# PowerPipe™ Drain Water Heat Recovery Systems: Effectiveness Testing of Commercial (C) Units

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**Prepared for:**

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**Disclaimer**

*The information contained in this report the results of measurements performed by the University of Waterloo, Solar Thermal Research Laboratory. Some general opinion on how the user may meet specified goals may also have been expressed.*

*The Author has tested the systems reported here using the test procedure specified by Natural Resources Canada (NRCan, 2008). Where deviations from that test procedure have occurred, an explanation has been provided.*

*The Author does not accept any third party liability for any damages or losses whatsoever, arising out of, or in any way related to, the use of this information.*

**Notes**

*This report replaces a previous report entitled '**Effectiveness Testing of Powerpipe Drain Water Heat Recovery Systems: C-Units**' (dated Feb 12 / 2010).*

*Only the results for units C3-48, 60, 72, and 120 remain the same from that report. All other results are either for previously untested units, or replacement results for units that have undergone design changes (i.e. all of the C4 units).*

## 1.0 Procedure and Methodology

The test apparatus, test procedure, and data analysis generally follows the test standard described by Natural Resources Canada (NRCan, 2008). That document will henceforth be referred to as the Standard.

Any deviations from the Standard will be fully explained in the text.

## 1.1 Equipment

The test apparatus was modeled on the device described in the Standard. The reader is referred to that document for more detail. A brief description of the apparatus follows.

Potable Water Side (Cold-Side): Mains water entered the system after passing through a pressure regulator. Mains temperature remained constant at approximately 5.5$^{o}$C (41.9 F) throughout the test period, so it was heated to bring it to standard test conditions (8$^{o}$C or 46.4 F). Some mains water was diverted to an electric water heater before being mixed with the remaining mains water at the flow control panel using two gate valves.

The cold-side flow rate, temperature, and pressure were measured between the mixing point and the inlet to the heat exchanger. Cold-side temperature and pressure were measured immediately after the heat exchanger. (see Figure 1)


Figure 1: Drain Water Heat Recovery Apparatus; Cold Stream Data Acquisition. Inlet on Left. Outlet on Right.

All cold-side pipes and fittings are nominal ¾” copper or PEX.

Drain Water Side (Hot-Side): The cold-side outlet was divided into two streams. Part was sent to a gas fired water heater and then remixed with the remaining portion via a thermostatic mixing valve. The gas heater was sufficient to provide hot water for the duration of the tests.

The water was then conditioned prior to entry into the heat exchanger. A shower was simulated by allowing the water to flow into a small catchment basin. The shower was located 0.5 m (20 in) from the centerline of the heat exchanger. Following this, the water temperature is measured. Finally, a heat exchanger entry region (flow conditioner) consisted of a 0.305 m (1 ft) horizontal run, followed by a Y transition to a 0.610 m (2 ft) vertical run, both of equal diameter to the heat exchanger being tested. To accomplish this, three flow conditioners were built at 2”, 3”, and 4” nominal diameters (Figure 2).

Figure 2: Drain Water Heat Recovery Apparatus; 2” and 3” Hot-Side Flow Conditioner.

The hot-side inlet and outlet temperatures were measured in immersion wells. The inlet temperature was measured directly after the simulated shower, and before the flow conditioner. The outlet temperature was measured at the bottom of the heat exchanger. Hot-side data acquisition points are shown in Figure 3.

Figure 2: Drain Water Heat Recovery Apparatus; Hot Stream Data Acquisition. Inlet on Left. Outlet on Right.

Hot-side pipes and fitting are nominal ¾” copper or PEX except those noted above, which are made from ABS pipe.

Temperature Measurements: All temperature measurements were performed using Resistance Temperature Devices (RTD's) purchased from Omega. All measurements were 4-wire and taken using OMEGA process controllers, and output to an OMEGA Data Acquisition System (DAQ). The RTD measurements were calibrated by comparing data recorded via the DAQ to the digital readout of the process controller values. Quoted temperature measurements are considered accurate to +/- 0.1 $^{o}$C (0.2 F).

Care was taken to ensure that the RTD probes were fully immersed into the fluid and not located in regions where the fluid may stagnate. Temperatures were measured as close as possible to the inlets and outlets of the heat exchanger.

Pressure Measurements: Pressure measurements were performed using pressure gauges from OMEGA (DPG1000B-100G). It is considered accurate to +/- 0.25%[1]. Pressure measurements were recorded manually every 20 seconds during data acquisition periods.

To accommodate different sizes of heat exchanger, there was as much as 3 or 4 meters (10 to 13 ft) of piping added between the pressure gauges and heat exchanger. The static pressure head between the sensor locations, and the pressure drop caused by flow through the connector pipes and fittings was determined by bypassing the heat exchanger (i.e. connecting the cold-side inlet to the cold-side outlet), and recording the pressure difference at the flow rate of interest.

Flow Measurements: Flow measurements were taken using a Hall Effect flowmeter purchased from OMEGA (FTB-4605), and connected to the DAQ. It is considered accurate to +/- 1.5% of the reading[1]. A second flowmeter was also installed, but not required in the current tests.

The flowmeter was re-calibrated using a gravimetric technique.

Deviations:
The following deviations from the equipment described in the Standard are noted:

- Hot-side temperature was measured in an immersion well and not by a sensor affixed to the heat exchanger wall before the heat exchanger. It was found that the suggested technique was problematic at low flow rates where there was significant potential for that sensor to not be in contact with the water.

[1] Accuracy quoted by OMEGA documents provided with device.

## 1.2 Procedure

Installation:

- The hot-side inlet flow conditioner was installed depending on the diameter of the heat exchanger to be tested.
- The heat exchanger was connected to the test rig. The hot water-side connections were made using rubber couplings in the same manner as used in an actual installation. A coupling also connected the hot-side outlet to the hot-side outlet temperature well.
- The unit was checked for vertical orientation and secured to the test frame.
- Cold-side connections were made using SharkBite fittings.

Test Start-Up:

- The system was pressurized and air was allowed to bleed from the system.
- The flowrate was set using a gate valve located at the cold-side inlet.
- Cold-side and hot-side temperatures were set manually. The cold-side was controlled via two gate valves until a setpoint of 8 $^{o}$C +/- 0.3 $^{o}$C (46.4 F +/- 0.5 F) was achieved. The hot-side temperature was controlled via a thermostatic mixing valve until a setpoint of 36 $^{o}$C +/- 0.3 $^{o}$C (96.8 F +/- 0.5 F) was achieved.
- The system was allowed to operate until all temperature readings stabilized. The final temperature difference between the hot and cold side inlets was checked to ensure that the temperature difference was within the specified conditions of 28 $^{o}$C +/-1 $^{o}$C (50.4 F +/- 1.8 F).
- The heat balance between the hot- and cold-sides of the heat exchanger was checked to ensure that equilibrium was achieved.
- Temperature readings were monitored for approximately 5 minutes (10 minutes for the 4 L/min / 0.88 gpm tests) to ensure that temperature measurements were stable, and that fluctuations in temperature did not exhibit any trending.
- Data was recorded for the next 5 minutes.

This procedure test was repeated at nominal flowrates of 4, 8, 11, and 14 L/min +/- 0.5 L/min (0.88, 1.76., 2.42, and 3.08 gpm +/- 0.11 gpm).

Data Analysis:

- The collected data was plotted to ensure stability, and average values were produced for the test period.
- The temperature difference between the hot-side and cold-side was checked for balance. The balance had to be within 5% for the data to be accepted.

- The effectiveness of the heat exchanger was calculated using
$$\varepsilon = \frac{\left(T_{c,out} - T_{c,in}\right)}{\left(T_{h,in} - T_{c,in}\right)}$$
This equation is valid due to the equal flow condition.
- The heat transfer and pressure drop from the cold-side of the heat exchanger was calculated. The heat transfer was given by
$$q = \dot{m}C_p\left(T_{c,out} - T_{c,in}\right)$$
- The pressure drop was corrected to account for static head between the sensors and pressure loss in the connection piping and fittings (see Section 1.1).

The results from all four flowrates were collected, and the effectiveness, pressure drop, and heat recovery rate were calculated for the nominal operating condition of 9.5 L/min (2.09 gpm), 8 $^{o}$C (46.4 F) cold-side inlet temperature, and 36 $^{o}$C (96.8 F) hot side inlet temperature. Results are also reported for 9.2 L/min as required by some European Standards.

The engineering uncertainty in all measurements was calculated using the method described in Kline and McClintock (1953).

<u>Deviations:</u>

- Heat recovery rates were not used to determine if flow equilibrium was achieved as suggested by the Standard. Heat recovery rates were seen to balance even when the system was clearly not at steady state. A more rigorous condition was applied instead. i.e., all base readings had stabilized, and no trends were observed in the fluctuation of those measurements for five minutes prior to the data collection period.

## 1.3 Samples

Twenty three heat exchangers were tested for RenewABILITY Energy Inc. The products tested are:

- 3” nominal diameter units: 30”, 36”, 48”, 60”, 72”, 84”, 96”, 108”, 120”
- 4” nominal diameter units: 30”, 36”, 42”, 48”, 54”, 60”, 66”, 72”, 78”, 84”, 90”, 96”, 108”, 120”

All units had a 3/8” Type L wrap tube with 6 parallel wraps.

## 2.0 Results

The test results are summarized in the following tables. Table 1 represents results are for the standard test condition of 9.5 L/min flowrate, 8°C mains water inlet temperature, and 36°C drain water inlet temperature. Table 2 represents results are for the test condition of 9.2 L/min flowrate, 8°C mains water inlet temperature, and 36°C drain water inlet temperature.

Complete test reports are included as Appendices A (3" diameter units) and B (4"diameter units).

**Table 1: Results at standard test condition of 9.5 L/min flowrate, 8°C mains water inlet temperature, and 36°C drain water inlet temperature.**

| Model | Nominal Diameter (m / in) | Length (m / ft) | Effectiveness (%) | Pressure Loss (kPa / PSI) | Heat Recovery (kW / BTU/hr) |
|---|---|---|---|---|---|
| C3-30 | 0.08 / 3 | 0.76 / 2.5 | 24.0 | 1.39 / 0.20 | 4.38 / 14974.6 |
| C3-36 | 0.08 / 3 | 0.91 / 3.0 | 30.5 | 2.27 / 0.33 | 5.56 / 18999.7 |
| C3-48 | 0.08 / 3 | 1.22 / 4.0 | 40.1 | 2.73 / 0.40 | 7.55 / 25785.0 |
| C3-60 | 0.08 / 3 | 1.52 / 5.0 | 46.3 | 3.47 / 0.50 | 8.67 / 29603.5 |
| C3-72 | 0.08 / 3 | 1.83 / 6.0 | 48.4 | 3.47 / 0.50 | 8.99 / 30714.7 |
| C3-84 | 0.08 / 3 | 2.13 / 7.0 | 55.8 | 4.60 / 0.67 | 10.14 / 34635.7 |
| C3-96 | 0.08 / 3 | 2.44 / 8.0 | 59.6 | 5.12 / 0.74 | 10.96 / 37419.1 |
| C3-108 | 0.08 / 3 | 2.74 / 9.0 | 61.9 | 5.97 / 0.87 | 11.63 / 39718.2 |
| C3-120 | 0.08 / 3 | 3.05 / 10.0 | 66.1 | 6.36 / 0.92 | 12.13 / 41439.0 |
| | | | | | |
| C4-30 | 0.10 / 4 | 0.76 / 2.5 | 27.9 | 1.84 / 0.27 | 5.17 / 17657.4 |
| C4-36 | 0.10 / 4 | 0.91 / 3.0 | 34.3 | 2.88 / 0.42 | 6.46 / 22076.7 |
| C4-42 | 0.10 / 4 | 1.07 / 3.5 | 39.9 | 3.07 / 0.45 | 7.53 / 25705.0 |
| C4-48 | 0.10 / 4 | 1.22 / 4.0 | 42.5 | 3.89 / 0.56 | 8.01 / 27356.8 |
| C4-54 | 0.10 / 4 | 1.37 / 4.5 | 47.4 | 3.70 / 0.54 | 8.77 / 29944.2 |
| C4-60 | 0.10 / 4 | 1.52 / 5.0 | 49.6 | 4.47 / 0.65 | 9.27 / 31644.3 |
| C4-66 | 0.10 / 4 | 1.68 / 5.5 | 51.7 | 4.94 / 0.72 | 9.63 / 32889.7 |
| C4-72 | 0.10 / 4 | 1.83 / 6.0 | 57.3 | 5.68 / 0.82 | 10.57 / 36111.0 |
| C4-78 | 0.10 / 4 | 1.98 / 6.5 | 58.6 | 5.95 / 0.86 | 10.65 / 36386.6 |
| C4-84 | 0.10 / 4 | 2.13 / 7.0 | 62.6 | 6.11 / 0.89 | 11.41 / 38955.8 |
| C4-90 | 0.10 / 4 | 2.29 / 7.5 | 60.4 | 6.65 / 0.97 | 11.27 / 38494.1 |
| C4-96 | 0.10 / 4 | 2.44 / 8.0 | 64.8 | 7.02 / 1.02 | 11.86 / 40508.3 |
| C4-108 | 0.10 / 4 | 2.74 / 9.0 | 68.3 | 7.66 / 1.11 | 12.58 / 42957.6 |
| C4-120 | 0.10 / 4 | 3.05 / 10.0 | 70.7 | 8.58 / 1.24 | 12.49 / 42646.3 |

**Table 2: Results at test condition of 9.2 L/min flowrate, 8°C mains water inlet temperature, and 36°C drain water inlet temperature.**

| Model | Nominal Diameter (m / in) | Length (m / ft) | Effectiveness (%) | Pressure Loss (kPa / PSI) | Heat Recovery (kW / BTU/hr) |
|---|---|---|---|---|---|
| C3-30 | 0.08 / 3 | 0.76 / 2.5 | 24.3 | 1.23 / 0.18 | 4.39 / 15002.0 |
| C3-36 | 0.08 / 3 | 0.91 / 3.0 | 31.0 | 2.15 / 0.31 | 5.47 / 18689.0 |
| C3-48 | 0.08 / 3 | 1.22 / 4.0 | 41.4 | 2.63 / 0.38 | 7.42 / 25342.2 |
| C3-60 | 0.08 / 3 | 1.52 / 5.0 | 46.7 | 3.27 / 0.47 | 8.43 / 28798.7 |
| C3-72 | 0.08 / 3 | 1.83 / 6.0 | 48.6 | 3.23 / 0.47 | 8.76 / 29910.2 |
| C3-84 | 0.08 / 3 | 2.13 / 7.0 | 56.1 | 4.35 / 0.63 | 9.90 / 33808.6 |
| C3-96 | 0.08 / 3 | 2.44 / 8.0 | 60.2 | 4.87 / 0.71 | 10.69 / 36514.4 |
| C3-108 | 0.08 / 3 | 2.74 / 9.0 | 62.5 | 5.67 / 0.82 | 11.33 / 38700.6 |
| C3-120 | 0.08 / 3 | 3.05 / 10.0 | 66.3 | 6.07 / 0.88 | 11.80 / 40289.8 |
| | | | | | |
| C4-30 | 0.10 / 4 | 0.76 / 2.5 | 28.1 | 1.70 / 0.25 | 5.04 / 17195.8 |
| C4-36 | 0.10 / 4 | 0.91 / 3.0 | 34.6 | 2.76 / 0.40 | 6.26 / 21374.1 |
| C4-42 | 0.10 / 4 | 1.07 / 3.5 | 40.4 | 2.90 / 0.42 | 7.28 / 24856.6 |
| C4-48 | 0.10 / 4 | 1.22 / 4.0 | 43.1 | 3.70 / 0.54 | 7.71 / 26339.7 |
| C4-54 | 0.10 / 4 | 1.37 / 4.5 | 47.7 | 3.52 / 0.51 | 8.50 / 29022.9 |
| C4-60 | 0.10 / 4 | 1.52 / 5.0 | 50.1 | 4.30 / 0.62 | 9.00 / 30741.1 |
| C4-66 | 0.10 / 4 | 1.68 / 5.5 | 52.2 | 4.68 / 0.68 | 9.33 / 31851.8 |
| C4-72 | 0.10 / 4 | 1.83 / 6.0 | 57.1 | 5.41 / 0.78 | 10.22 / 34889.8 |
| C4-78 | 0.10 / 4 | 1.98 / 6.5 | 58.9 | 5.66 / 0.82 | 10.33 / 35294.5 |
| C4-84 | 0.10 / 4 | 2.13 / 7.0 | 62.9 | 5.81 / 0.84 | 11.10 / 37898.7 |
| C4-90 | 0.10 / 4 | 2.29 / 7.5 | 60.4 | 6.34 / 0.92 | 10.93 / 37325.3 |
| C4-96 | 0.10 / 4 | 2.44 / 8.0 | 65.4 | 6.64 / 0.96 | 11.55 / 39455.2 |
| C4-108 | 0.10 / 4 | 2.74 / 9.0 | 68.7 | 7.26 / 1.05 | 12.23 / 41783.7 |
| C4-120 | 0.10 / 4 | 3.05 / 10.0 | 70.8 | 8.14 / 1.18 | 12.16 / 41515.1 |

## 3.0 References

Natural Resources Canada, *Testing Method for Measuring Efficiency of Drain Water Heat Recovery Units*, December 2008.

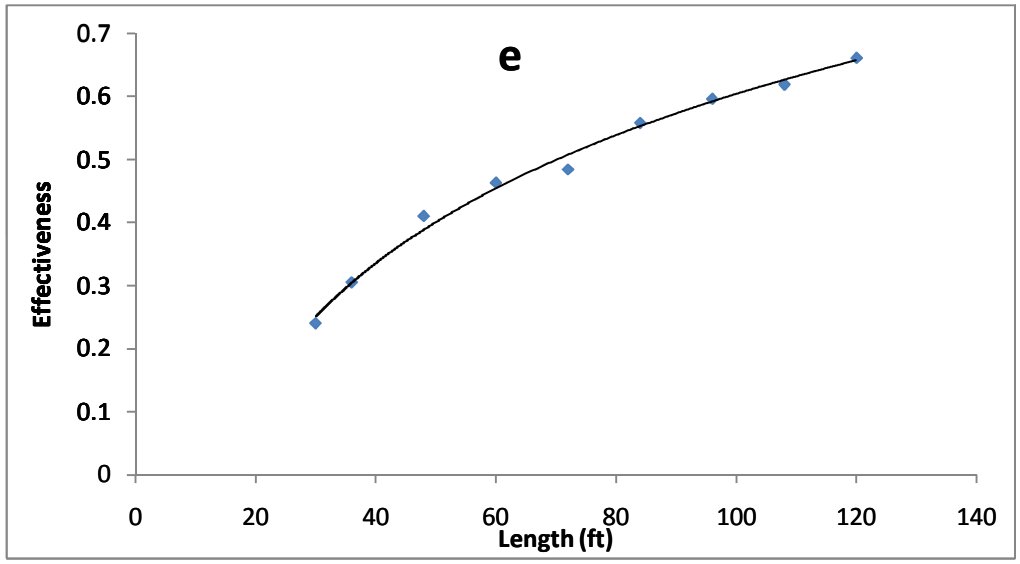
Kline, S.J., and McClintock, F.A. *Describing Experimental Uncertainties in Single Sample Experiments*. **Mechanical Engineering**, Vol. 73, pp. 3-8, 1953.

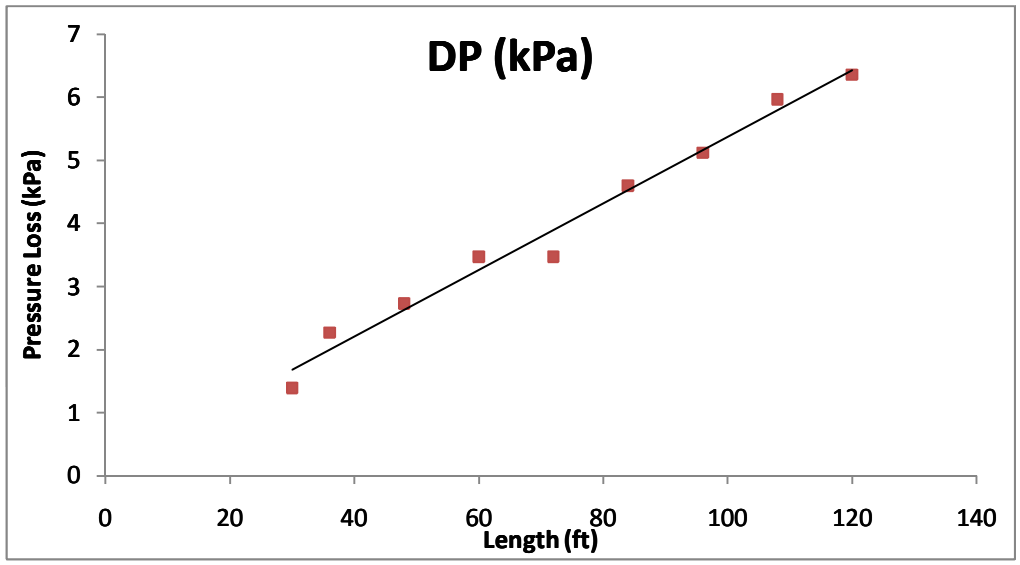
# Appendix A

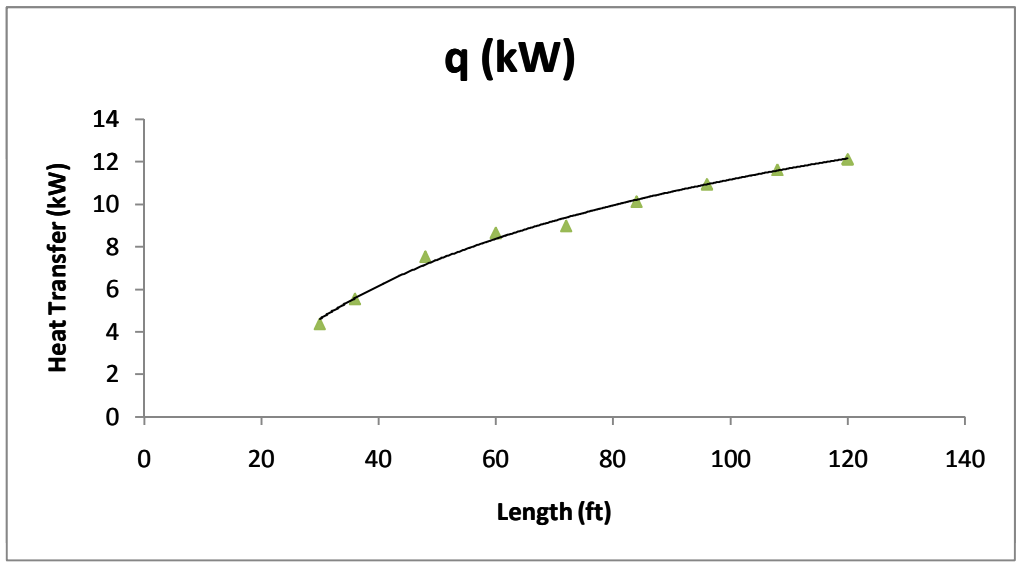
## Test Reports – 3” Nominal Diameter Units

