t_{\Delta 1}$ = 11 sec FR_{AV} = 7.8 L/min		T_{out} = 59.1°C T_{in} = 16.8°C T_{diff} = 42.3°C $WW_{\Delta 5}$ = 1.0 L $t_{\Delta 5}$ = 10 sec $WW_{\Delta 1}$ = 1.1 L $t_{\Delta 1}$ = 10 sec FR_{AV} = 7.6 L/min		T_{out} = 73.0°C T_{in} = 14.1°C T_{diff} = 58.9°C $WW_{\Delta 5}$ = 1.6 L $t_{\Delta 5}$ = 11 sec $WW_{\Delta 1}$ = 1.9 L $t_{\Delta 1}$ = 13 sec FR_{AV} = 10.2 L/min	
	Max	T_{out} = 36.5°C T_{in} = 14.8°C T_{diff} = 21.7°C $WW_{\Delta 5}$ = 2.6 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 5.6 L $t_{\Delta 1}$ = 18 sec FR_{AV} = 22.4 L/min		T_{out} = 46.1°C T_{n} = 15.5°C T_{diff} = 30.6°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 1.3 L $t_{\Delta 1}$ = 9 sec FR_{AV} = 18.1 L/min				T_{out} = 58.7°C T_{in} = 15.4°C T_{diff} = 43.3°C $WW_{\Delta 5}$ = 1.1 L $t_{\Delta 5}$ = 10 sec $WW_{\Delta 1}$ = 1.2 L $t_{\Delta 1}$ = 11 sec FR_{AV} = 12.3 L/min		T_{out} = 73.1°C T_{in} = 17.0°C T_{diff} = 56.1°C $WW_{\Delta 5}$ = 1.6 L $t_{\Delta 5}$ = 11 sec $WW_{\Delta 1}$ = 1.8 L $t_{\Delta 1}$ = 12 sec FR_{AV} = 10.9 L/min	

Water wastage – instantaneous gas water heaters

Table 6 – Test unit D (p. 3/4)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min										
	Med			T_{out} = 46.2°C T_{in} = 15.4°C T_{diff} = 30.8°C $WW_{\Delta 5}$ = 0.9 L $WW_{\Delta 1}$ = 1.0 L FR_{AV} = 8.0 L/min							
	Max			T_{out} = 46.2°C T_{in} = 15.4°C T_{diff} = 30.8°C $WW_{\Delta 5}$ = 1.9 L $WW_{\Delta 1}$ = 1.9 L FR_{AV} = 17.1 L/min							

Water wastage – instantaneous gas water heaters

Table 6 – Test unit D (p.4/4)

Pressure (kPa)	Flow rate setting	Temperature control setting									
		37°C		Default		50°C		60°C		75°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
800	Min										
	Med			T_{out} = 46.4°C T_{in} = 15.8°C T_{diff} = 30.6°C $WW_{\Delta 5}$ = 1.0 L $WW_{\Delta 1}$ = 1.1 L FR_{AV} = 6.2 L/min							
	Max	T_{out} = 36.8°C T_{in} = 14.0°C T_{diff} = 22.8°C $WW_{\Delta 5}$ = 2.6 L $WW_{\Delta 1}$ = 3.1 L FR_{AV} = 22.0 L/min		T_{out} = 46.2°C T_{in} = 14.8°C T_{diff} = 31.4°C $WW_{\Delta 5}$ = 1.6 L $WW_{\Delta 1}$ = 1.6 L FR_{AV} = 16.7 L/min				T_{out} = 58.7°C T_{in} = 15.2°C T_{diff} = 43.5°C $WW_{\Delta 5}$ = 1.2 L $WW_{\Delta 1}$ = 1.2 L FR_{AV} = 13.9 L/min			

Water wastage – instantaneous gas water heaters

Table 7 – Test unit E (p.1/5)