Effectiveness and Pressure Drop at Standard Conditions (9.5 L/min - 8°C Mains, 36 °C Shower)

| L (ft) | ε | ΔP (kPa) | q (kW) |
|---|---|---|---|
| 30 | 0.24 | 1.39 | 4.38 |
| 36 | 0.305 | 2.27 | 5.56 |
| 48 | 0.410 | 2.73 | 7.55 |
| 60 | 0.463 | 3.47 | 8.67 |
| 72 | 0.484 | 3.47 | 8.99 |
| 84 | 0.558 | 4.60 | 10.14 |
| 96 | 0.596 | 5.12 | 10.96 |
| 108 | 0.619 | 5.97 | 11.63 |
| 120 | 0.661 | 6.36 | 12.13 |



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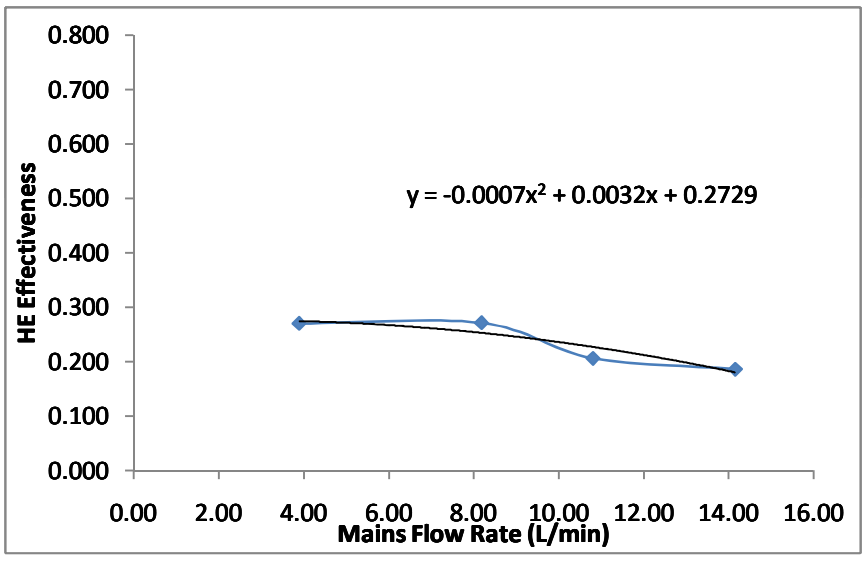
**Product:** 30in C3in
**Manufacturer:** Renewability
**Test Date:** February 8 / 2011

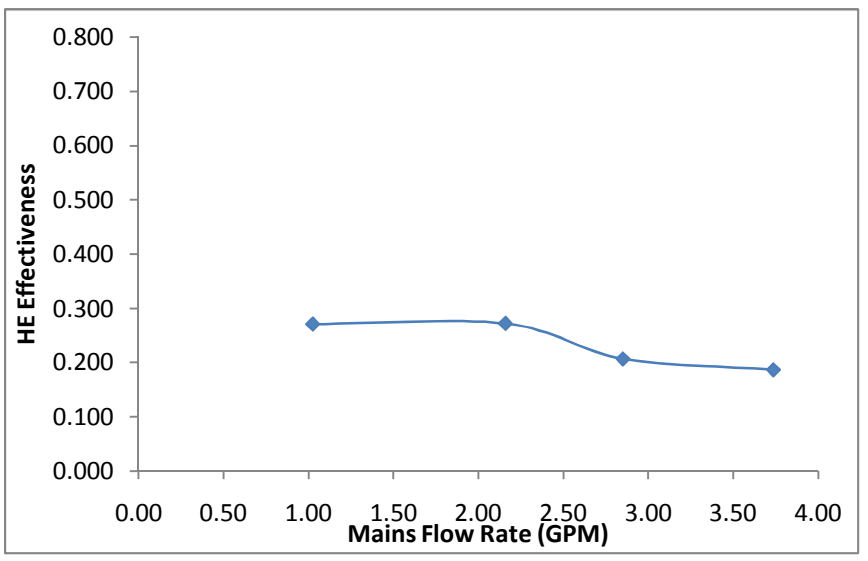
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.89 | 0.271 | 2.05 | 0.00 |
| 8.18 | 0.272 | 4.42 | 0.69 |
| 10.80 | 0.207 | 4.35 | 2.07 |
| 14.15 | 0.187 | 5.36 | 4.87 |

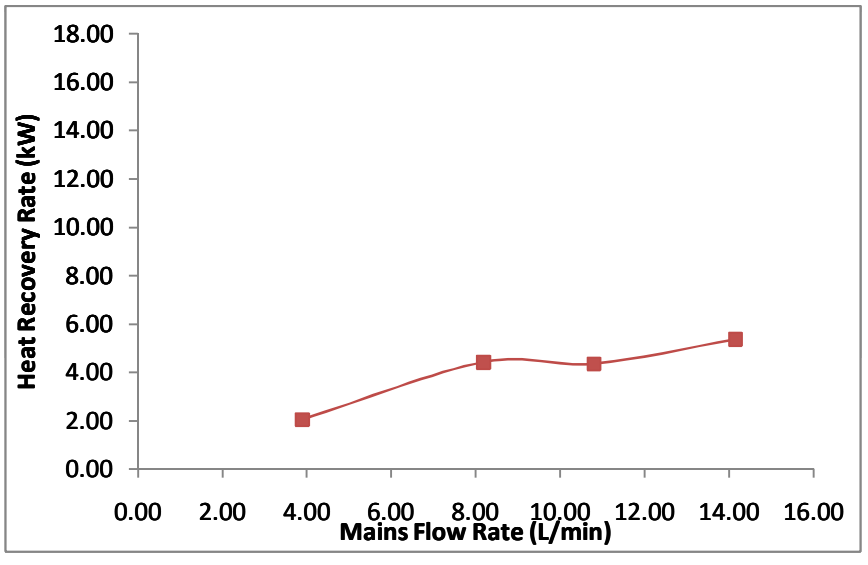
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.03 | 0.271 | 7001.12 | 0.00 |
| 2.16 | 0.272 | 15095.09 | 0.10 |
| 2.85 | 0.207 | 14856.03 | 0.30 |
| 3.74 | 0.187 | 18305.36 | 0.71 |

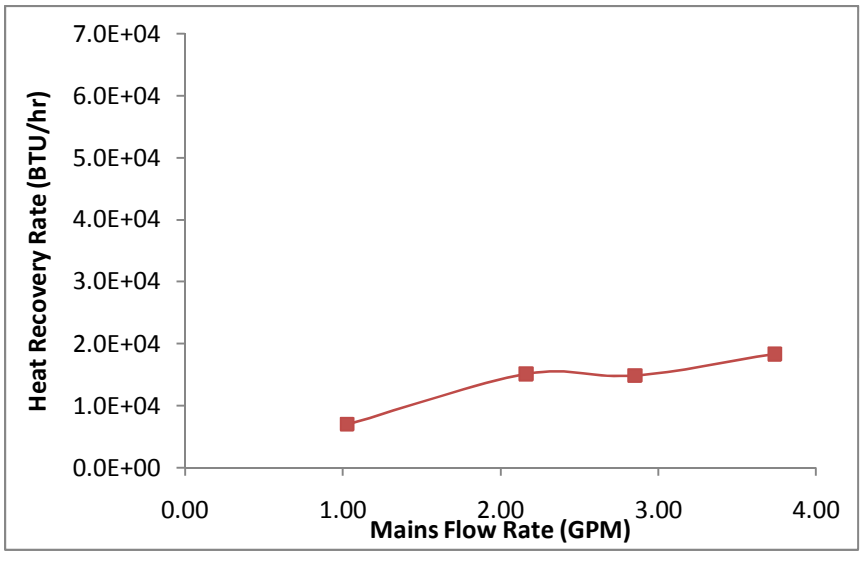
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

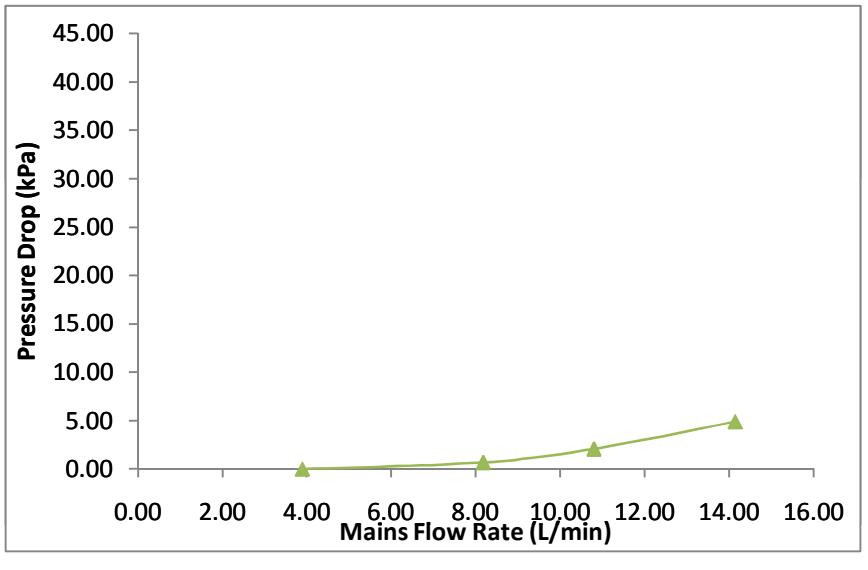
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.240 | | | |
| Heat Recovery | 4.38 | kW | 14974.6 | BTU/hr |
| Pressure Drop | 1.39 | kPa | 0.20 | PSI |

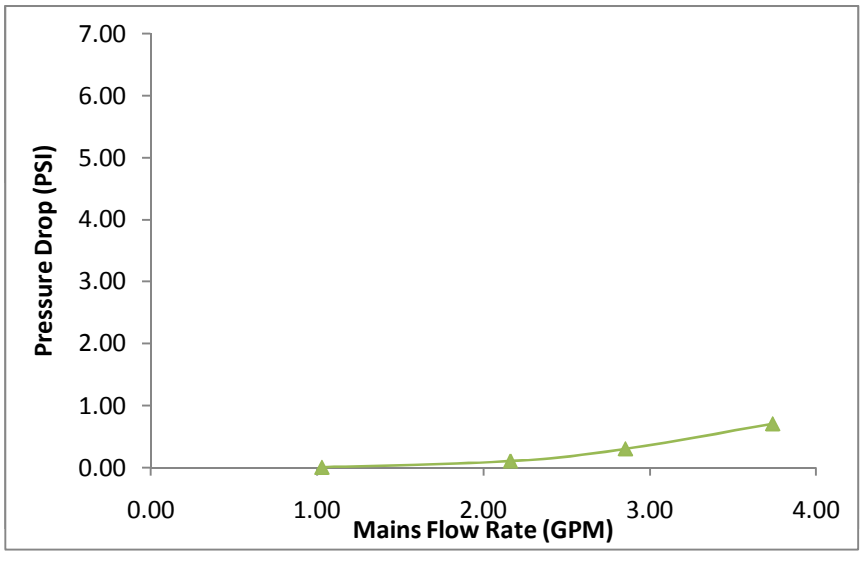


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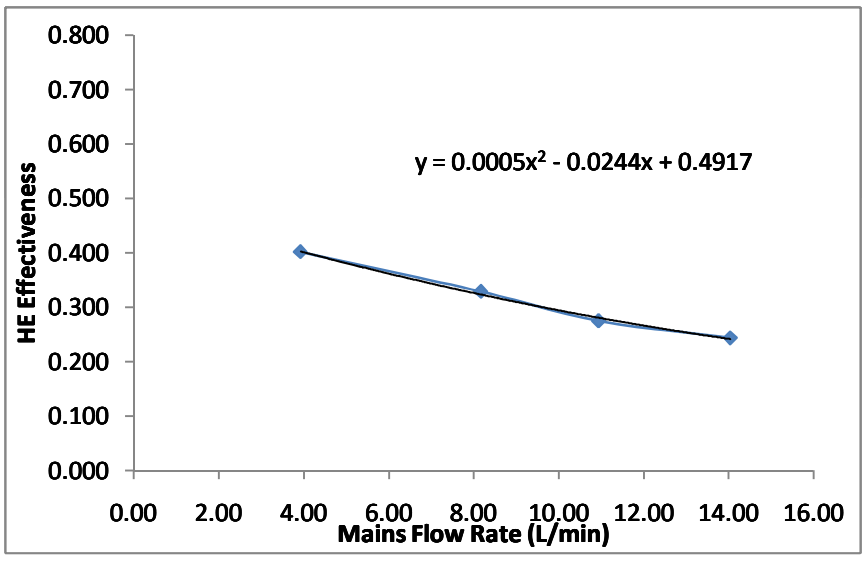
**Product:** 36in C3in
**Manufacturer:** Renewability
**Test Date:** February 24 / 2011

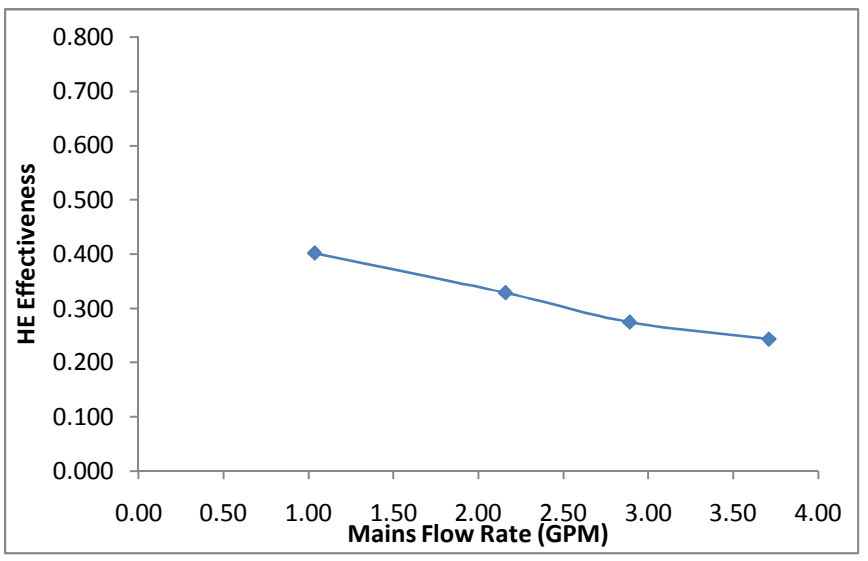
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.92 | 0.402 | 3.11 | 0.52 |
| 8.17 | 0.329 | 5.16 | 1.73 |
| 10.94 | 0.275 | 6.00 | 2.85 |
| 14.04 | 0.244 | 6.89 | 3.56 |

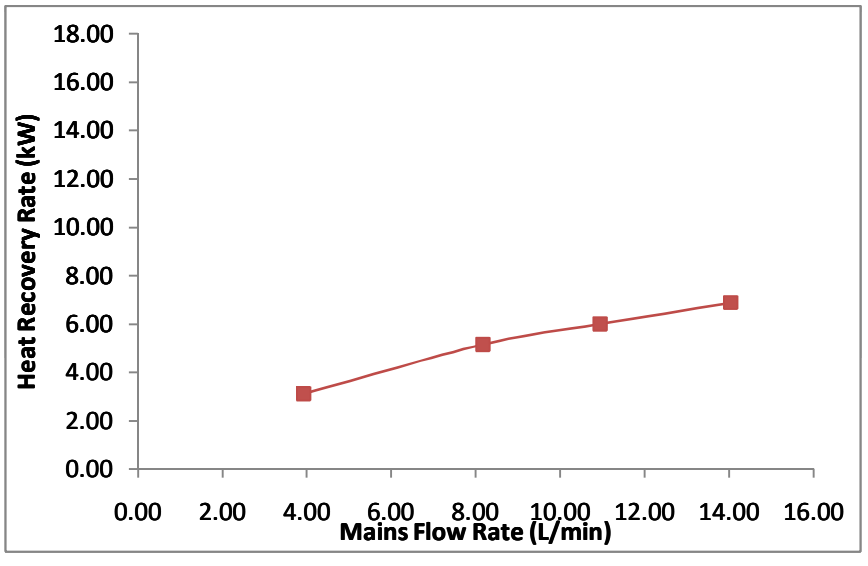
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.04 | 0.402 | 10621.21 | 0.08 |
| 2.16 | 0.329 | 17622.32 | 0.25 |
| 2.89 | 0.275 | 20491.07 | 0.41 |
| 3.71 | 0.244 | 23530.58 | 0.52 |

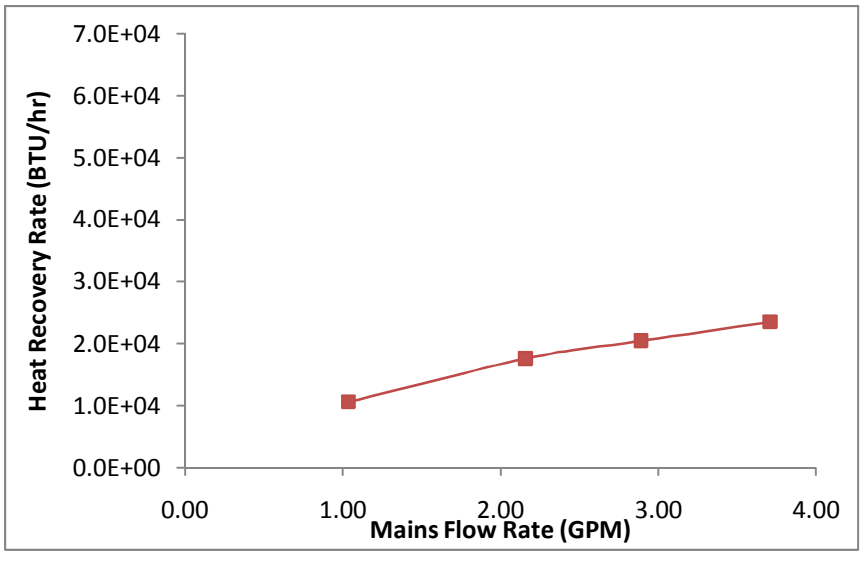
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

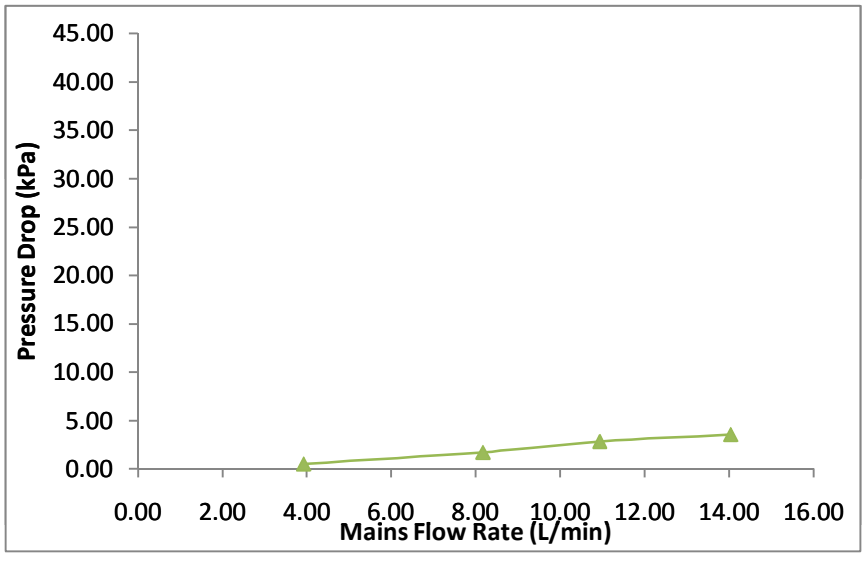
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.305 | | | |
| Heat Recovery | 5.56 | kW | 18999.7 | BTU/hr |
| Pressure Drop | 2.27 | kPa | 0.33 | PSI |

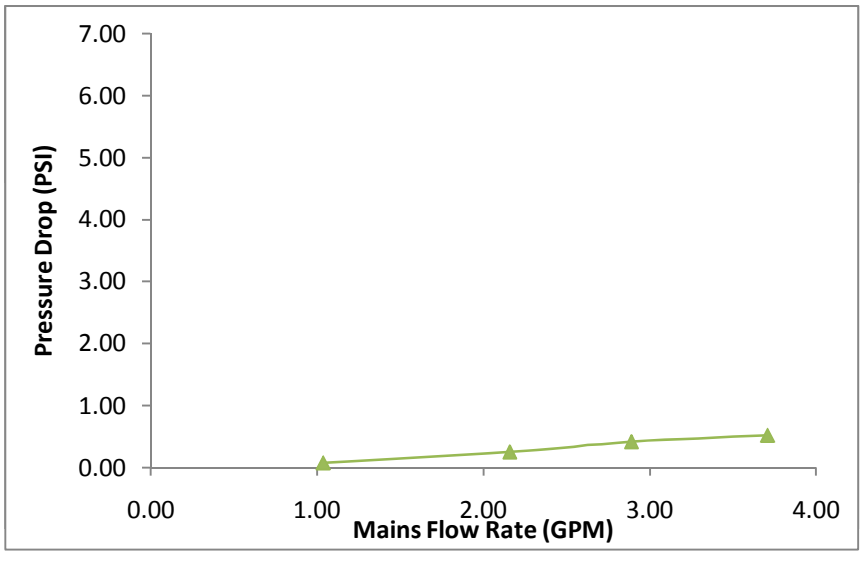


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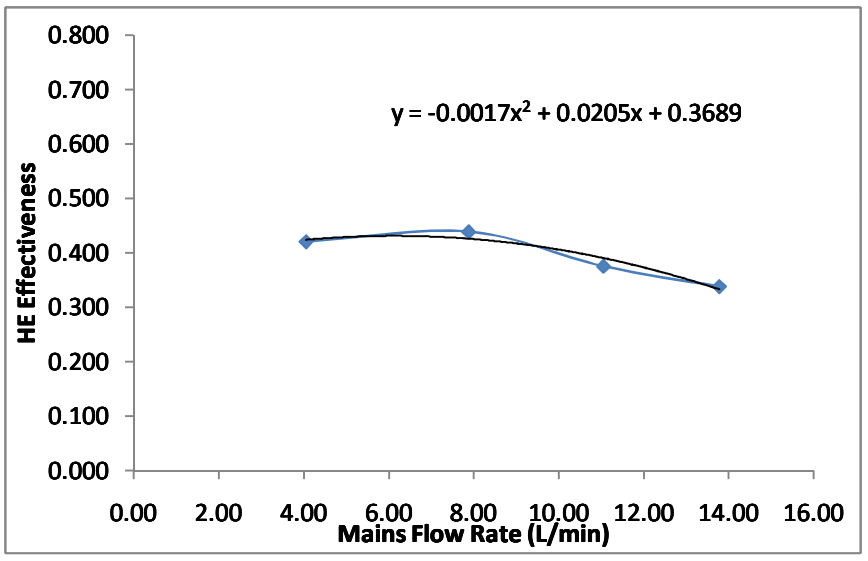
**Product:** 48in C3in
**Manufacturer:** Renewability
**Test Date:** March 10 / 2010

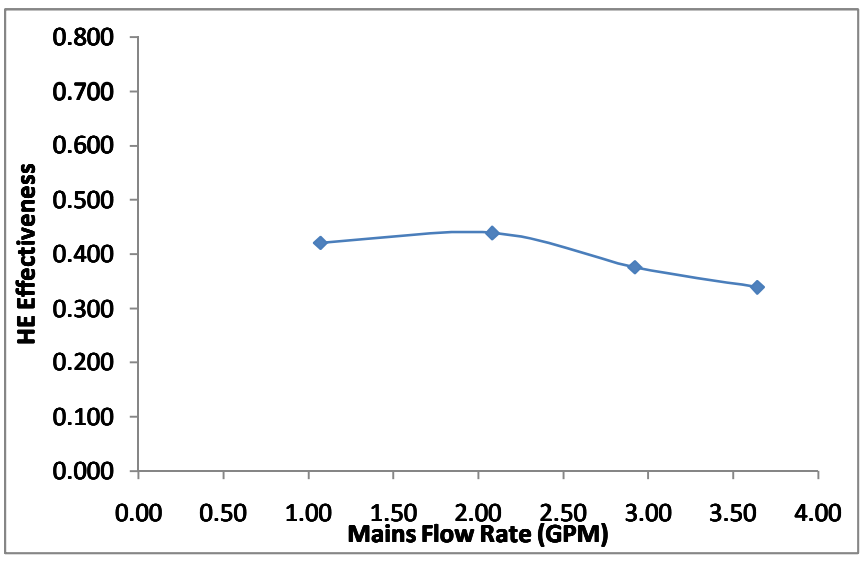
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.05 | 0.421 | 3.32 | 0.00 |
| 7.88 | 0.439 | 6.85 | 2.21 |
| 11.05 | 0.376 | 8.22 | 3.22 |
| 13.78 | 0.339 | 9.02 | 5.04 |

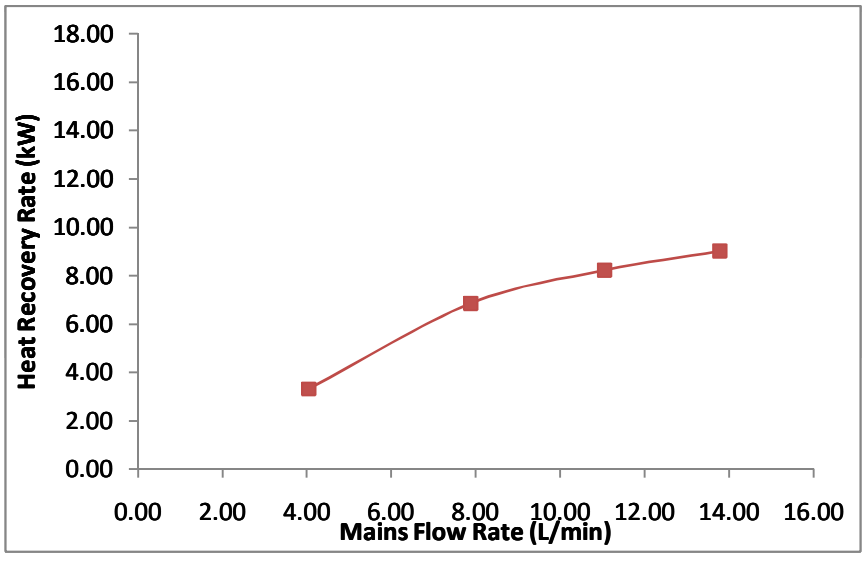
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.07 | 0.421 | 11338.39 | 0.00 |
| 2.08 | 0.439 | 23393.98 | 0.32 |
| 2.92 | 0.376 | 28072.77 | 0.47 |
| 3.64 | 0.339 | 30804.91 | 0.73 |

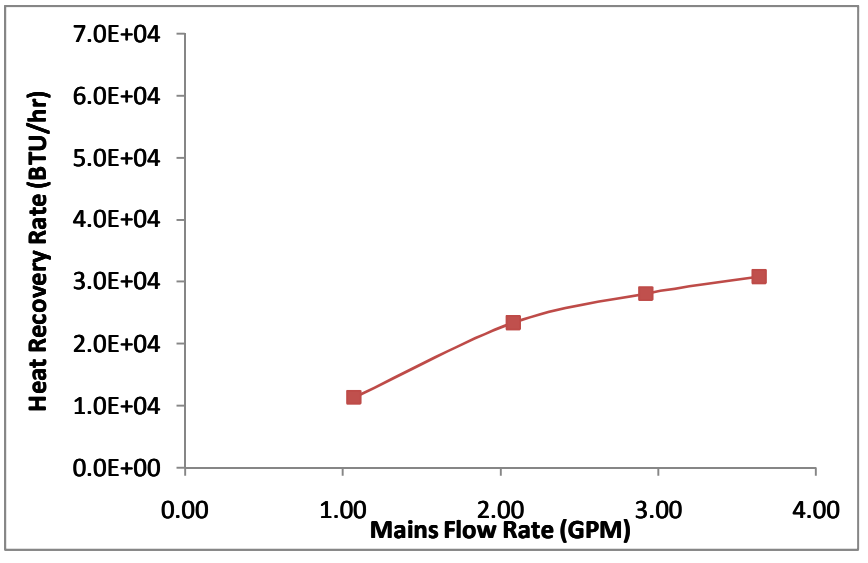
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

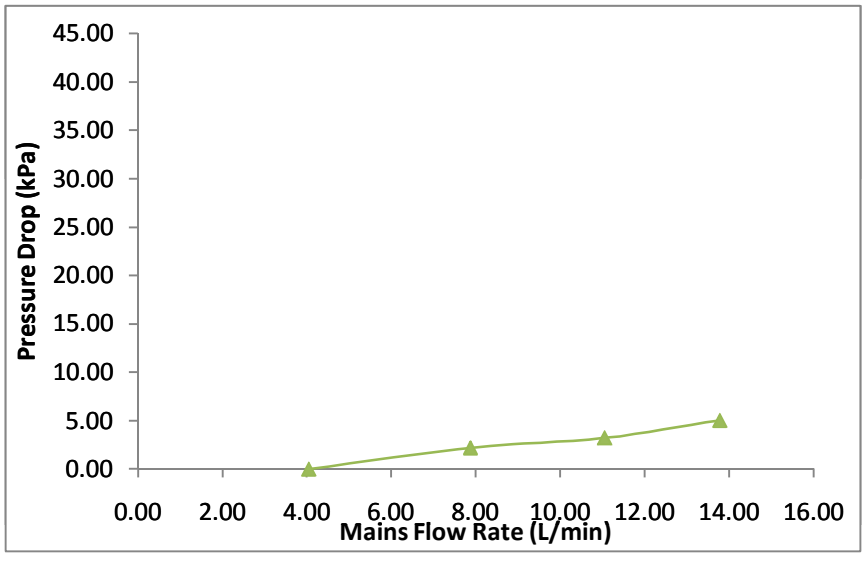
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.410 | | | |
| Heat Recovery | 7.55 | kW | 25785.0 | BTU/hr |
| Pressure Drop | 2.73 | kPa | 0.40 | PSI |

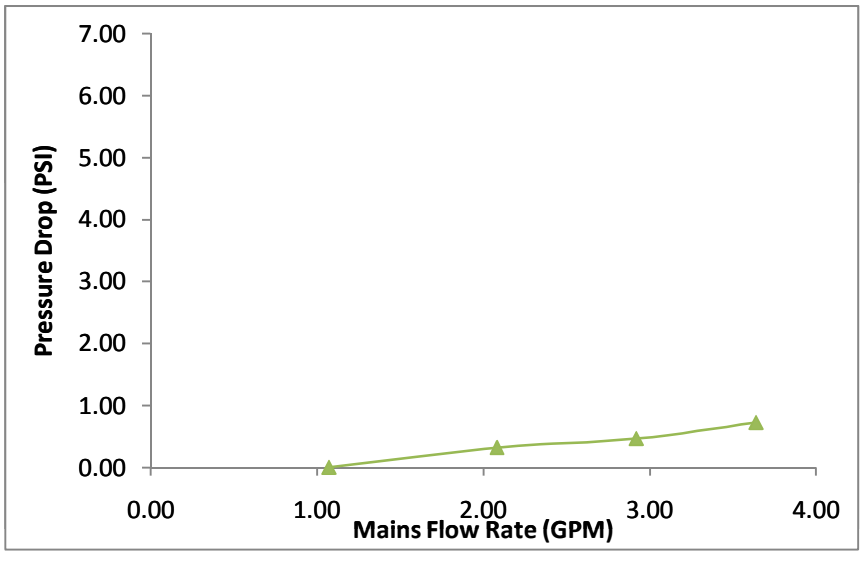


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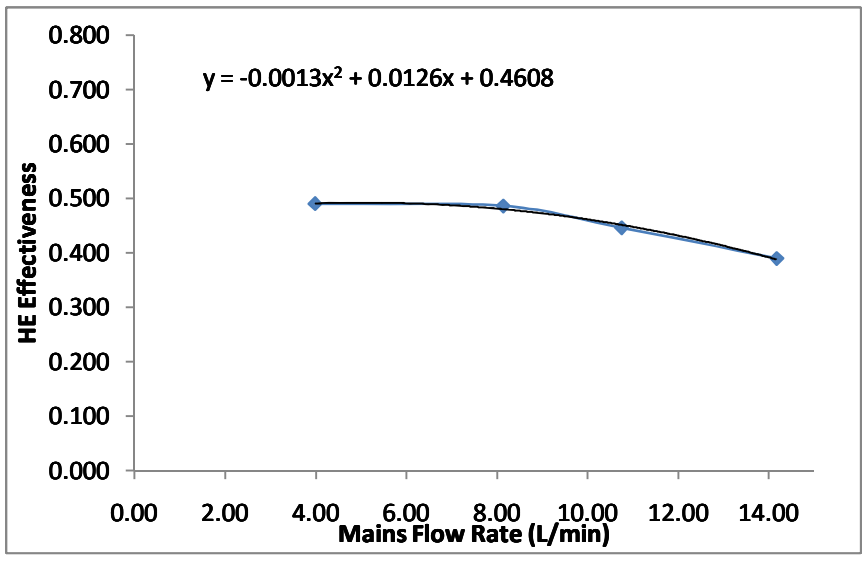
**Product:** 60in C3in
**Manufacturer:** Renewability
**Test Date:** March 10 / 2010

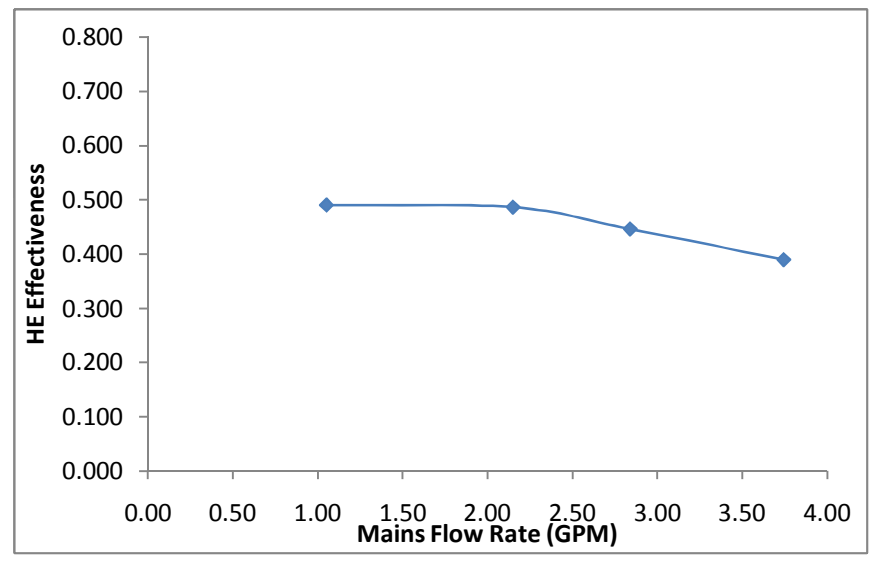
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.99 | 0.490 | 3.88 | 0.65 |
| 8.14 | 0.486 | 7.60 | 2.57 |
| 10.75 | 0.446 | 9.65 | 4.30 |
| 14.17 | 0.390 | 10.56 | 7.98 |

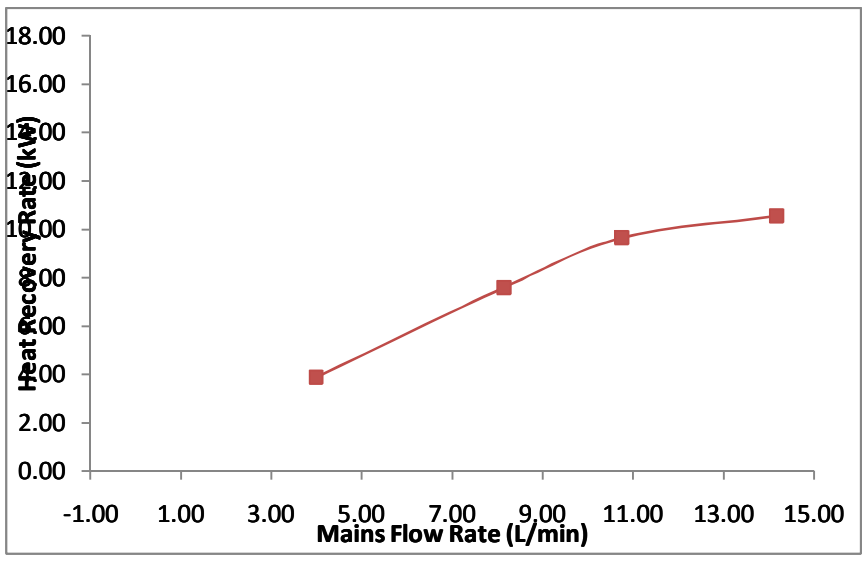
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.05 | 0.490 | 13250.89 | 0.09 |
| 2.15 | 0.486 | 25955.36 | 0.37 |
| 2.84 | 0.446 | 32956.48 | 0.62 |
| 3.74 | 0.390 | 36064.29 | 1.16 |

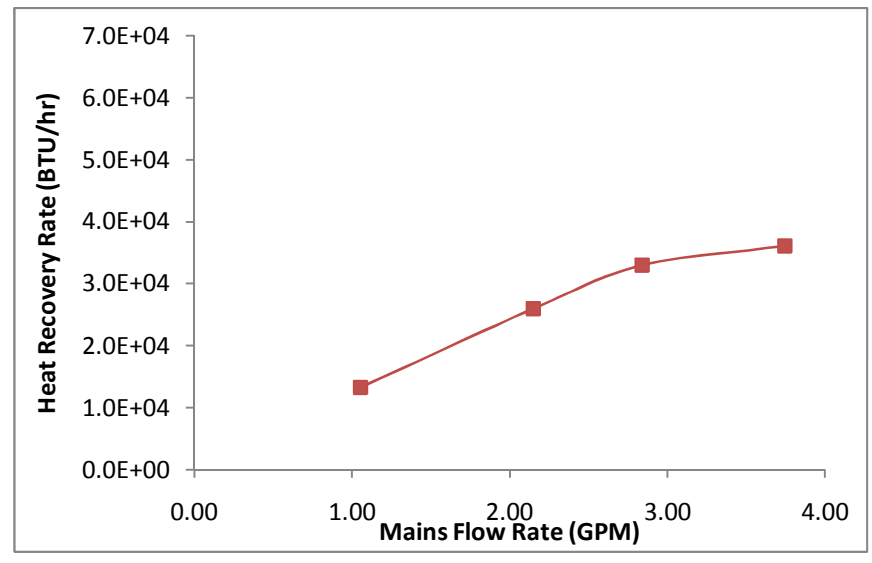
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

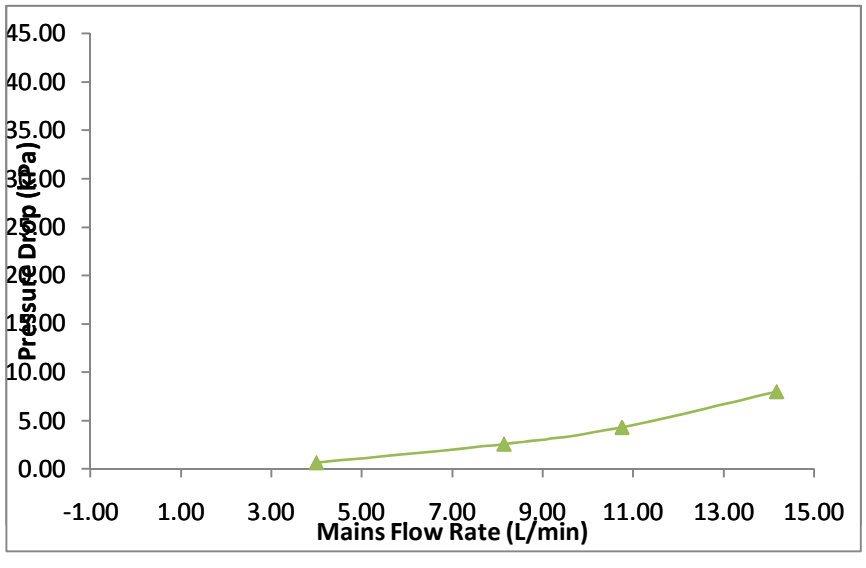
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.463 | | | |
| Heat Recovery | 8.67 | kW | 29603.5 | BTU/hr |
| Pressure Drop | 3.47 | kPa | 0.50 | PSI |

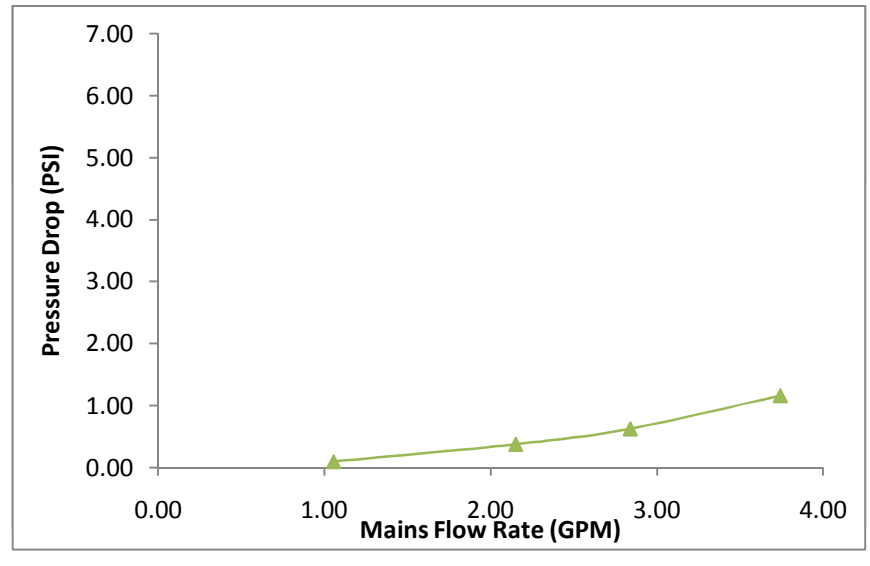


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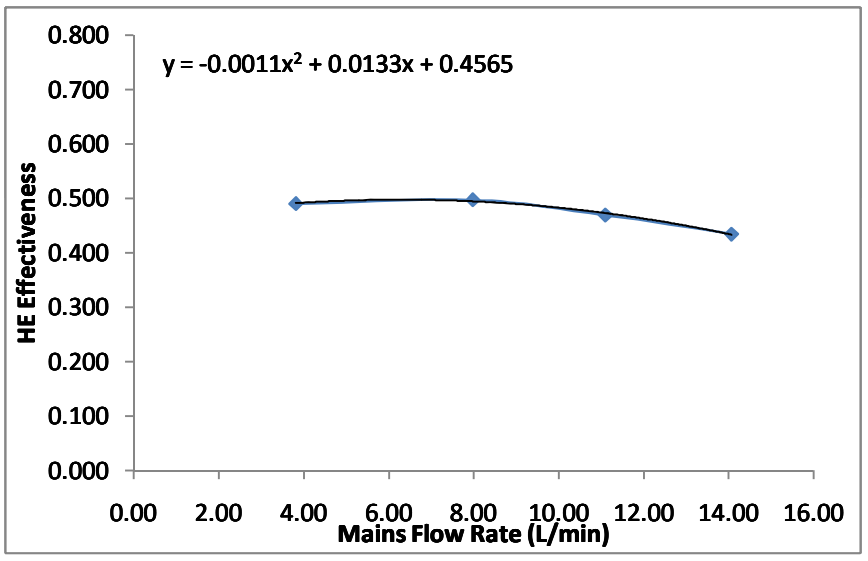
**Product:** 72in C3in
**Manufacturer:** Renewability
**Test Date:** February 11 / 2010

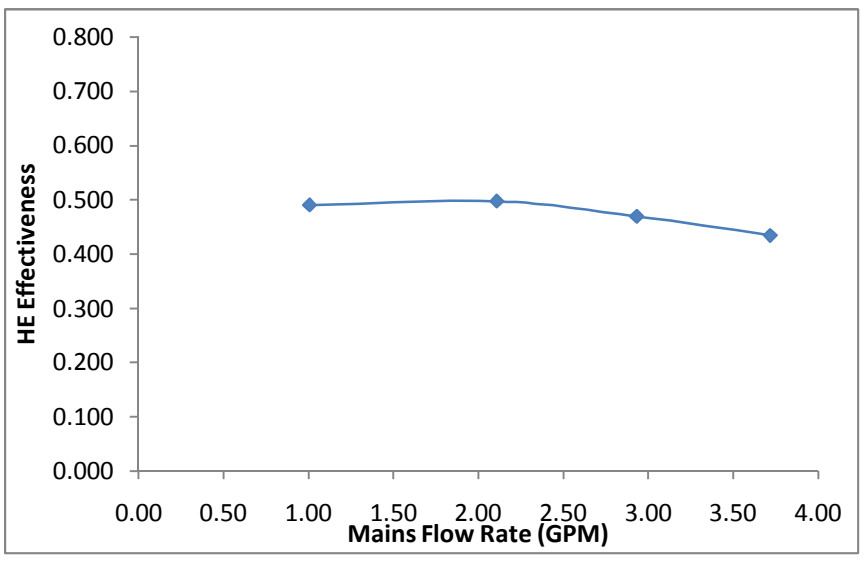
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.81 | 0.491 | 3.56 | 0.00 |
| 7.98 | 0.498 | 7.80 | 2.26 |
| 11.10 | 0.470 | 10.25 | 4.74 |
| 14.07 | 0.435 | 12.23 | 7.32 |