Pressure (kPa)	Flow rate setting	Temperature control setting							
		37˚C		Default		50˚C		60˚C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min								
	Med	T_{out} = 37.2˚C T_{in} = 14.6˚C T_{diff} = 22.6˚C $WW_{\Delta 5}$ = 1.2 L $WW_{\Delta 1}$ = 1.4 L FR_{AV} = 11.6 L/min		T_{out} = 50.5˚C T_{in} = 14.5˚C T_{diff} = 36.0˚C $WW_{\Delta 5}$ = 1.1 L $WW_{\Delta 1}$ = 1.2 L FR_{AV} = 8.1 L/min				T_{out} = 60.3˚C T_{in} = 14.8˚C T_{diff} = 45.5˚C $WW_{\Delta 5}$ = 1.1 L $WW_{\Delta 1}$ = 1.3 L FR_{AV} = 7.0 L/min	
	Max	T_{out} = 37.1˚C T_{in} = 15.6˚C T_{diff} = 21.5˚C $WW_{\Delta 5}$ = 1.2 L $WW_{\Delta 1}$ = 1.4 L FR_{AV} = 7.4 L/min		T_{out} = 50.5˚C T_{in} = 15.0˚C T_{diff} = 35.5˚C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 2.1 L FR_{AV} = 15.8 L/min				T_{out} = 60.1˚C T_{in} = 15.2˚C T_{diff} = 44.9˚C $WW_{\Delta 5}$ = 1.1 L $WW_{\Delta 1}$ = 1.3 L FR_{AV} = 6.7 L/min	

Water wastage – instantaneous gas water heaters

Table 7 – Test unit E (p.2/5)

Pressure (kPa)	Flow rate setting	Temperature control setting							
		37°C		Default		50°C		60°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 38.7°C T_{in} = 16.8°C T_{diff} = 21.9°C $WW_{\Delta5}$ = 1.0 L $t_{\Delta5}$ = 18 sec $WW_{\Delta1}$ = 4.6 L $t_{\Delta1}$ = 80 sec FR_{AV} = 3.5 L/min		T_{out} = 50.5°C T_{in} = 17.1°C T_{diff} = 33.4°C $WW_{\Delta5}$ = 1.1 L $t_{\Delta5}$ = 19 sec $WW_{\Delta1}$ = 2.5 L $t_{\Delta1}$ = 45 sec FR_{AV} = 3.5 L/min		T_{out} = 50.2°C T_{in} = 17.4°C T_{diff} = 32.8°C $WW_{\Delta5}$ = 1.0 L $t_{\Delta5}$ = 17 sec $WW_{\Delta1}$ = 1.3 L $t_{\Delta1}$ = 22 sec FR_{AV} = 3.4 L/min		T_{out} = 60.3°C T_{in} = 17.1°C T_{diff} = 42.6°C $WW_{\Delta5}$ = 1.0 L $t_{\Delta5}$ = 16 sec $WW_{\Delta1}$ = 1.1 L $t_{\Delta1}$ = 20 sec FR_{AV} = 3.4 L/min	
	Med	T_{out} = 37.1°C T_{in} = 14.5°C T_{diff} = 22.6°C $WW_{\Delta5}$ = 1.2 L $t_{\Delta5}$ = 7 sec $WW_{\Delta1}$ = 1.4 L $t_{\Delta1}$ = 9 sec FR_{AV} = 8.3 L/min		T_{out} = 50.5°C T_{in} = 14.3°C T_{diff} = 36.2°C $WW_{\Delta5}$ = 1.3 L $t_{\Delta5}$ = 4 sec $WW_{\Delta1}$ = 1.5 L $t_{\Delta1}$ = 5 sec FR_{AV} = 7.0 L/min		T_{out} = 50.3°C T_{in} = 15.2°C T_{diff} = 35.1°C $WW_{\Delta5}$ = 1.1 L $t_{\Delta5}$ = 8 sec $WW_{\Delta1}$ = 1.2 L $t_{\Delta1}$ = 9 sec FR_{AV} = 7.6 L/min		T_{out} = 60.3°C T_{in} = 14.8°C T_{diff} = 45.5°C $WW_{\Delta5}$ = 1.2 L $t_{\Delta5}$ = 7 sec $WW_{\Delta1}$ = 1.4 L $t_{\Delta1}$ = 8 sec FR_{AV} = 8.0 L/min	
	Max	T_{out} = 36.9°C T_{in} = 14.8°C T_{diff} = 22.1°C $WW_{\Delta5}$ = 1.7 L $t_{\Delta5}$ = 10 sec $WW_{\Delta1}$ = 2.0 L $t_{\Delta1}$ = 11 sec FR_{AV} = 17.7 L/min		T_{out} = 50.2°C T_{in} = 14.9°C T_{diff} = 35.3°C $WW_{\Delta5}$ = 2.9 L $t_{\Delta5}$ = 5 sec $WW_{\Delta1}$ = 3.9 L $t_{\Delta1}$ = 8 sec FR_{AV} = 25.0 L/min				T_{out} = 60.0°C T_{in} = 16.3°C T_{diff} = 33.7°C $WW_{\Delta5}$ = 1.5 L $t_{\Delta5}$ = 6 sec $WW_{\Delta1}$ = 1.7 L $t_{\Delta1}$ = 7 sec FR_{AV} = 10.5 L/min	