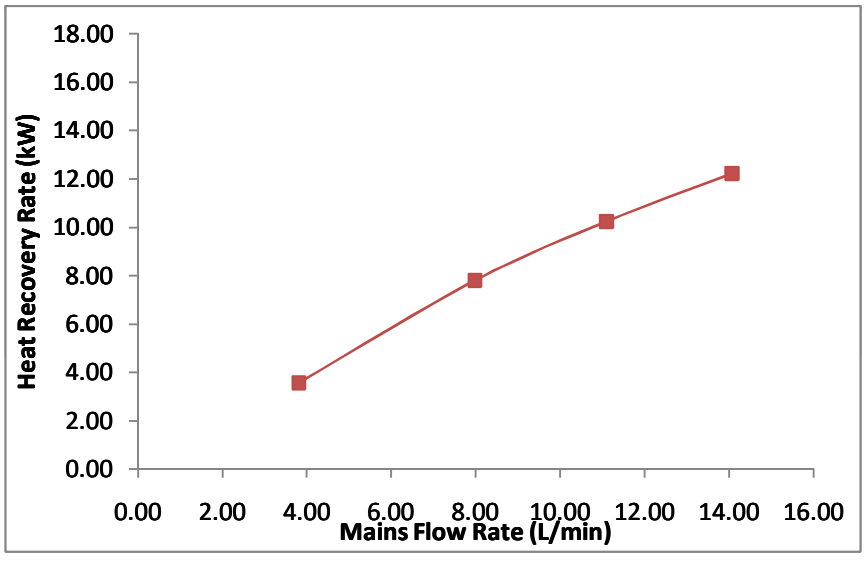
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.01 | 0.491 | 12158.04 | 0.00 |
| 2.11 | 0.498 | 26638.40 | 0.33 |
| 2.93 | 0.470 | 35005.58 | 0.69 |
| 3.72 | 0.435 | 41767.64 | 1.06 |

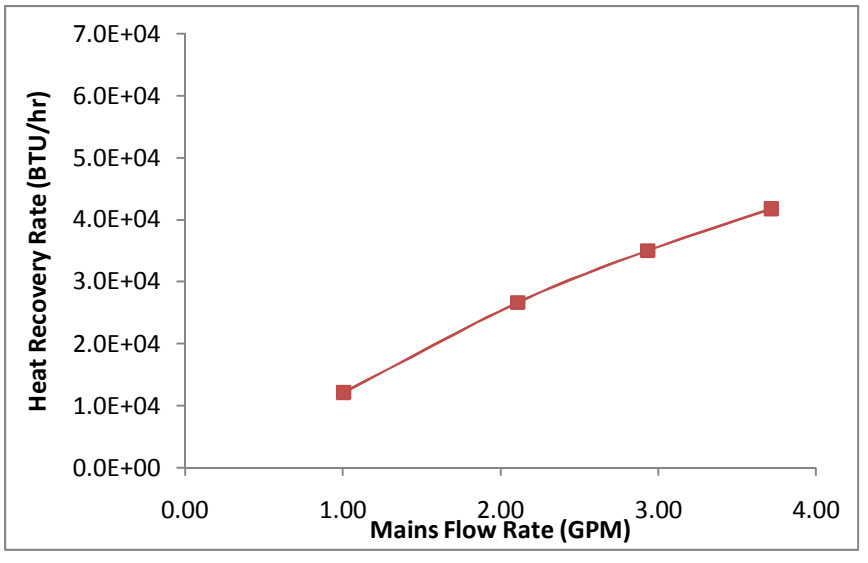
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

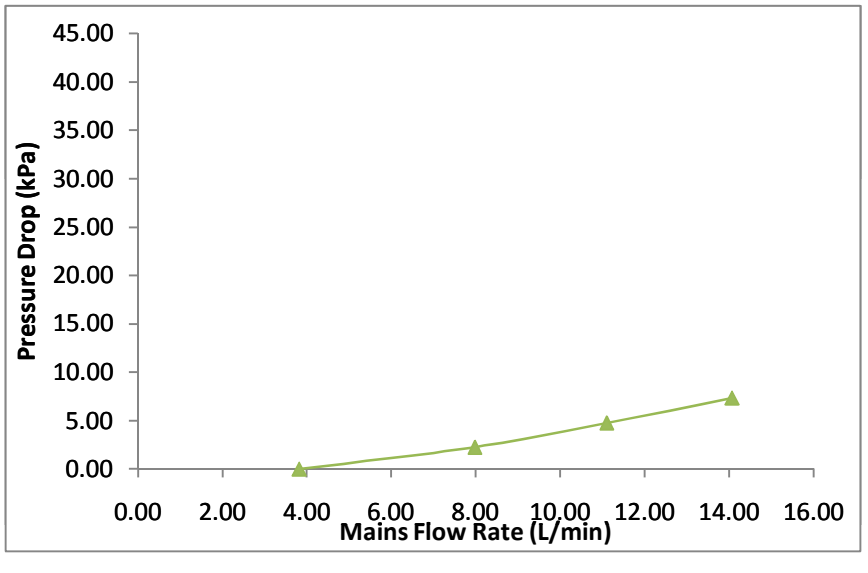
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.484 | | | |
| Heat Recovery | 8.99 | kW | 30714.7 | BTU/hr |
| Pressure Drop | 3.47 | kPa | 0.50 | PSI |

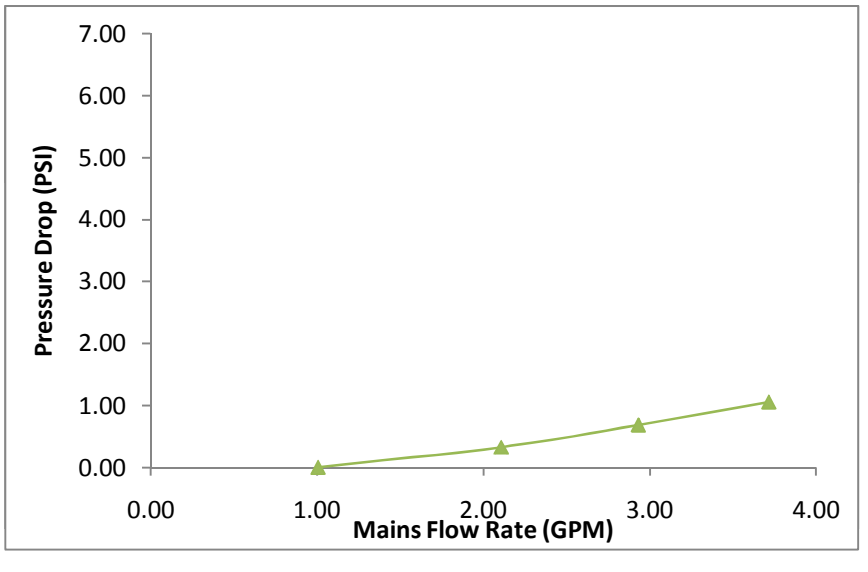


UNIVERSITY OF Waterloo

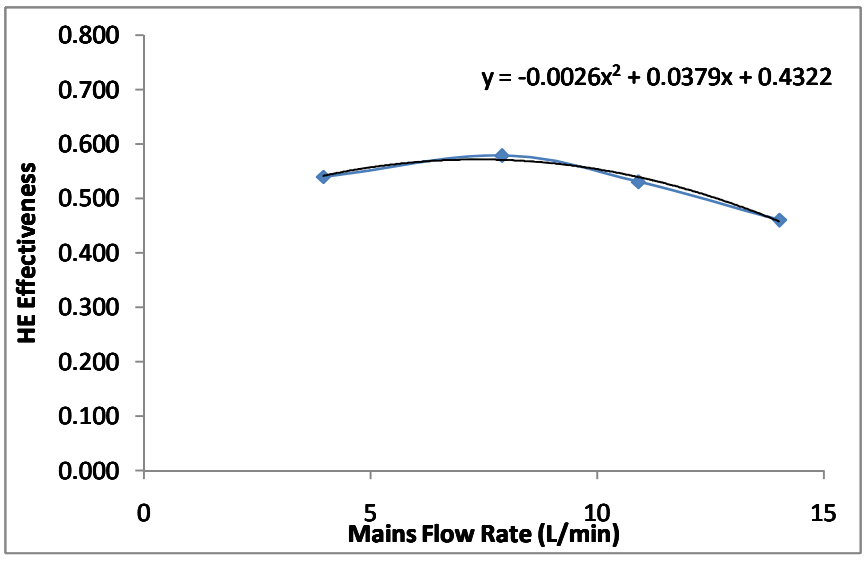
**Product:** 84in C3in
**Manufacturer:** Renewability
**Test Date:** February 8 /2011

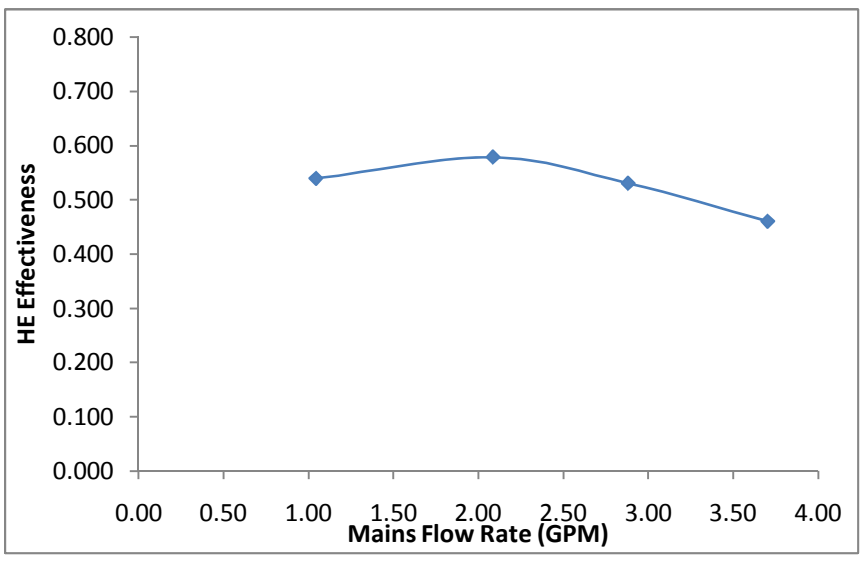
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.96 | 0.540 | 4.22 | 1.37 |
| 7.9 | 0.579 | 8.85 | 3.30 |
| 10.91 | 0.531 | 11.28 | 5.74 |
| 14.02 | 0.461 | 12.33 | 7.79 |

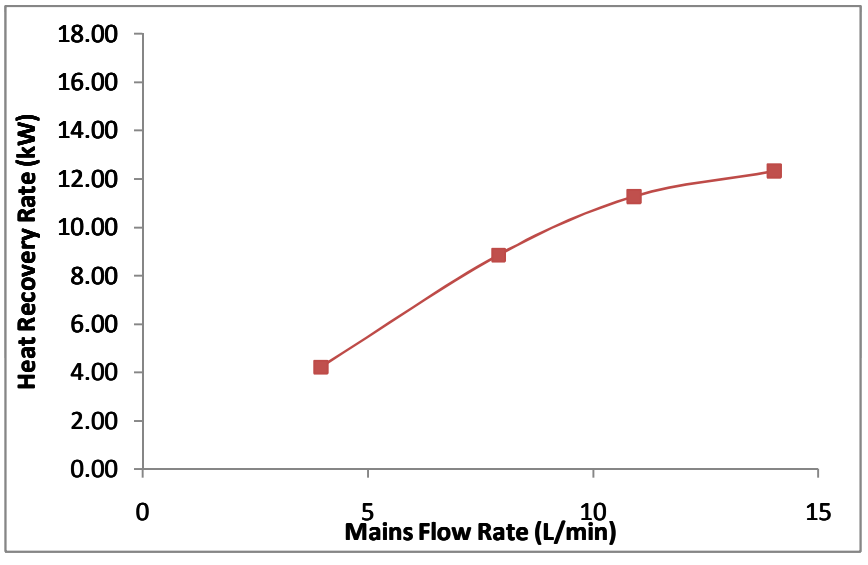
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.05 | 0.540 | 14412.06 | 0.20 |
| 2.09 | 0.579 | 30224.33 | 0.48 |
| 2.88 | 0.531 | 38523.22 | 0.83 |
| 3.70 | 0.461 | 42109.16 | 1.13 |

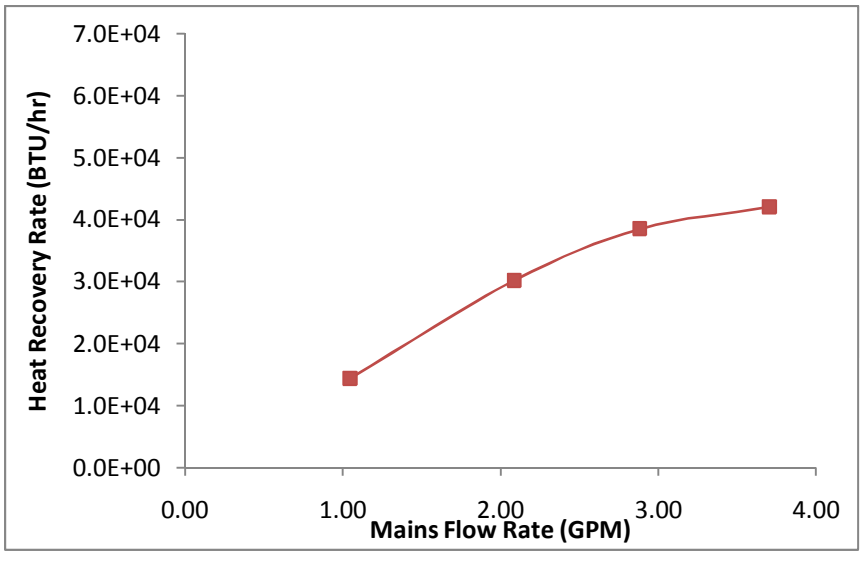
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

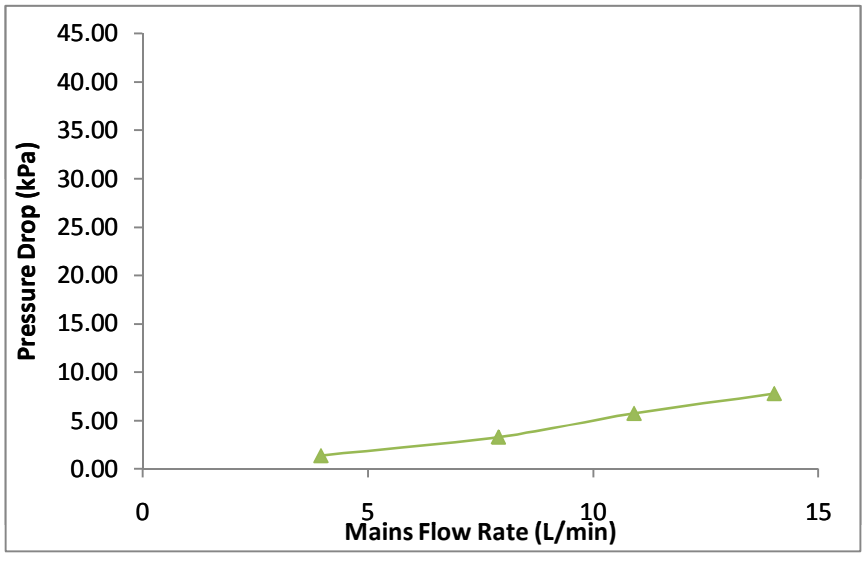
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.558 | | | |
| Heat Recovery | 10.14 | kW | 34635.7 | BTU/hr |
| Pressure Drop | 4.60 | kPa | 0.67 | PSI |

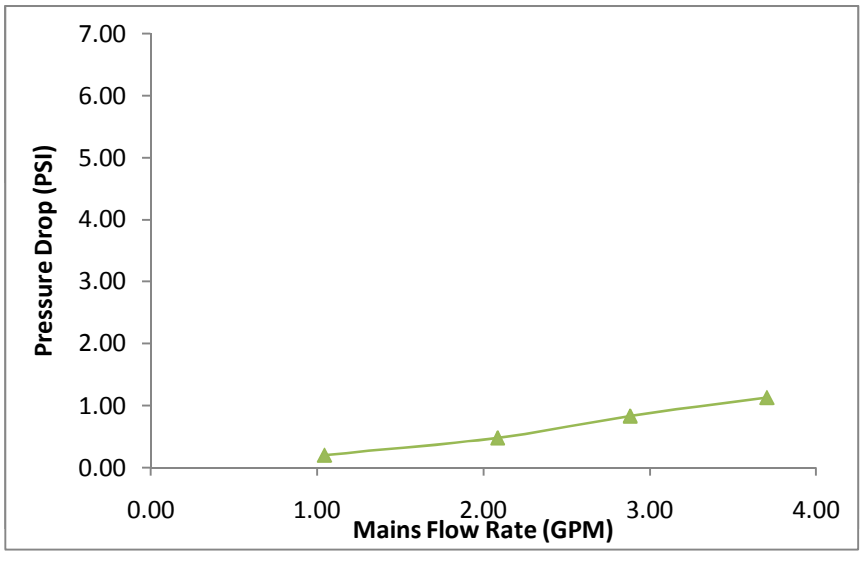


UNIVERSITY OF Waterloo

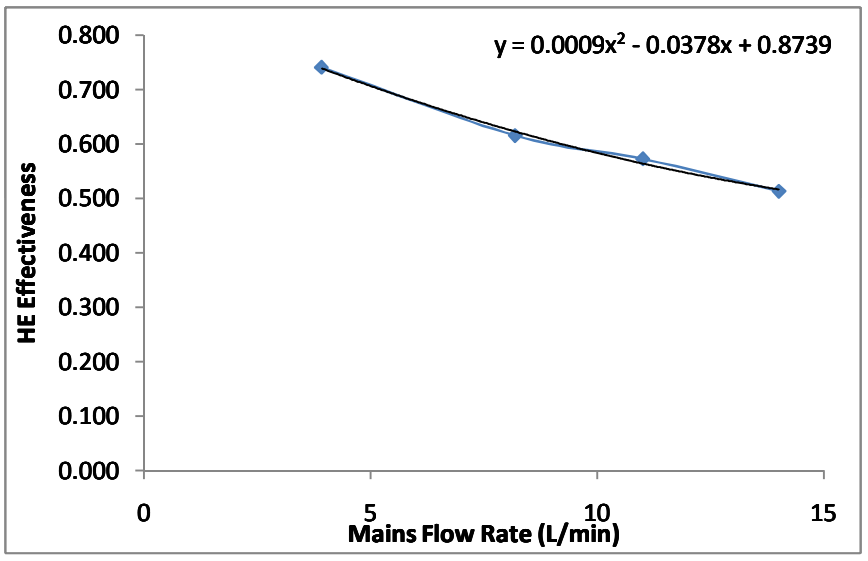
**Product:** 96in C3in
**Manufacturer:** Renewability
**Test Date:** February 8 /2011

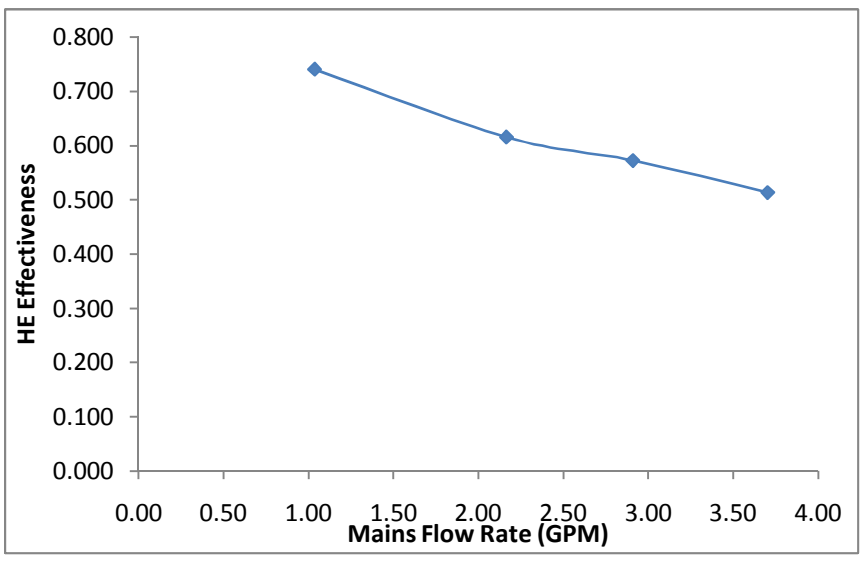
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.92 | 0.741 | 5.48 | 1.17 |
| 8.19 | 0.616 | 9.80 | 4.02 |
| 11.01 | 0.573 | 12.29 | 6.38 |
| 14.01 | 0.514 | 14.13 | 9.85 |

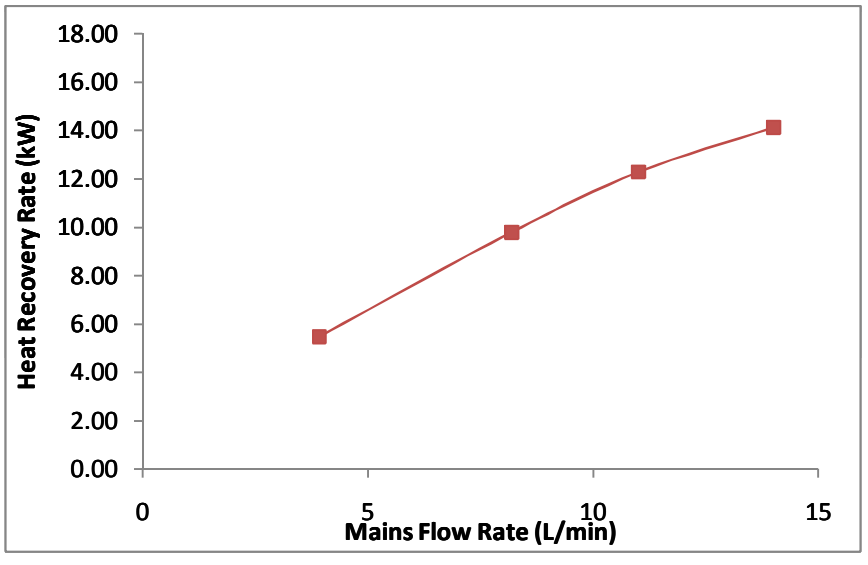
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.04 | 0.741 | 18715.18 | 0.17 |
| 2.16 | 0.616 | 33468.75 | 0.58 |
| 2.91 | 0.573 | 41972.55 | 0.93 |
| 3.70 | 0.514 | 48256.48 | 1.43 |