Water wastage – instantaneous gas water heaters

Table 7 – Test unit E (p.3/5)

Pressure (kPa)	Flow rate setting	Temperature control setting							
		37°C		Default		50°C		60°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min								
	Med	T_{out} = 36.7°C T_{in} = 14.2°C T_{diff} = 22.5°C $WW_{\Delta 5}$ = 2.8 L $WW_{\Delta 1}$ = 5.9 L FR_{AV} = 5.7 L/min						T_{out} = 60.1°C T_{in} = 15.5°C T_{diff} = 44.6°C $WW_{\Delta 5}$ = 3.9 L $WW_{\Delta 1}$ = 7.4 L FR_{AV} = 6.4 L/min	
	Max	T_{out} = 36.8°C T_{in} = 16.0°C T_{diff} = 20.8°C $WW_{\Delta 5}$ = 1.6 L $WW_{\Delta 1}$ = 2.0 L FR_{AV} = 15.1 L/min				T_{out} = 50.2°C T_{in} = 13.8°C T_{diff} = 36.4°C $WW_{\Delta 5}$ = 1.5 L $WW_{\Delta 1}$ = 1.7 L FR_{AV} = 12.4 L/min		T_{out} = 59.4°C T_{in} = 15.6°C T_{diff} = 43.8°C $WW_{\Delta 5}$ = 2.3 L $WW_{\Delta 1}$ = 2.7 L FR_{AV} = 14.7 L/min	

Water wastage – instantaneous gas water heaters

Table 7 – Test unit E (p.4/5)

Pressure (kPa)	Flow rate setting	Temperature control setting							
		37°C		Default		50°C		60°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
750	Min								
	Med								
	Max			T_{out} = 50.0°C T_{in} = 14.2°C T_{diff} = 35.8°C $WW_{\Delta 5}$ = 4.6 L $WW_{\Delta 1}$ = 5.3 L FR_{AV} = 18.0 L/min		T_{out} = 50.7°C T_{in} = 14.2°C T_{diff} = 34.1°C $WW_{\Delta 5}$ = 2.0 L $WW_{\Delta 1}$ = 3.9 L FR_{AV} = 18.5 L/min		T_{out} = 60.6°C T_{in} = 16.5°C T_{diff} = 44.1°C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 3.6 L FR_{AV} = 14.3 L/min	

Water wastage – instantaneous gas water heaters

Table 7 – Test unit E (p.5/5)

Pressure (kPa)	Flow rate setting	Temperature control setting							
		37°C		Default		50°C		60°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
1000	Min								
	Med	T_{out} = 36.8°C T_{in} = 15.0°C T_{diff} = 21.8°C $WW_{\Delta 5}$ = 1.5 L $WW_{\Delta 1}$ = 4.9 L FR_{AV} = 8.3 L/min				T_{out} = 50.1°C T_{in} = 15.0°C T_{diff} = 35.1°C $WW_{\Delta 5}$ = 4.5 L $WW_{\Delta 1}$ = 5.2 L FR_{AV} = 8.4 L/min		T_{out} = 60.1°C T_{in} = 14.8°C T_{diff} = 45.5°C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 4.2 L FR_{AV} = 8.3 L/min	
	Max	T_{out} = 36.9°C T_{in} = 14.6°C T_{diff} = 22.3°C $WW_{\Delta 5}$ = 1.8 L $WW_{\Delta 1}$ = 2.2 L FR_{AV} = 19.0 L/min				T_{out} = 50.4°C T_{in} = 15.2°C T_{diff} = 35.2°C $WW_{\Delta 5}$ = 2.3 L $WW_{\Delta 1}$ = 3.7 L FR_{AV} = 18.6 L/min			

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Table 8 – Test unit F (p.1/3)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min	T_{out} = 36.5°C T_{in} = 13.6°C T_{diff} = 22.9°C $WW_{\Delta 5}$ = 0.9 L $WW_{\Delta 1}$ = 1.7 L FR_{AV} = 4.2 L/min		T_{out} = 53.9°C T_{in} = 14.7°C T_{diff} = 39.2°C $WW_{\Delta 5}$ = 1.3 L $WW_{\Delta 1}$ = 2.1 L FR_{AV} = 4.1 L/min		T_{out} = 47.1°C T_{in} = 13.0°C T_{diff} = 34.1°C $WW_{\Delta 5}$ = 1.3 L $WW_{\Delta 1}$ = 2.2 L FR_{AV} = 4.2 L/min	
	Med	T_{out} = 36.3°C T_{in} = 15.8°C T_{diff} = 20.5°C $WW_{\Delta 5}$ = 1.2 L $WW_{\Delta 1}$ = 1.6 L FR_{AV} = 7.9 L/min		T_{out} = 54.1°C T_{diff} = 37.0°C $WW_{\Delta 5}$ = 1.3 L $WW_{\Delta 1}$ = 2.6 L FR_{AV} = 7.9 L/min		T_{out} = 47.2°C T_{in} = 15.7°C T_{diff} = 31.5°C $WW_{\Delta 5}$ = 1.2 L $WW_{\Delta 1}$ = 2.3 L FR_{AV} = 7.9 L/min	
	Max			T_{out} = 54.1°C T_{in} = 15.8°C T_{diff} = 38.3°C $WW_{\Delta 5}$ = 2.3 L $WW_{\Delta 1}$ = 2.9 L FR_{AV} = 15.0 L/min		T_{out} = 47.3°C T_{in} = 15.7°C T_{diff} = 31.6°C $WW_{\Delta 5}$ = 3.6 L $WW_{\Delta 1}$ = 4.8 L FR_{AV} = 18.1 L/min	