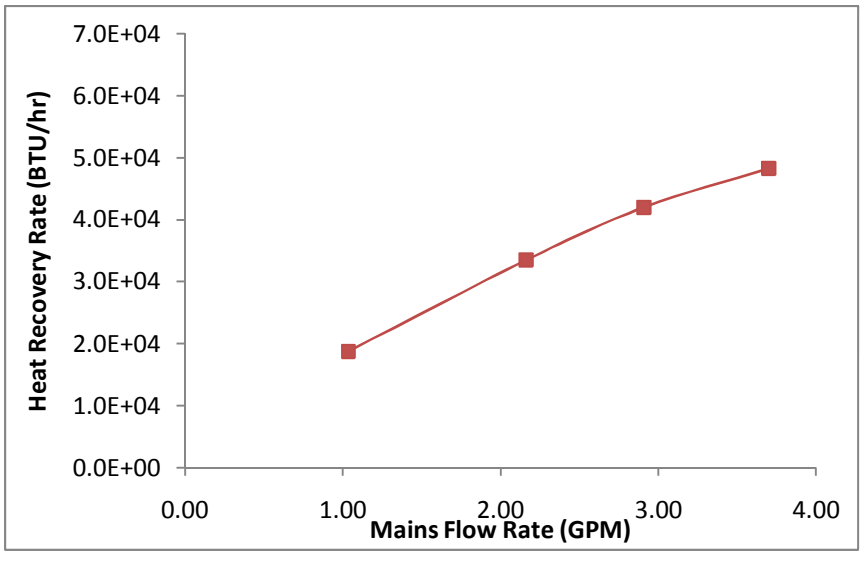
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

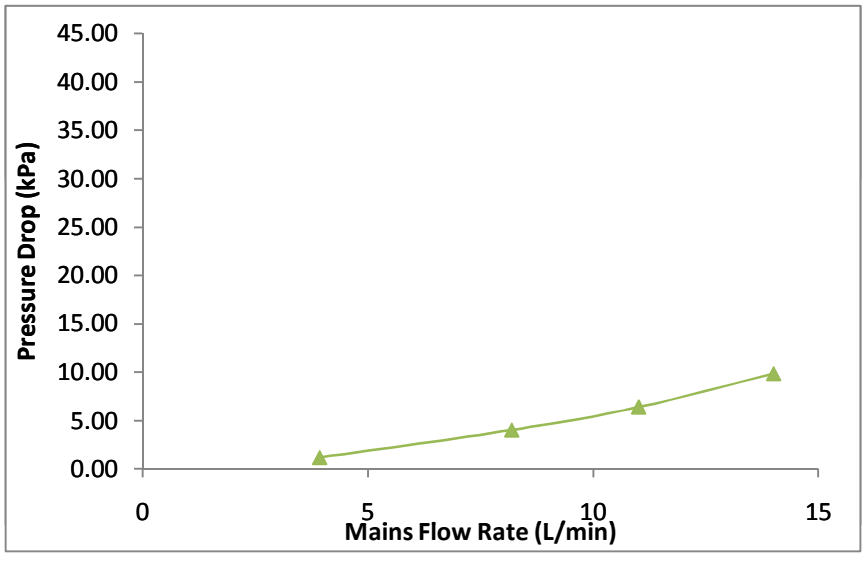
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.596 | | | |
| Heat Recovery | 10.96 | kW | 37419.1 | BTU/hr |
| Pressure Drop | 5.12 | kPa | 0.74 | PSI |

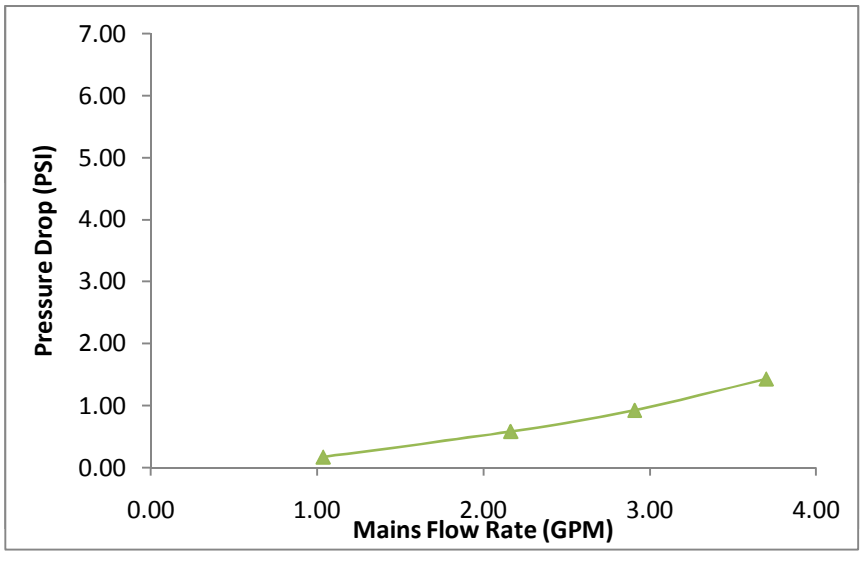


UNIVERSITY OF Waterloo

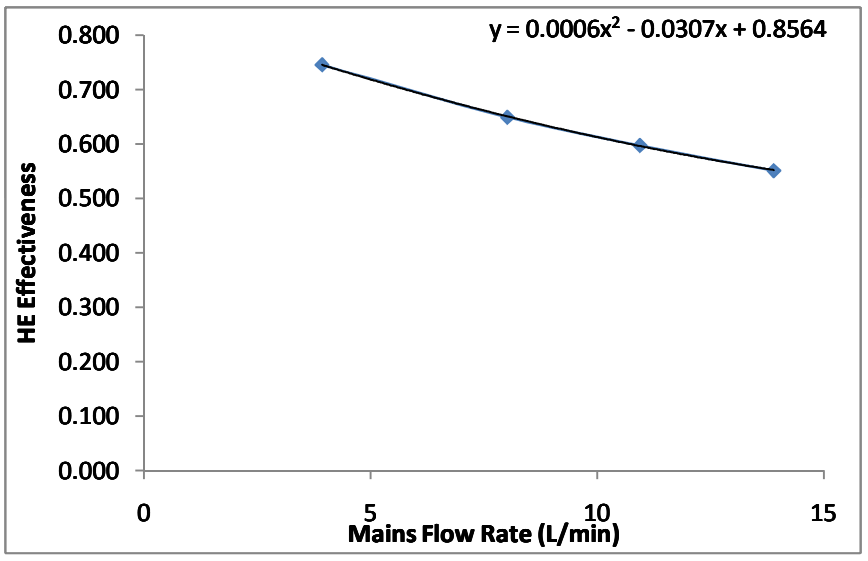
**Product:** 108in C3in
**Manufacturer:** Renewability
**Test Date:** February 8 /2011

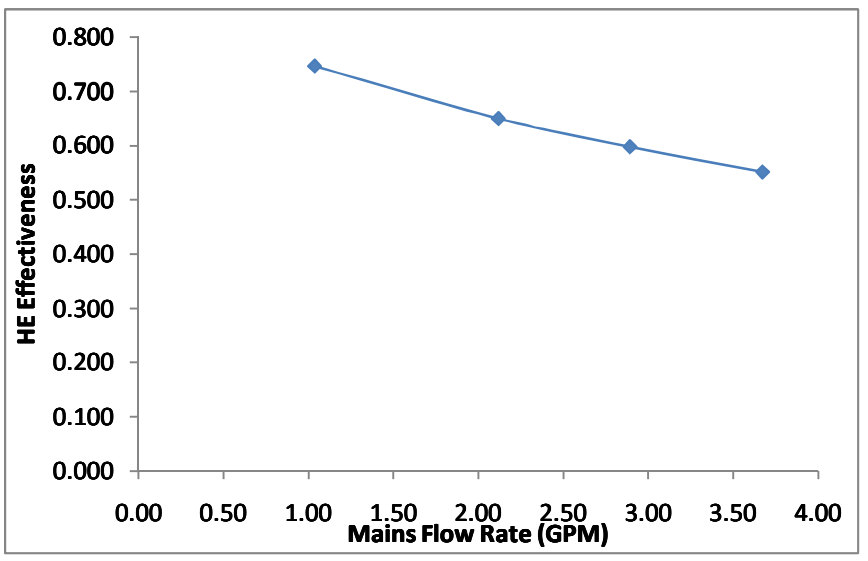
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.93 | 0.746 | 5.90 | 1.75 |
| 8.02 | 0.650 | 10.16 | 4.47 |
| 10.95 | 0.598 | 13.07 | 7.44 |
| 13.9 | 0.552 | 15.23 | 10.09 |

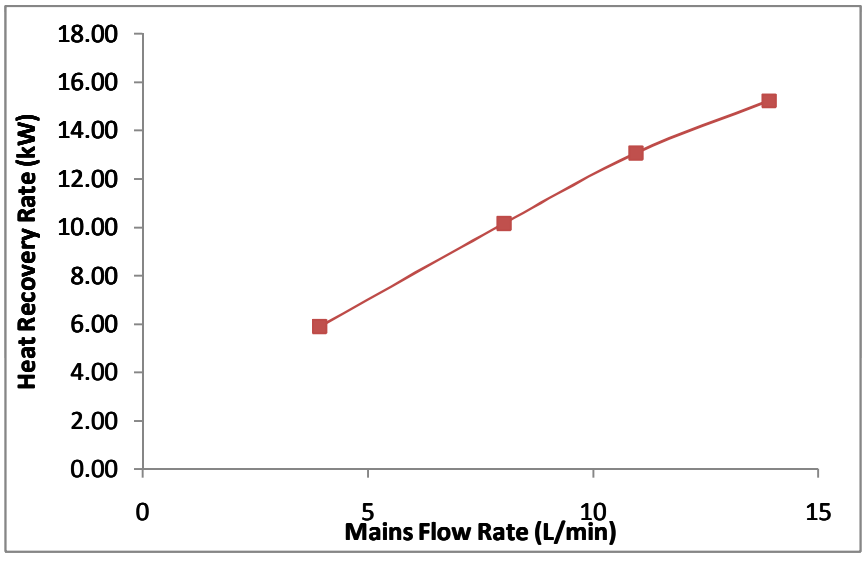
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.04 | 0.746 | 20149.56 | 0.25 |
| 2.12 | 0.650 | 34698.22 | 0.65 |
| 2.89 | 0.598 | 44636.39 | 1.08 |
| 3.67 | 0.552 | 52013.18 | 1.46 |

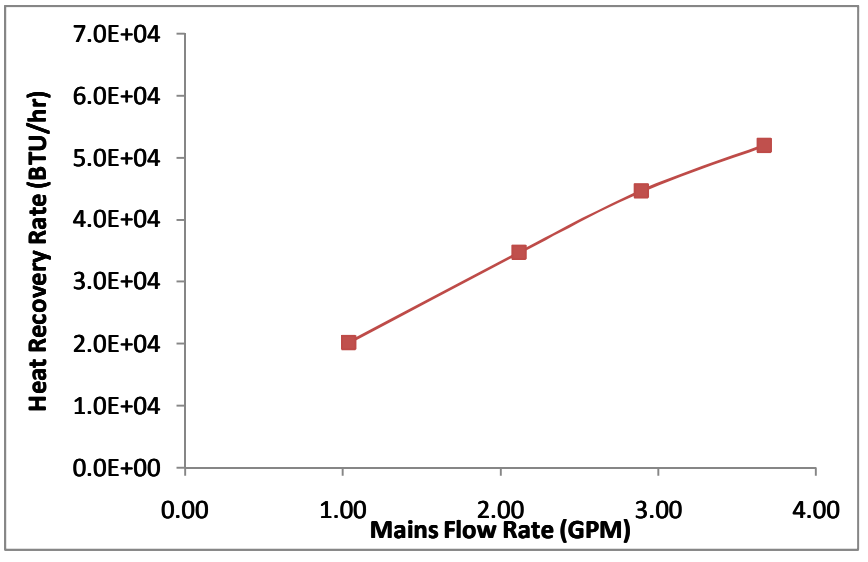
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

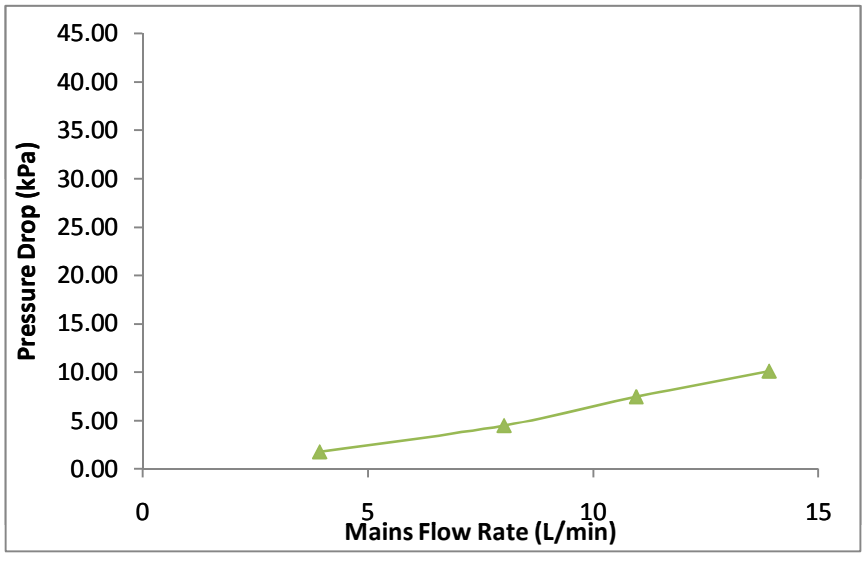
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.619 | | | |
| Heat Recovery | 11.63 | kW | 39718.2 | BTU/hr |
| Pressure Drop | 5.97 | kPa | 0.87 | PSI |

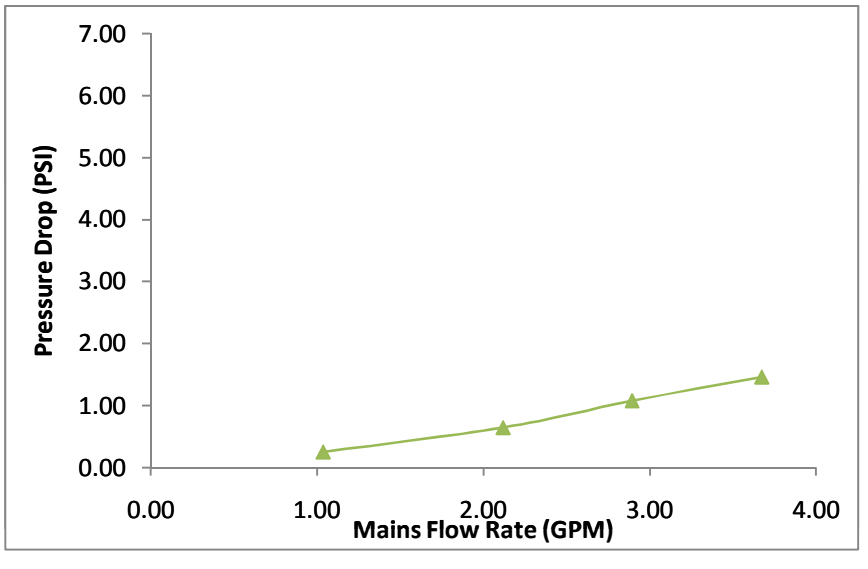


UNIVERSITY OF Waterloo

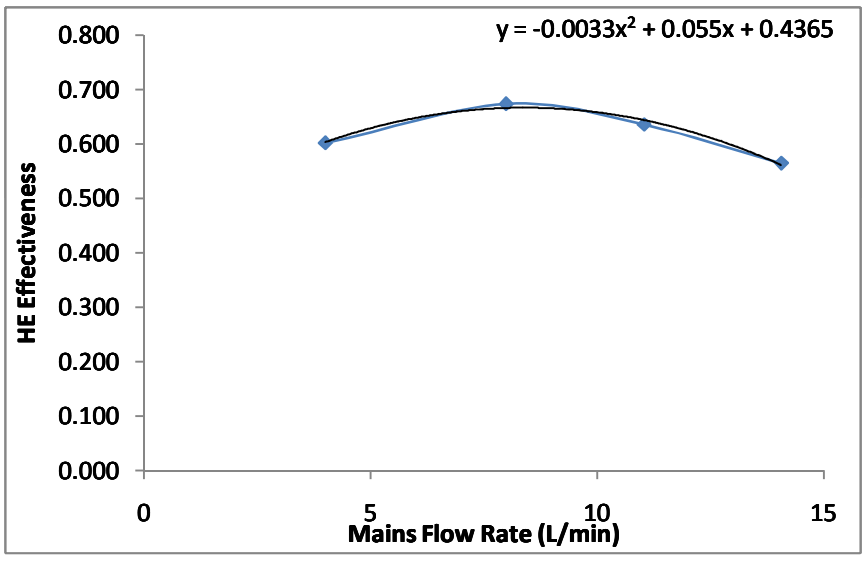
**Product:** 120in C3in
**Manufacturer:** Renewability
**Test Date:** March 10 / 2010

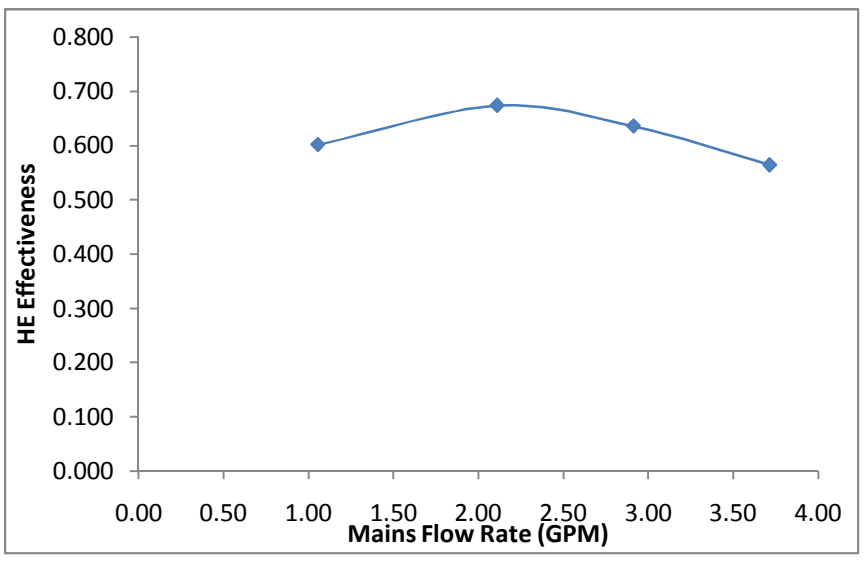
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4 | 0.602 | 4.67 | 1.00 |
| 7.99 | 0.674 | 10.44 | 4.93 |
| 11.03 | 0.636 | 13.85 | 7.80 |
| 14.06 | 0.565 | 15.41 | 12.85 |

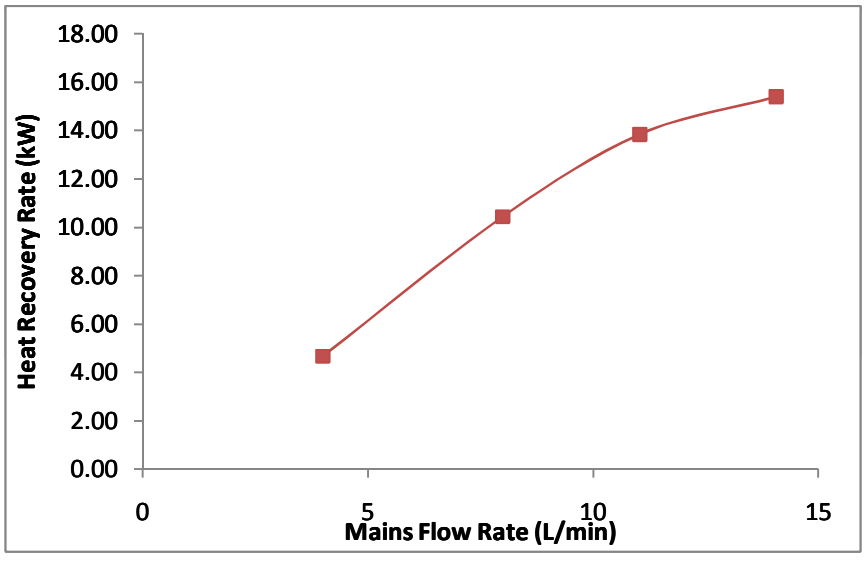
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.06 | 0.602 | 15948.89 | 0.15 |
| 2.11 | 0.674 | 35654.47 | 0.72 |
| 2.91 | 0.636 | 47300.23 | 1.13 |
| 3.71 | 0.565 | 52627.91 | 1.86 |

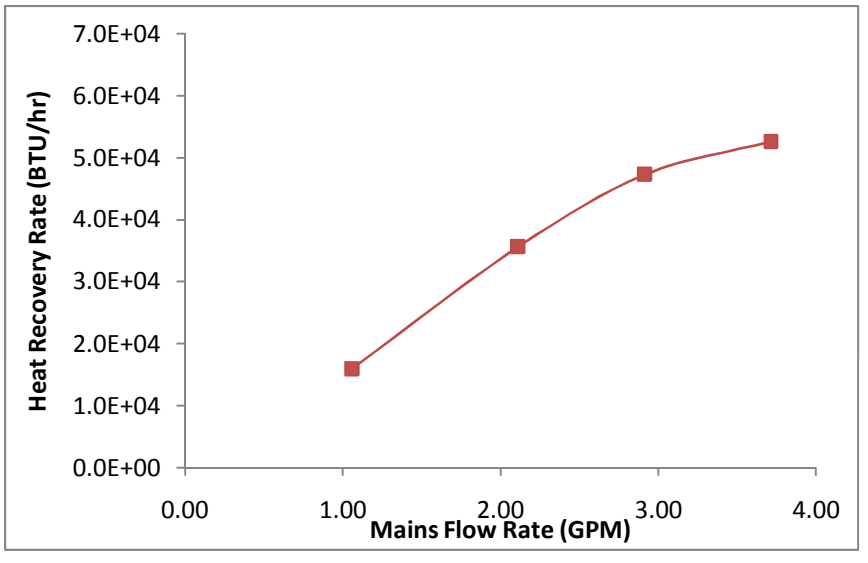
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

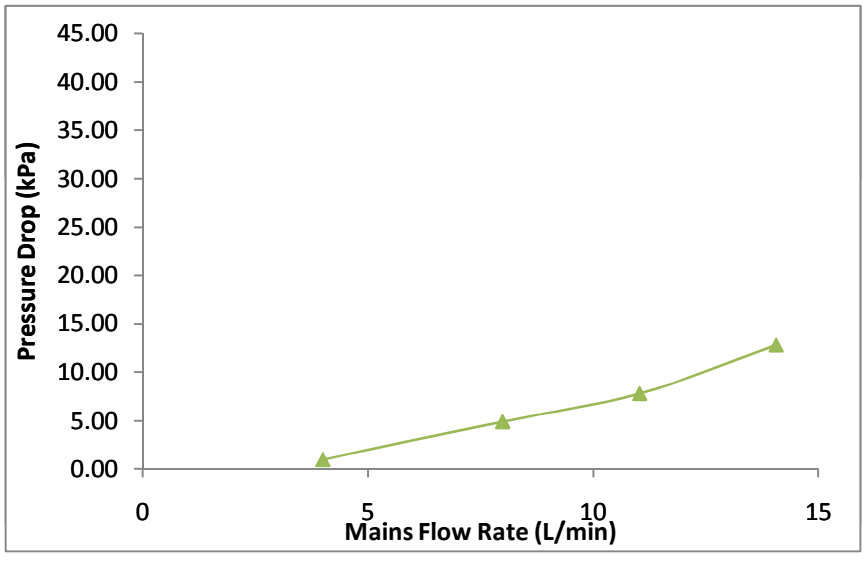
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.661 | | | |
| Heat Recovery | 12.13 | kW | 41439.0 | BTU/hr |
| Pressure Drop | 6.36 | kPa | 0.92 | PSI |

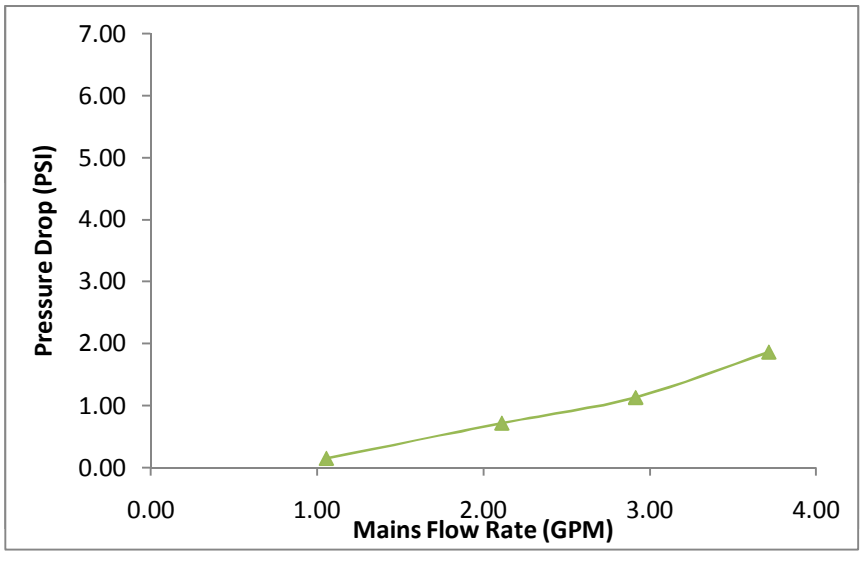


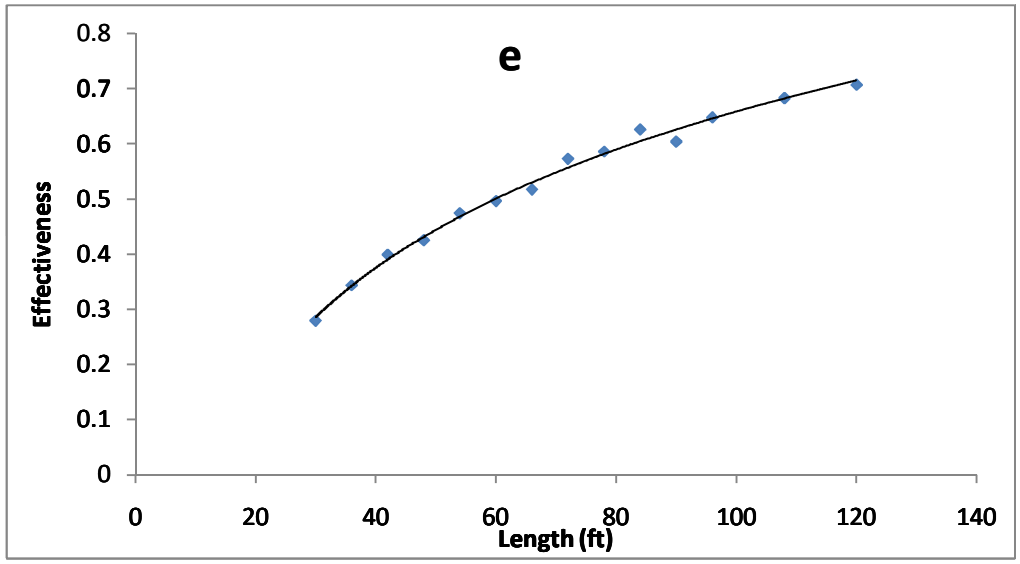



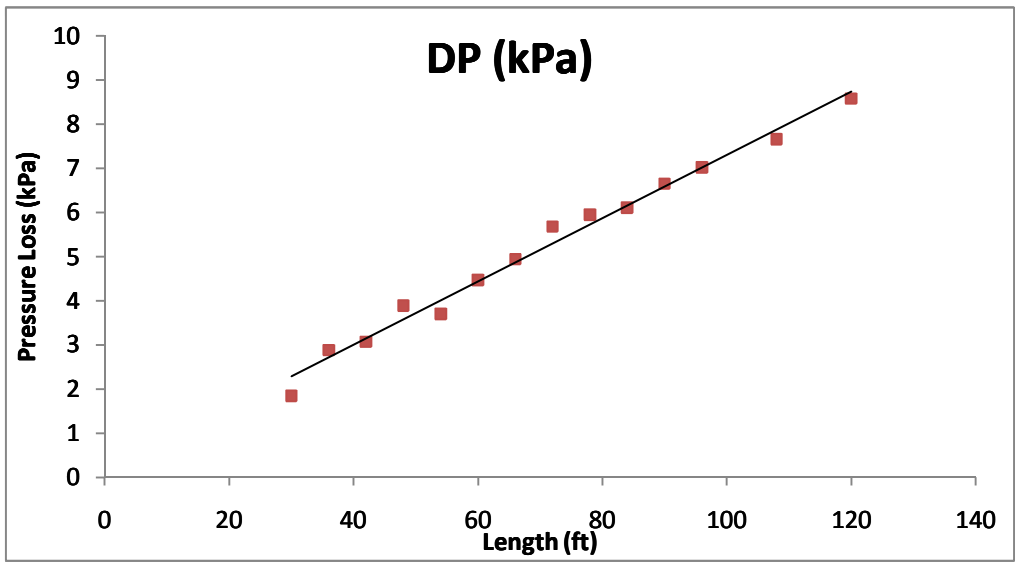
# Appendix B

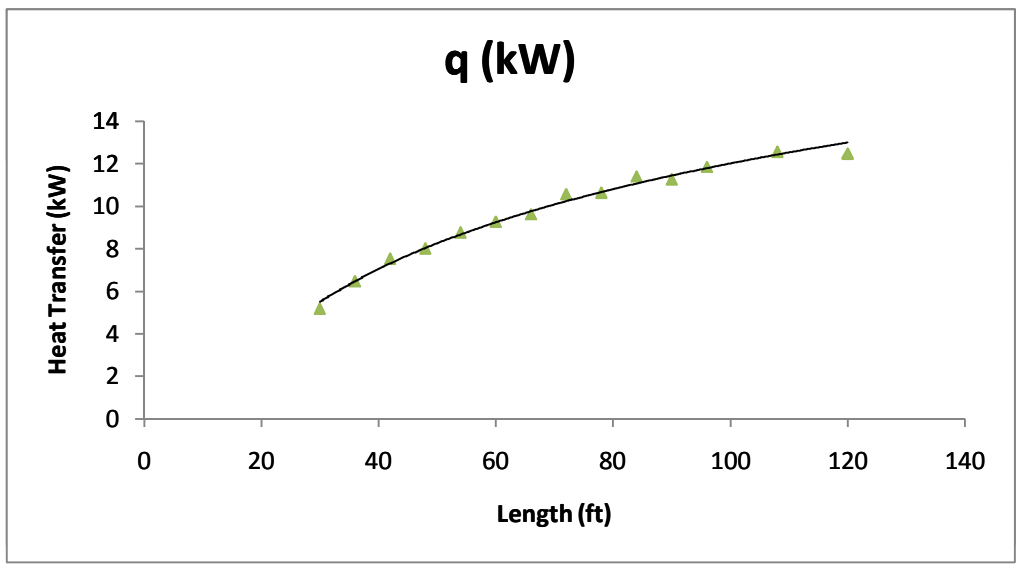
## Test Reports – 4” Nominal Diameter Units

Effectiveness and Pressure Drop at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

| L (ft) | ε | ΔP (kPa) | q (kW) |
|---|---|---|---|
| 30 | 0.279 | 1.84 | 5.17 |
| 36 | 0.343 | 2.88 | 6.46 |
| 42 | 0.399 | 3.07 | 7.53 |
| 48 | 0.425 | 3.89 | 8.01 |
| 54 | 0.474 | 3.70 | 8.77 |
| 60 | 0.496 | 4.47 | 9.27 |
| 66 | 0.517 | 4.94 | 9.63 |
| 72 | 0.573 | 5.68 | 10.57 |
| 78 | 0.586 | 5.95 | 10.65 |
| 84 | 0.626 | 6.11 | 11.41 |
| 90 | 0.604 | 6.65 | 11.27 |
| 96 | 0.648 | 7.02 | 11.86 |
| 108 | 0.683 | 7.66 | 12.58 |
| 120 | 0.707 | 8.58 | 12.49 |



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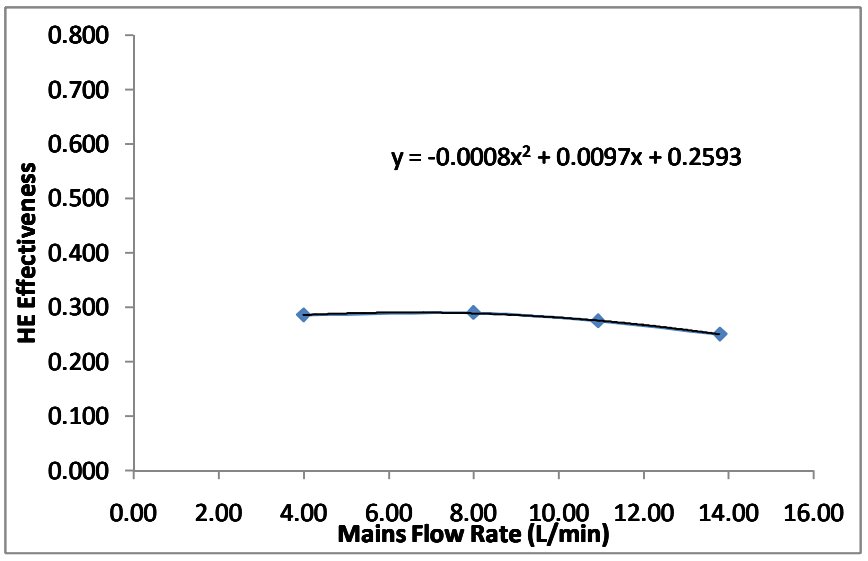
**Product:** 30in C4in
**Manufacturer:** Renewability
**Test Date:** February 23 / 2011

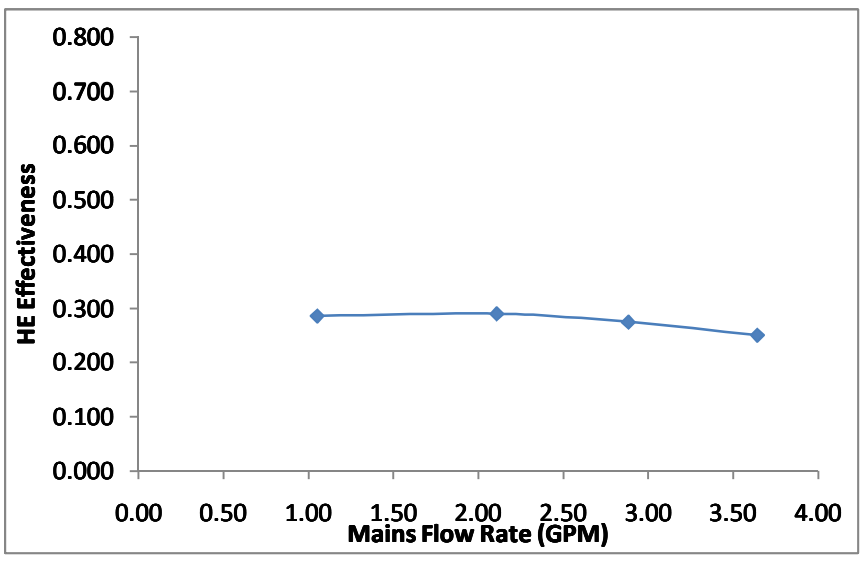
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.99 | 0.286 | 2.17 | 0.49 |
| 7.99 | 0.290 | 4.49 | 1.12 |
| 10.92 | 0.275 | 5.81 | 2.52 |
| 13.79 | 0.251 | 6.78 | 4.06 |

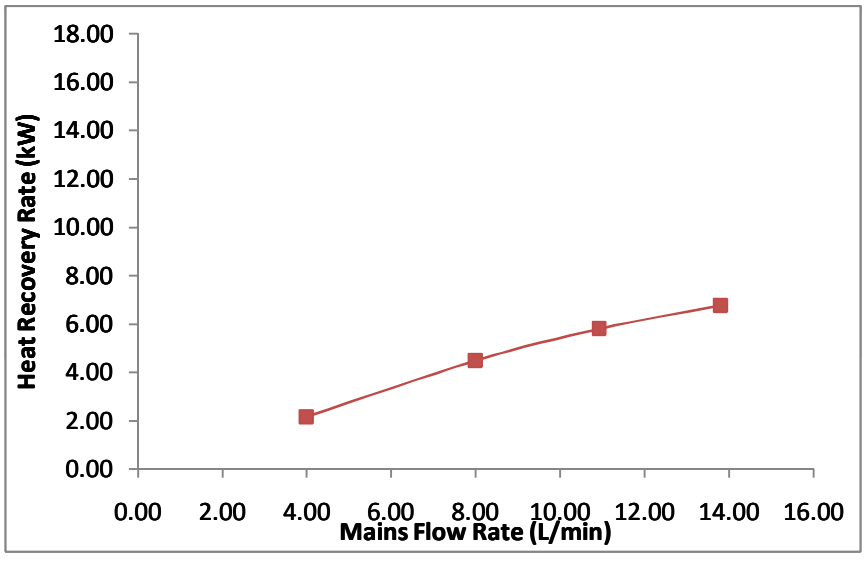
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.05 | 0.286 | 7410.94 | 0.07 |
| 2.11 | 0.290 | 15334.15 | 0.16 |
| 2.88 | 0.275 | 19842.19 | 0.37 |
| 3.64 | 0.251 | 23154.91 | 0.59 |

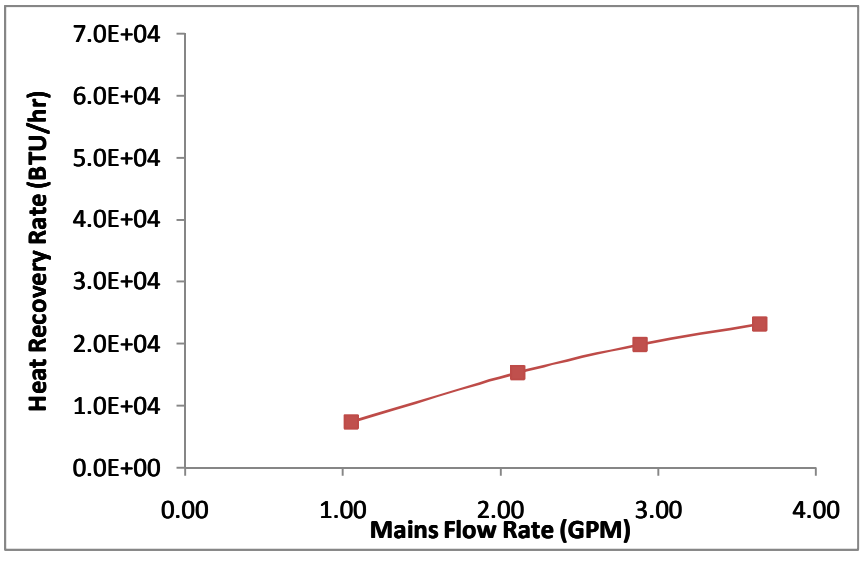
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

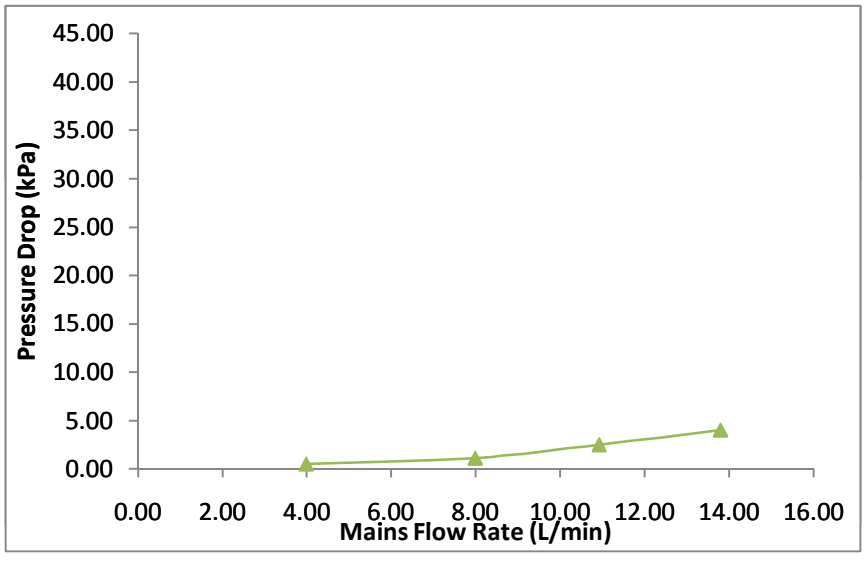
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.279 | | | |
| Heat Recovery | 5.17 | kW | 17657.4 | BTU/hr |
| Pressure Drop | 1.84 | kPa | 0.27 | PSI |

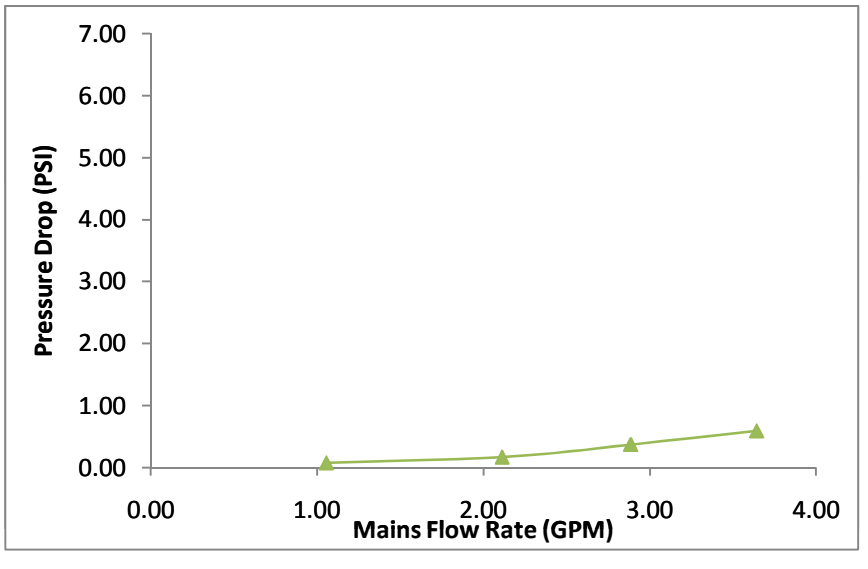


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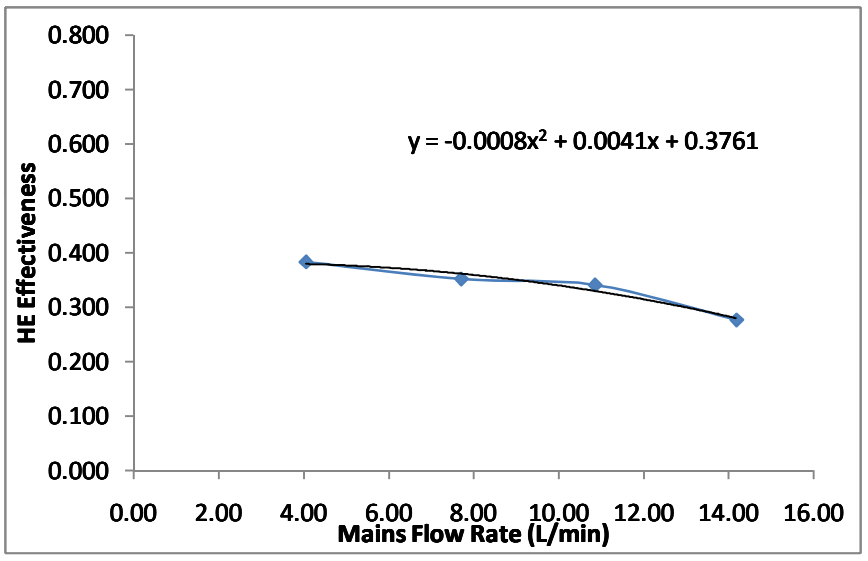
**Product:** 36in C4in
**Manufacturer:** Renewability
**Test Date:** February 23 / 2011

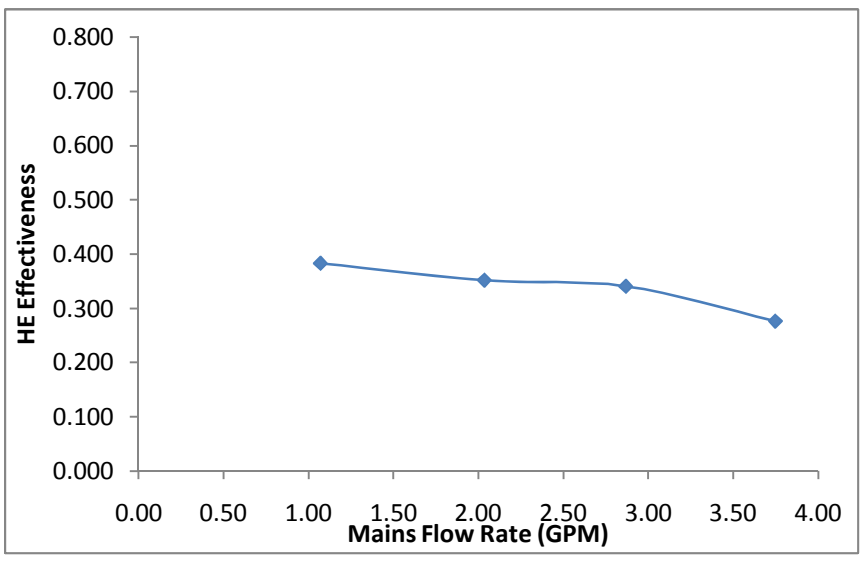
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.05 | 0.383 | 2.98 | 0.88 |
| 7.70 | 0.352 | 5.23 | 2.16 |
| 10.85 | 0.341 | 7.39 | 3.42 |
| 14.18 | 0.277 | 7.57 | 5.19 |