Water wastage – instantaneous gas water heaters

Table 8 – Test unit F (p.2/3)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 36.3°C T_{in} = 13.4°C T_{diff} = 22.9°C $WW_{\Delta 5}$ = 1.0 L $t_{\Delta 5}$ = 13 sec $WW_{\Delta 1}$ = 1.7 L $t_{\Delta 1}$ = 22 sec FR_{AV} = 4.7 L/min		T_{out} = 54.0°C T_{in} = 16.8°C T_{diff} = 37.2°C $WW_{\Delta 5}$ = 1.4 L $t_{\Delta 5}$ = 22 sec $WW_{\Delta 1}$ = 2.2 L $t_{\Delta 1}$ = 36 sec FR_{AV} = 3.7 L/min		T_{out} = 47.2°C T_{in} = 14.0°C T_{diff} = 33.2°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 21 sec $WW_{\Delta 1}$ = 2.1 L $t_{\Delta 1}$ = 35 sec FR_{AV} = 3.6 L/min	
	Med	T_{out} = 36.4°C T_{in} = 15.9°C T_{diff} = 20.5°C $WW_{\Delta 5}$ = 1.1 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 1.7 L $t_{\Delta 1}$ = 13 sec FR_{AV} = 7.8 L/min		T_{out} = 54.0°C T_{in} = 16.7°C T_{diff} = 37.3°C $WW_{\Delta 5}$ = 1.4 L $t_{\Delta 5}$ = 11 sec $WW_{\Delta 1}$ = 2.6 L $t_{\Delta 1}$ = 19 sec FR_{AV} = 7.9 L/min		T_{out} = 47.2°C T_{in} = 15.9°C T_{diff} = 31.3°C $WW_{\Delta 5}$ = 1.2 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 2.1 L $t_{\Delta 1}$ = 16 sec FR_{AV} = 7.8 L/min	
	Max						

Water wastage – instantaneous gas water heaters

Table 8 – Test unit F (p.3/3)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min	T_{out} = 36.4°C T_{in} = 14.7°C T_{diff} = 21.7°C $WW_{\Delta 5}$ = 1.0 L $WW_{\Delta 1}$ = 1.7 L FR_{AV} = 4.2 L/min		T_{out} = 54.0°C T_{in} = 15.5°C T_{diff} = 38.5°C $WW_{\Delta 5}$ = 1.4 L $WW_{\Delta 1}$ = 2.5 L FR_{AV} = 4.3 L/min		T_{out} = 47.2°C T_{in} = 15.1°C T_{diff} = 32.1°C $WW_{\Delta 5}$ = 1.4 L $WW_{\Delta 1}$ = 2.2 L FR_{AV} = 4.2 L/min	
	Med						
	Max						

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Table 9 – Test unit G (p.1/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min	T_{out} = 36.8°C T_{in} = 18.5°C T_{diff} = 18.3°C $WW_{\Delta 5}$ = 0.9 L $WW_{\Delta 1}$ = 1.2 L FR_{AV} = 3.3 L/min		T_{out} = 54.3°C T_{in} = 18.5°C T_{diff} = 35.9°C $WW_{\Delta 5}$ = 1.4 L $WW_{\Delta 1}$ = 1.8 L FR_{AV} = 2.8 L/min		T_{out} = 47.6°C T_{in} = 20.4°C T_{diff} = 27.2°C $WW_{\Delta 5}$ = 1.2 L $WW_{\Delta 1}$ = 1.5 L FR_{AV} = 2.5 L/min	
	Med						
	Max	T_{out} = 36.8°C T_{in} = 15.8°C T_{diff} = 21.0°C $WW_{\Delta 5}$ = 1.7 L $WW_{\Delta 1}$ = 1.9 L FR_{AV} = 22.6 L/min		T_{out} = 54.4°C T_{in} = 16.2°C T_{diff} = 38.2°C $WW_{\Delta 5}$ = 2.9 L $WW_{\Delta 1}$ = 3.7 L FR_{AV} = 14.7 L/min		T_{out} = 47.7°C T_{in} = 15.3°C T_{diff} = 32.3°C $WW_{\Delta 5}$ = 2.9 L $WW_{\Delta 1}$ = 4.6 L FR_{AV} = 17.3 L/min	