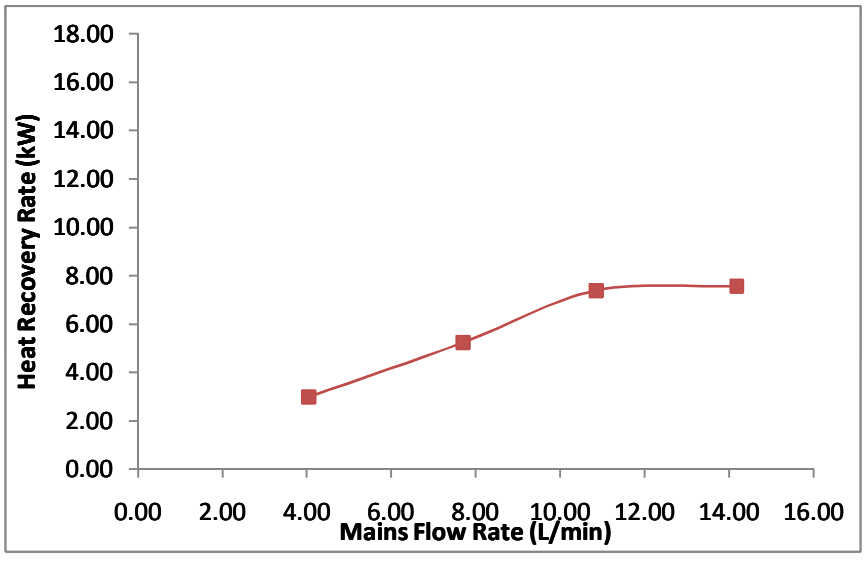
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.07 | 0.383 | 10177.23 | 0.13 |
| 2.03 | 0.352 | 17861.39 | 0.31 |
| 2.87 | 0.341 | 25238.17 | 0.50 |
| 3.75 | 0.277 | 25852.91 | 0.75 |

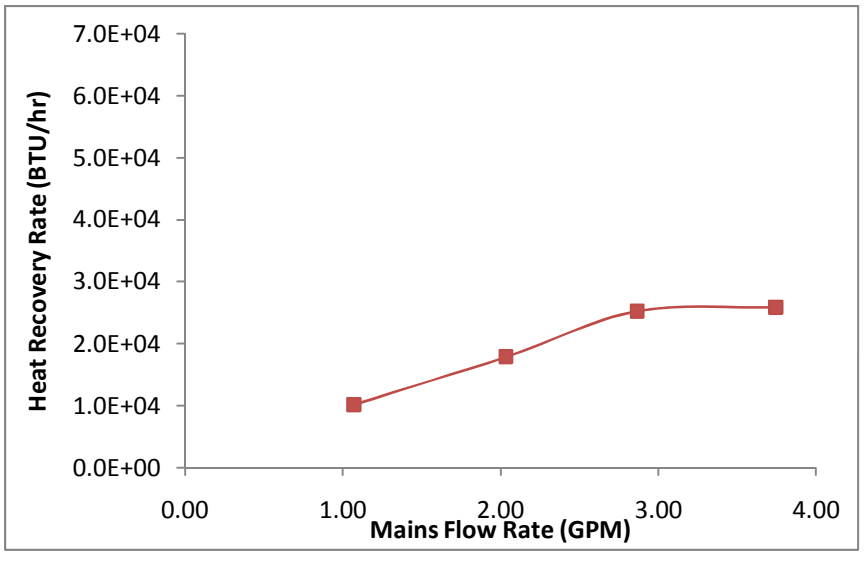
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

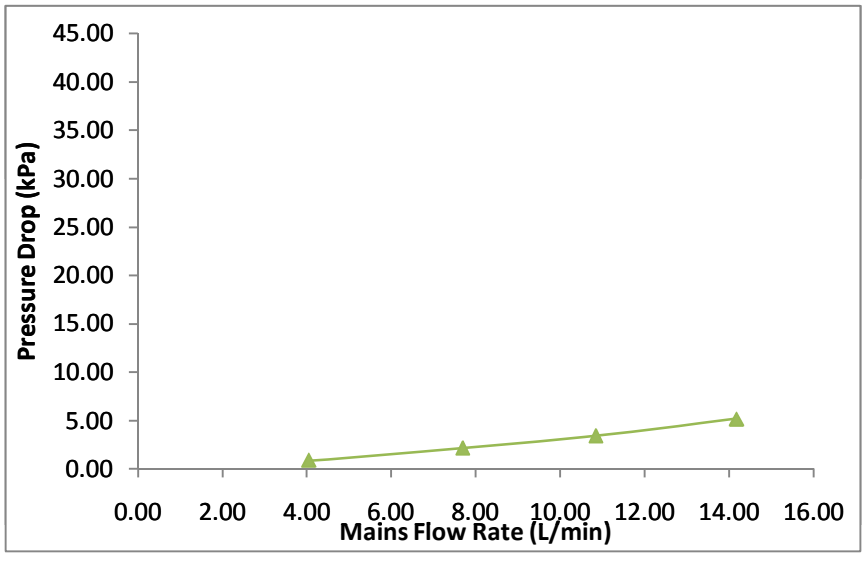
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.343 | | | |
| Heat Recovery | 6.46 | kW | 22076.7 | BTU/hr |
| Pressure Drop | 2.88 | kPa | 0.42 | PSI |

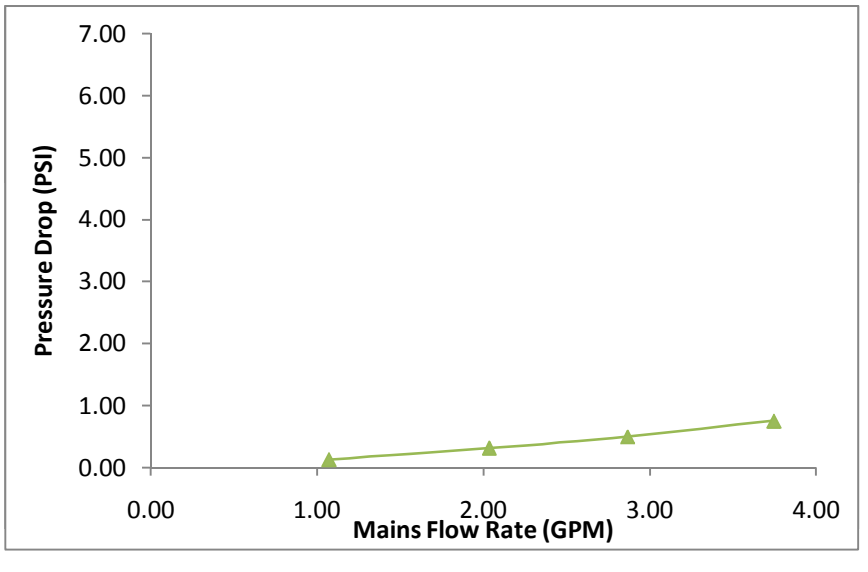


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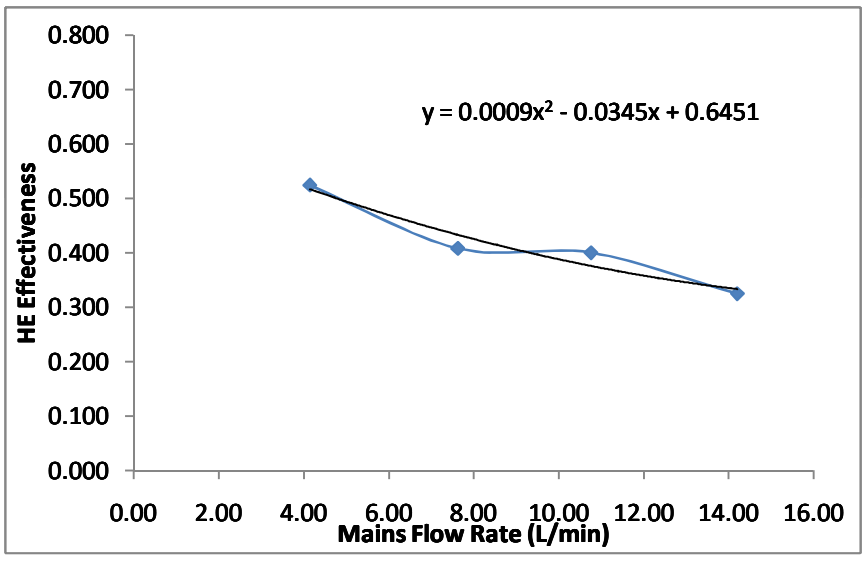
**Product:** 42in C4in
**Manufacturer:** Renewability
**Test Date:** February 23 / 2011

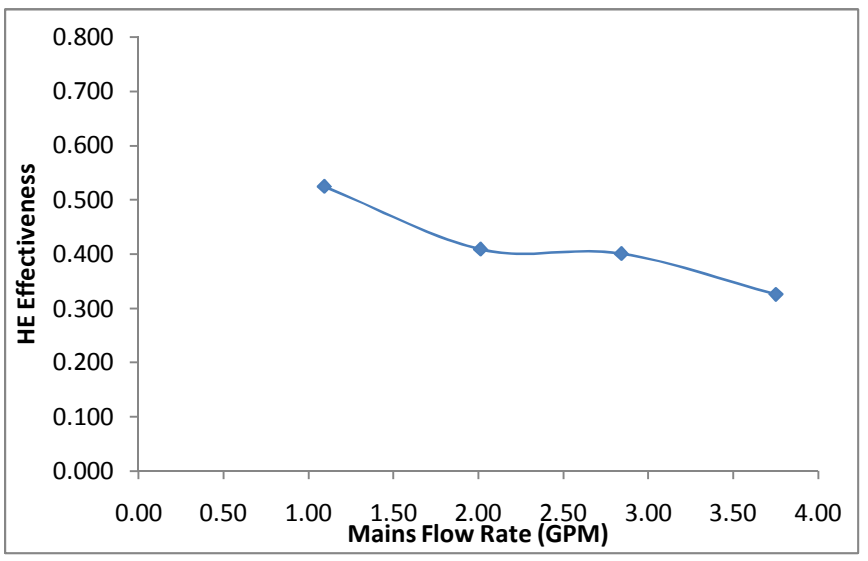
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.14 | 0.525 | 4.11 | 1.02 |
| 7.62 | 0.409 | 5.97 | 1.97 |
| 10.76 | 0.401 | 8.57 | 3.81 |
| 14.20 | 0.326 | 8.89 | 6.04 |

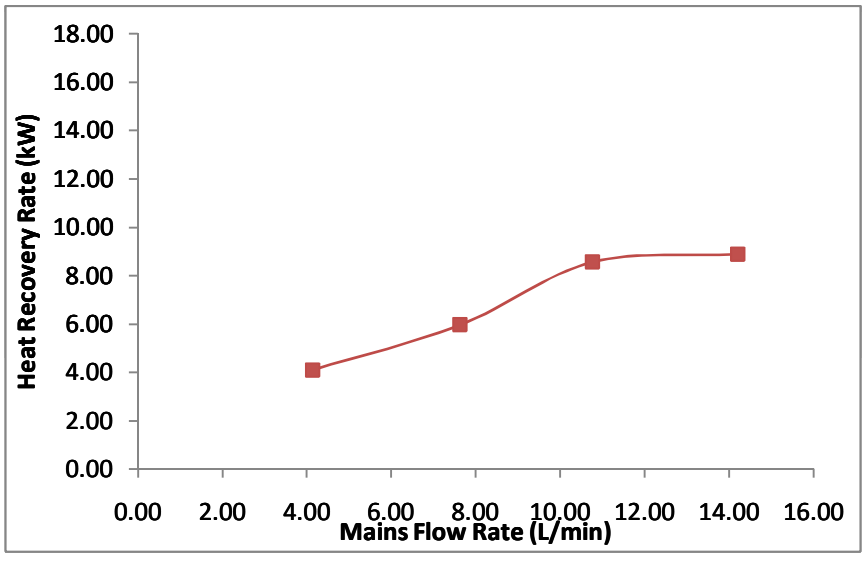
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.09 | 0.525 | 14036.39 | 0.15 |
| 2.01 | 0.409 | 20388.62 | 0.29 |
| 2.84 | 0.401 | 29268.08 | 0.55 |
| 3.75 | 0.326 | 30360.94 | 0.88 |

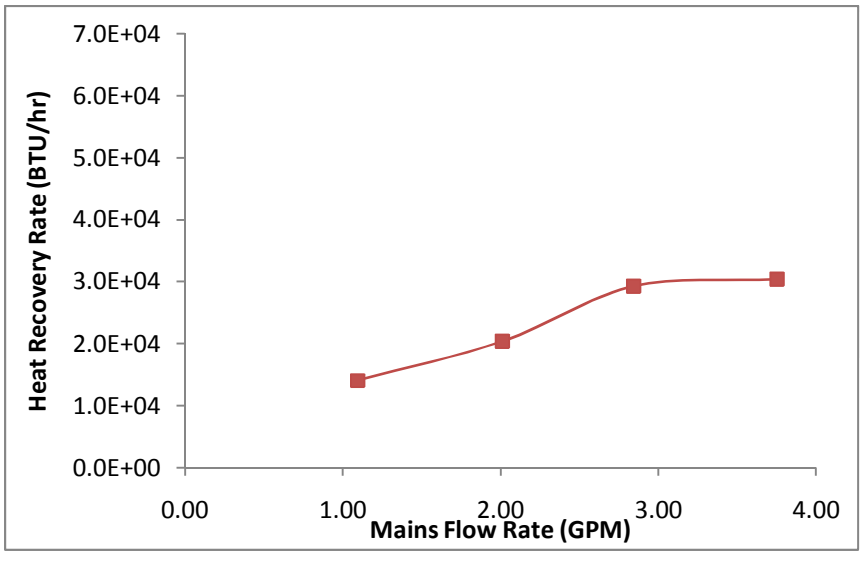
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

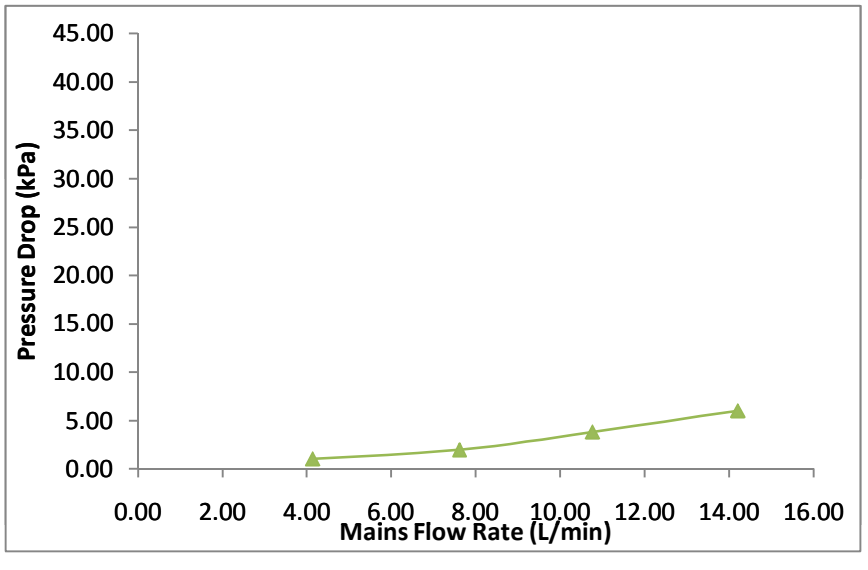
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.399 | | | |
| Heat Recovery | 7.53 | kW | 25705.0 | BTU/hr |
| Pressure Drop | 3.07 | kPa | 0.45 | PSI |

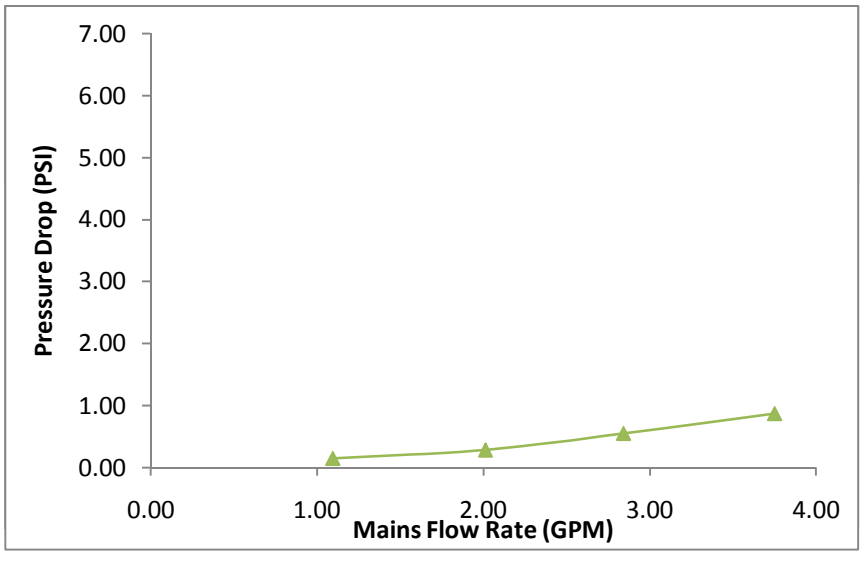


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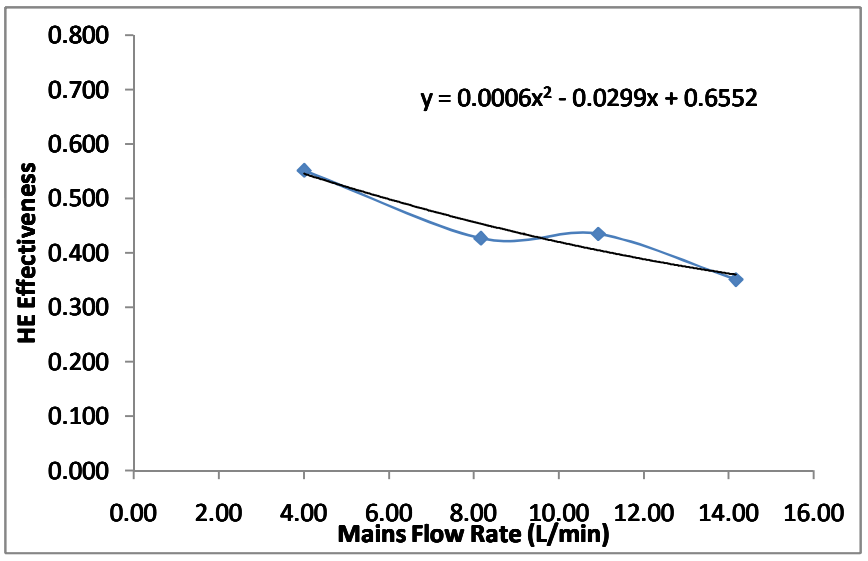
**Product:** 48in C4in
**Manufacturer:** Renewability
**Test Date:** February 23 / 2011

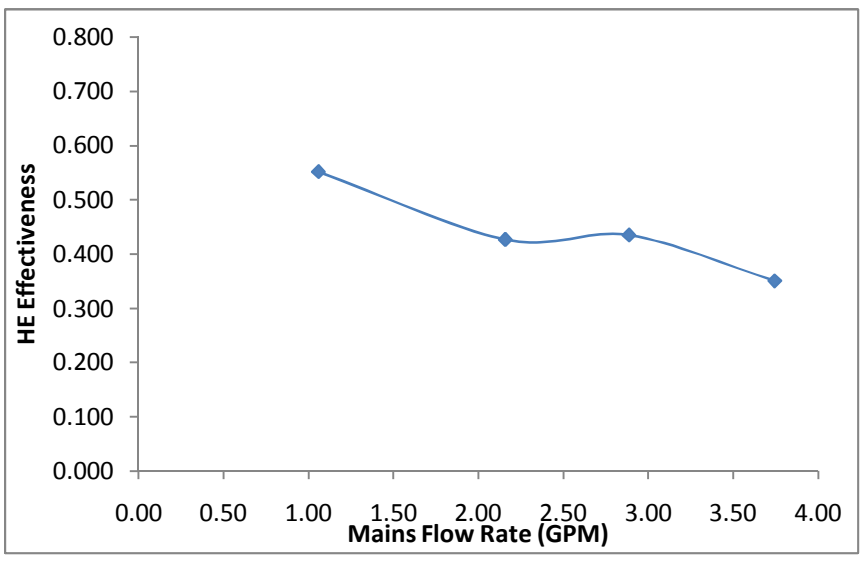
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.01 | 0.552 | 4.18 | 1.27 |
| 8.17 | 0.427 | 6.69 | 3.04 |
| 10.93 | 0.435 | 9.43 | 4.81 |
| 14.17 | 0.351 | 9.96 | 6.67 |

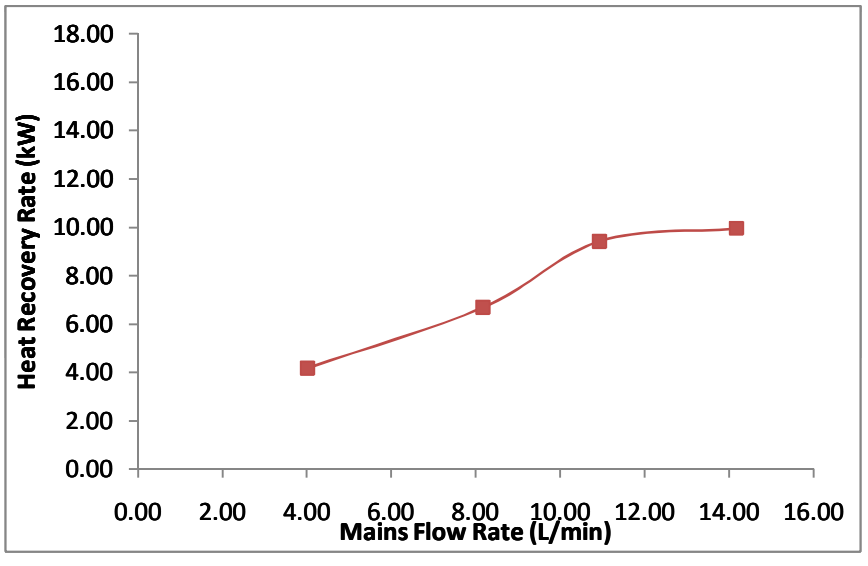
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.06 | 0.552 | 14275.45 | 0.18 |
| 2.16 | 0.427 | 22847.55 | 0.44 |
| 2.89 | 0.435 | 32205.14 | 0.70 |
| 3.74 | 0.351 | 34015.18 | 0.97 |