Water wastage – instantaneous gas water heaters

Table 9 – Test unit G (p.2/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min						
	Med	T_{out} = 36.9°C T_{in} = 17.4°C T_{diff} = 19.5°C $WW_{\Delta 5}$ = 1.1 L $t_{\Delta 5}$ = 7 sec $WW_{\Delta 1}$ = 1.7 L $t_{\Delta 1}$ = 12 sec FR_{AV} = 7.8 L/min		T_{out} = 54.3°C T_{in} = 15.4°C T_{diff} = 38.9°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 10 sec $WW_{\Delta 1}$ = 1.8 L $t_{\Delta 1}$ = 13 sec FR_{AV} = 7.6 L/min		T_{out} = 47.6°C T_{in} = 17.7°C T_{diff} = 29.9°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 1.8 L $t_{\Delta 1}$ = 13 sec FR_{AV} = 7.9 L/min	
	Max	T_{out} = 36.9°C T_{in} = 15.7°C T_{diff} = 21.2°C $WW_{\Delta 5}$ = 2.1 L $t_{\Delta 5}$ = 5 sec $WW_{\Delta 1}$ = 3.5 L $t_{\Delta 1}$ = 9 sec FR_{AV} = 26.1 L/min		T_{out} = 54.4°C T_{in} = 16.0°C T_{diff} = 38.4°C $WW_{\Delta 5}$ = 2.6 L $t_{\Delta 5}$ = 9 sec $WW_{\Delta 1}$ = 4.3 L $t_{\Delta 1}$ = 16 sec FR_{AV} = 14.7 L/min		T_{out} = 47.8°C T_{in} = 15.8°C T_{diff} = 32.0°C $WW_{\Delta 5}$ = 2.4 L $t_{\Delta 5}$ = 7 sec $WW_{\Delta 1}$ = 3.5 L $t_{\Delta 1}$ = 11 sec FR_{AV} = 17.4 L/min	

Water wastage – instantaneous gas water heaters

Table 9 – Test unit G (p.3/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min						
	Med						
	Max	T_{out} = 36.7°C T_{in} = 13.8°C T_{diff} = 22.9°C $WW_{\Delta 5}$ = 2.1 L $WW_{\Delta 1}$ = 2.4 L FR_{AV} = 26.9 L/min		T_{out} = 54.4°C T_{in} = 15.3°C T_{diff} = 39.1°C $WW_{\Delta 5}$ = 2.8 L $WW_{\Delta 1}$ = 3.8 L FR_{AV} = 14.6 L/min		T_{out} = 47.6°C T_{in} = 14.3°C T_{diff} = 33.2°C $WW_{\Delta 5}$ = 2.8 L $WW_{\Delta 1}$ = 4.4 L FR_{AV} = 17.0 L/min	

Water wastage – instantaneous gas water heaters

Table 9 – Test unit G (p.4/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
800	Min						
	Med						
	Max			T_{out} = 54.4°C T_{in} = 16.4°C T_{diff} = 38.0°C $WW_{\Delta 5}$ = 2.5 L $WW_{\Delta 1}$ = 3.4 L FR_{AV} = 14.8 L/min			

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Table 10 – Test unit H (p.1/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
150	Min						
	Med						
	Max	T_{out} = 36.5°C T_{in} = 15.4°C T_{diff} = 21.1°C $WW_{\Delta 5}$ = 1.7 L $t_{\Delta 5}$ = 6 sec $WW_{\Delta 1}$ = 2.1 L $t_{\Delta 1}$ = 7 sec FR_{AV} = 22.6 L/min		T_{out} = 54.1°C T_{in} = 16.0°C T_{diff} = 38.1°C $WW_{\Delta 5}$ = 2.4 L $t_{\Delta 5}$ = 7 sec $WW_{\Delta 1}$ = 3.4 L $t_{\Delta 1}$ = 10 sec FR_{AV} = 20.2 L/min		T_{out} = 47.2°C T_{in} = 15.7°C T_{diff} = 31.5°C $WW_{\Delta 5}$ = 2.0 L $t_{\Delta 5}$ = 6 sec $WW_{\Delta 1}$ = 2.2 L $t_{\Delta 1}$ = 7 sec FR_{AV} = 21.0 L/min	

Water wastage – instantaneous gas water heaters

Table 10 – Test unit H (p.2/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
320	Min	T_{out} = 36.2°C T_{in} = 14.5°C T_{diff} = 21.7°C $WW_{\Delta 5}$ = 1.1 L $t_{\Delta 5}$ = 19 sec $WW_{\Delta 1}$ = 1.4 L $t_{\Delta 1}$ = 24 sec FR_{AV} = 3.7 L/min		T_{out} = 54.1°C T_{in} = 21.4°C T_{diff} = 32.7°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 28 sec $WW_{\Delta 1}$ = 1.5 L $t_{\Delta 1}$ = 33 sec FR_{AV} = 2.8 L/min		T_{out} = 47.2°C T_{in} = 19.0°C T_{diff} = 28.2°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 25 sec $WW_{\Delta 1}$ = 1.5 L $t_{\Delta 1}$ = 31 sec FR_{AV} = 2.9 L/min	
	Med	T_{out} = 36.7°C T_{in} = 14.8°C T_{diff} = 21.9°C $WW_{\Delta 5}$ = 1.3 L $t_{\Delta 5}$ = 10 sec $WW_{\Delta 1}$ = 1.8 L $t_{\Delta 1}$ = 14 sec FR_{AV} = 7.7 L/min		T_{out} = 54.1°C T_{in} = 15.0°C T_{diff} = 39.1°C $WW_{\Delta 5}$ = 1.8 L $t_{\Delta 5}$ = 14 sec $WW_{\Delta 1}$ = 2.2 L $t_{\Delta 1}$ = 17 sec FR_{AV} = 7.8 L/min		T_{out} = 47.2°C T_{in} = 14.7°C T_{diff} = 32.5°C $WW_{\Delta 5}$ = 1.5 L $t_{\Delta 5}$ = 11 sec $WW_{\Delta 1}$ = 1.9 L $t_{\Delta 1}$ = 14 sec FR_{AV} = 7.7 L/min	
	Max	T_{out} = 36.2°C T_{in} = 14.5°C T_{diff} = 21.7°C $WW_{\Delta 5}$ = 2.0 L $t_{\Delta 5}$ = 19 sec $WW_{\Delta 1}$ = 2.2 L $t_{\Delta 1}$ = 24 sec FR_{AV} = 33.2 L/min		T_{out} = 54.0°C T_{in} = 14.7°C T_{diff} = 39.3°C $WW_{\Delta 5}$ = 2.6 L $t_{\Delta 5}$ = 8 sec $WW_{\Delta 1}$ = 2.9 L $t_{\Delta 1}$ = 9 sec FR_{AV} = 19.3 L/min		T_{out} = 47.2°C T_{in} = 13.3°C T_{diff} = 33.9°C $WW_{\Delta 5}$ = 3.1 L $t_{\Delta 5}$ = 8 sec $WW_{\Delta 1}$ = 3.6 L $t_{\Delta 1}$ = 9 sec FR_{AV} = 23.1 L/min	

Water wastage – instantaneous gas water heaters

Table 10 – Test unit H (p.3/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
500	Min						
	Med						
	Max			T_{out} = 54.1°C T_{in} = 14.5°C T_{diff} = 39.6°C $WW_{\Delta 5}$ = 2.8 L $WW_{\Delta 1}$ = 3.4 L FR_{AV} = 19.8 L/min			

Water wastage – instantaneous gas water heaters

Table 10 – Test unit H (p.4/4)

Pressure (kPa)	Flow rate setting	Temperature control setting					
		37°C		Default		50°C	
		At heater outlet	At discharge	At heater outlet	At discharge	At heater outlet	At discharge
800	Min						
	Med						
	Max			T_{out} = 54.1°C T_{in} = 13.4°C T_{diff} = 40.7°C $WW_{\Delta 5}$ = 2.6 L $WW_{\Delta 1}$ = 3.2 L FR_{AV} = 19.2 L/min			