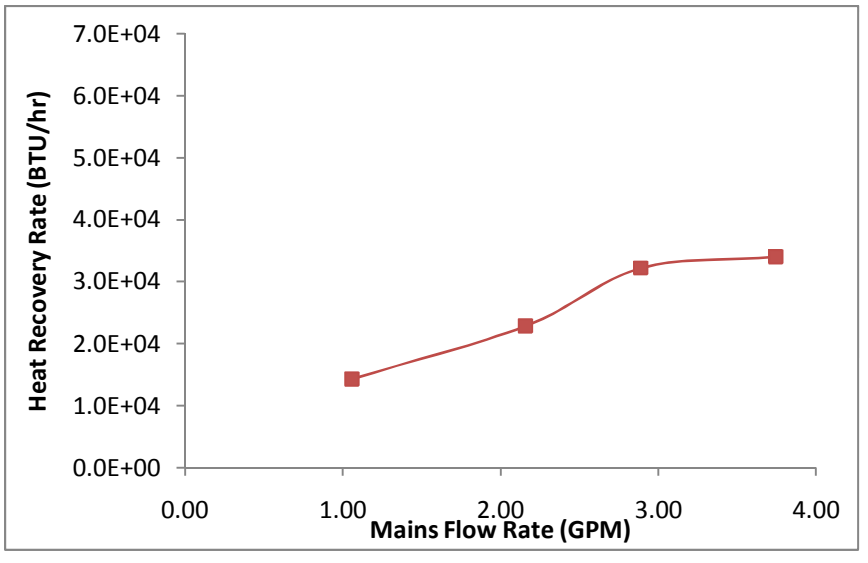
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

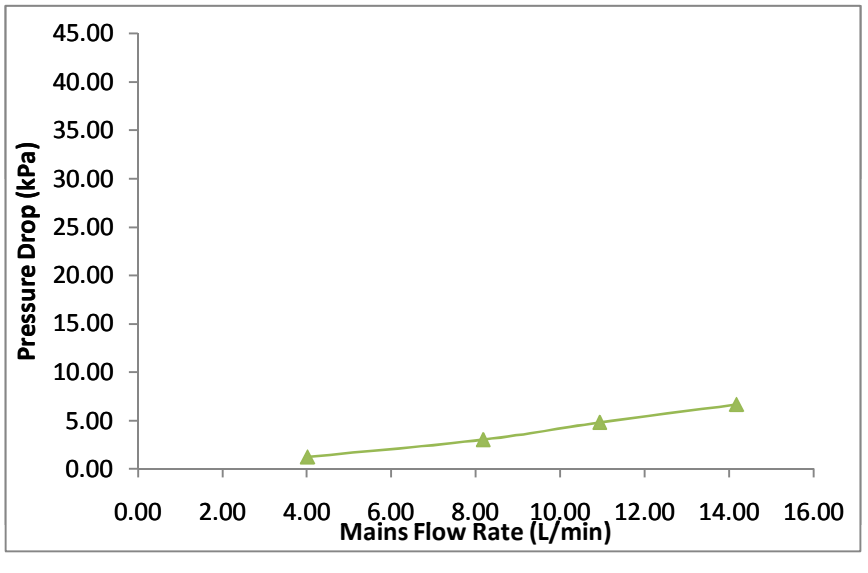
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.425 | | | |
| Heat Recovery | 8.01 | kW | 27356.8 | BTU/hr |
| Pressure Drop | 3.89 | kPa | 0.56 | PSI |

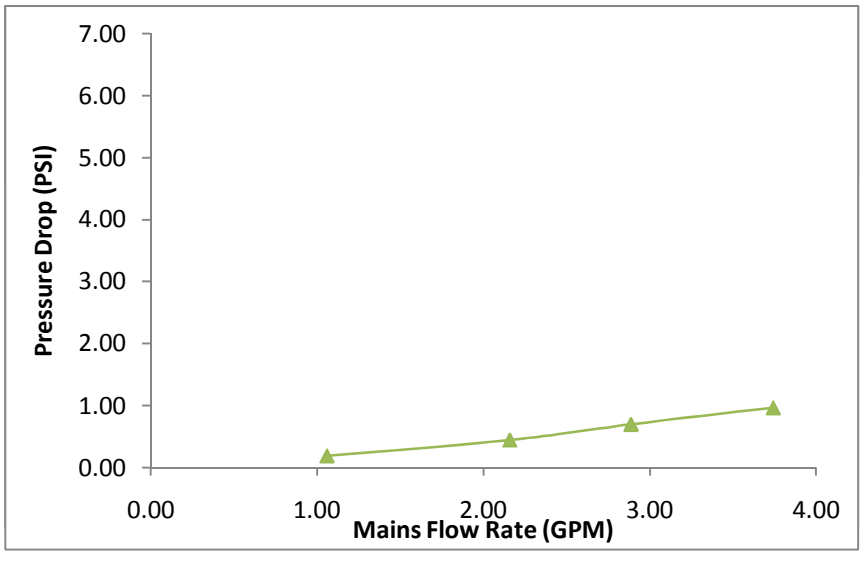


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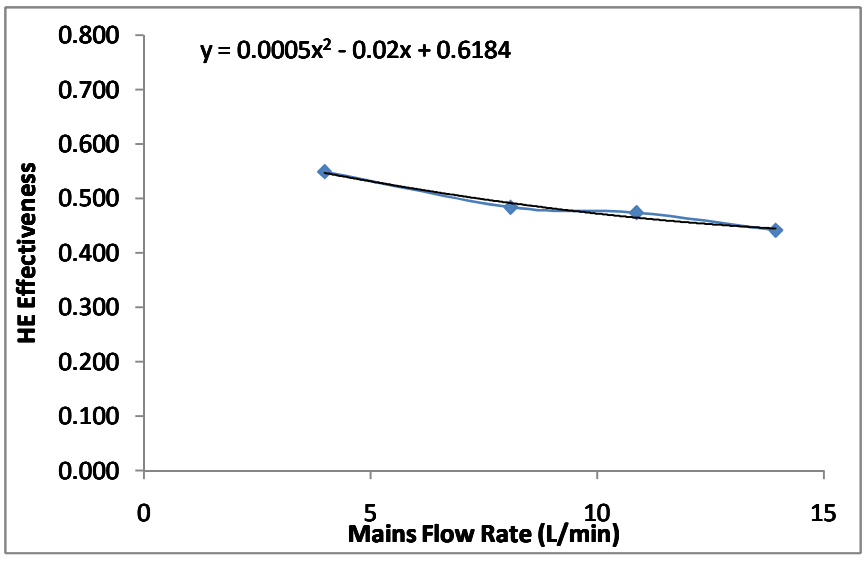
**Product:** 54in C4in
**Manufacturer:** Renewability
**Test Date:** February 23 / 2011

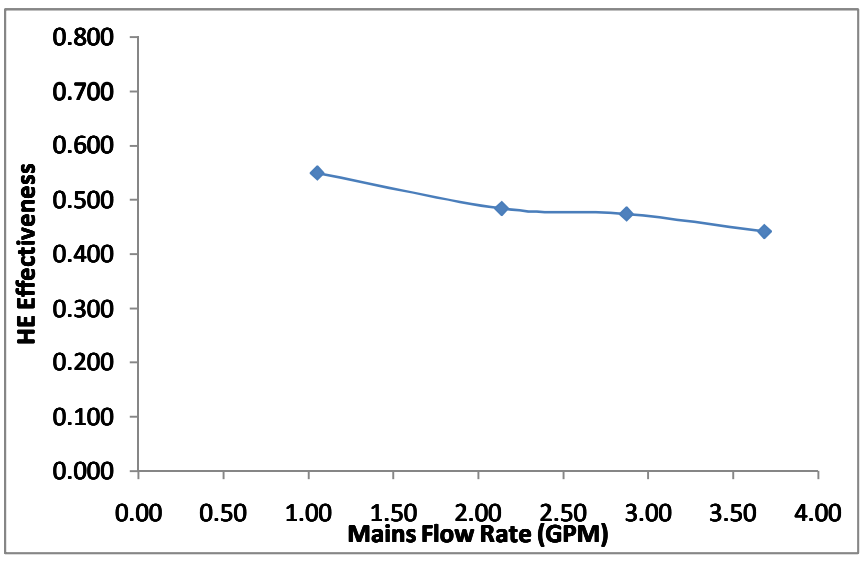
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.99 | 0.549 | 4.13 | 0.73 |
| 8.09 | 0.484 | 7.50 | 2.88 |
| 10.87 | 0.474 | 10.00 | 4.49 |
| 13.94 | 0.442 | 12.32 | 6.81 |

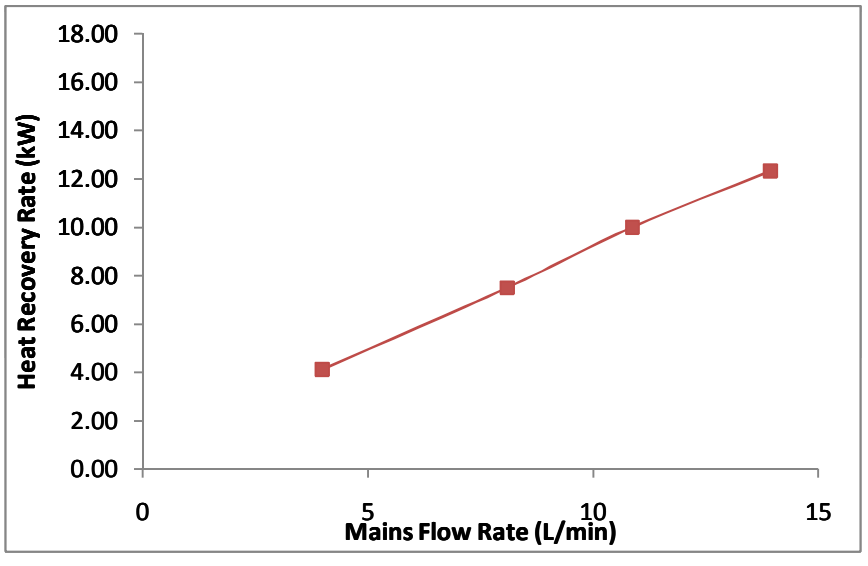
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.05 | 0.549 | 14104.69 | 0.11 |
| 2.14 | 0.484 | 25613.84 | 0.42 |
| 2.87 | 0.474 | 34151.79 | 0.65 |
| 3.68 | 0.442 | 42075.01 | 0.99 |

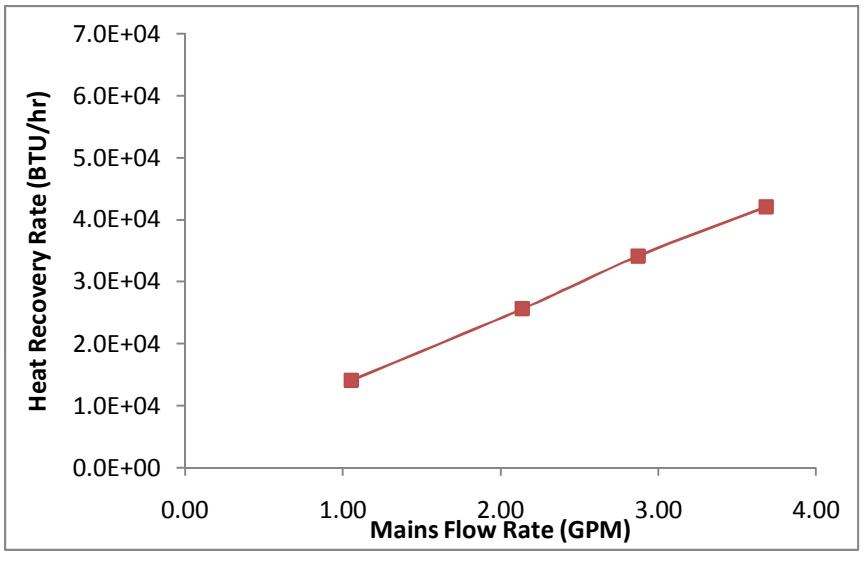
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

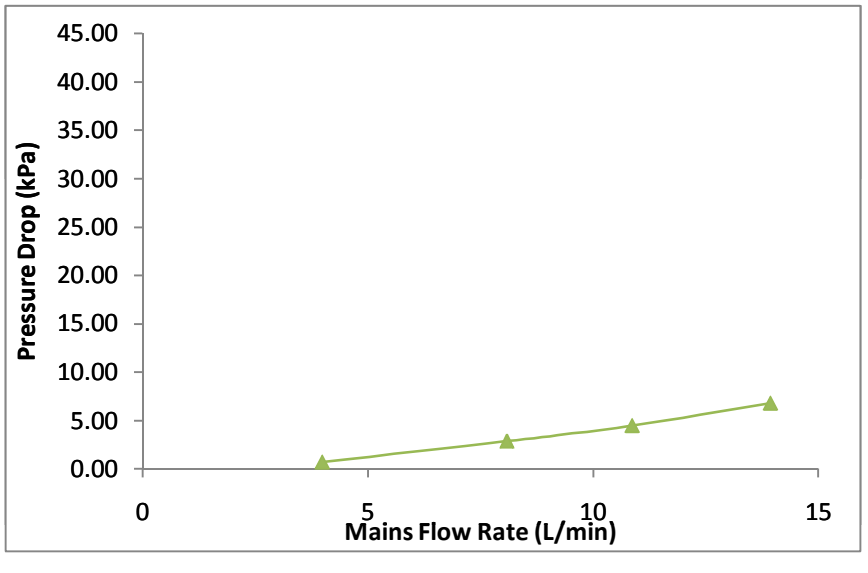
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.474 | | | |
| Heat Recovery | 8.77 | kW | 29944.2 | BTU/hr |
| Pressure Drop | 3.70 | kPa | 0.54 | PSI |

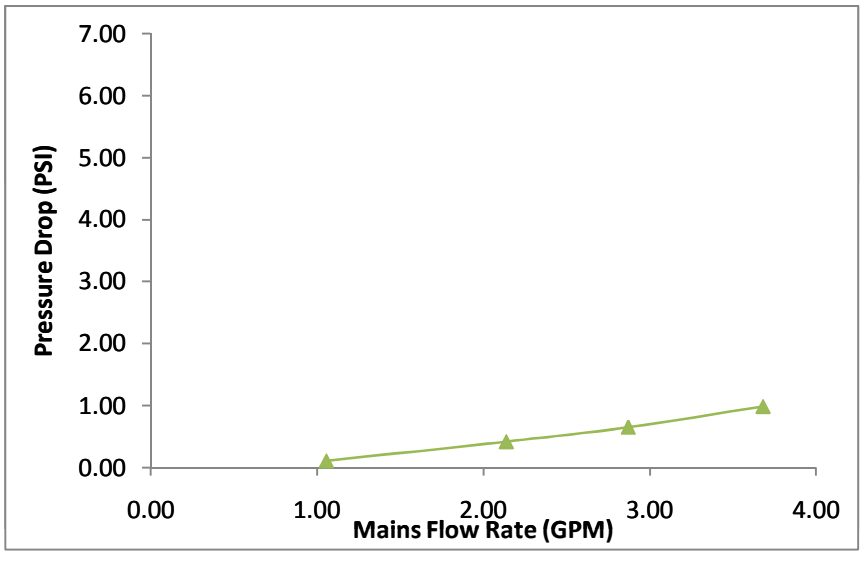


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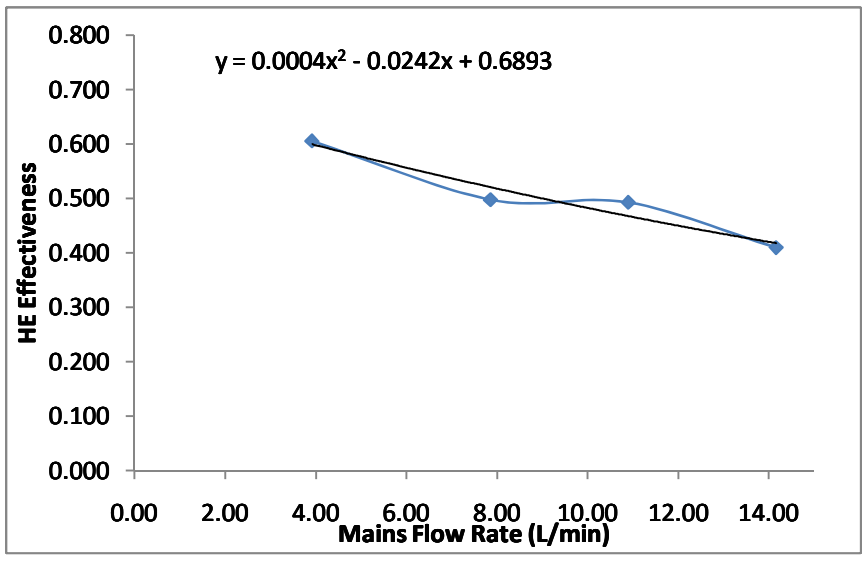
**Product:** 60in C4in
**Manufacturer:** Renewability
**Test Date:** February 23 /2011

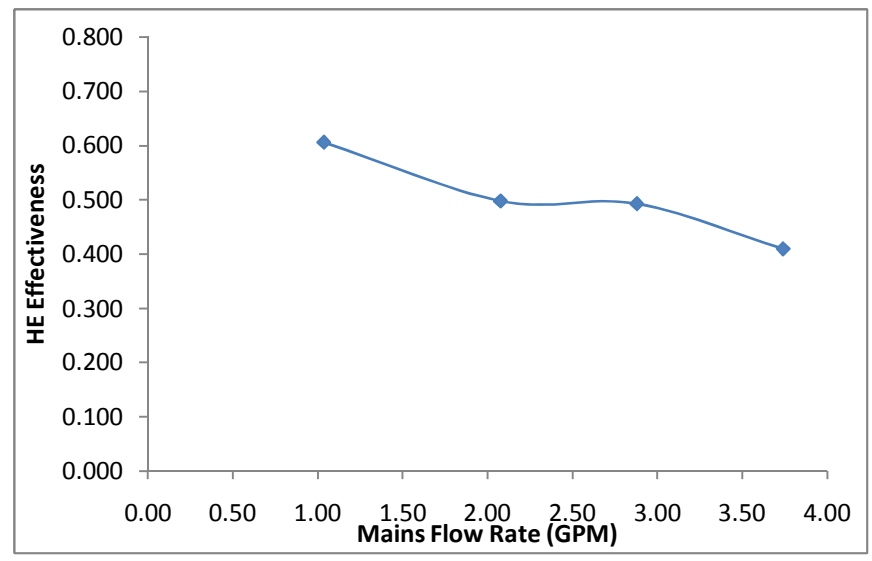
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.92 | 0.606 | 4.56 | 1.24 |
| 7.86 | 0.498 | 7.82 | 3.52 |
| 10.90 | 0.493 | 10.50 | 5.28 |
| 14.16 | 0.410 | 11.33 | 8.50 |

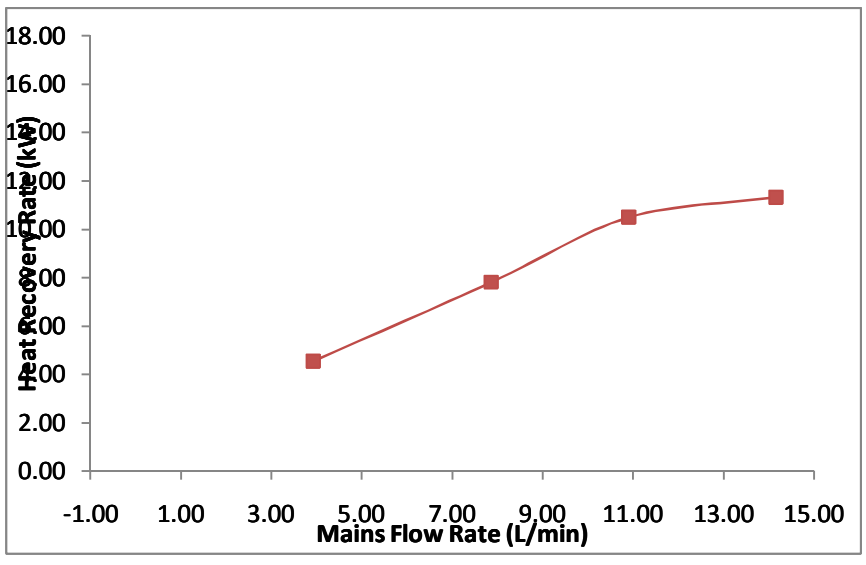
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.04 | 0.606 | 15573.22 | 0.18 |
| 2.08 | 0.498 | 26706.70 | 0.51 |
| 2.88 | 0.493 | 35859.38 | 0.77 |
| 3.74 | 0.410 | 38693.98 | 1.23 |

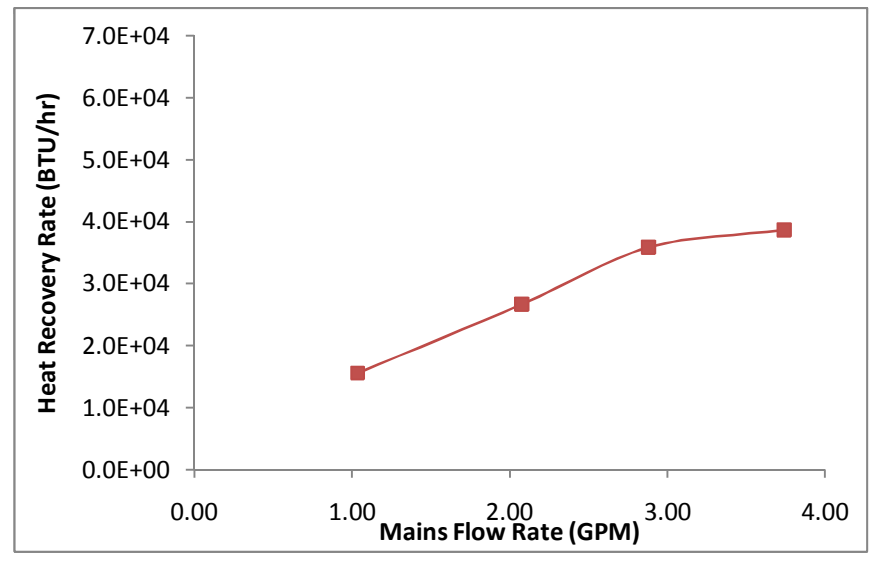
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

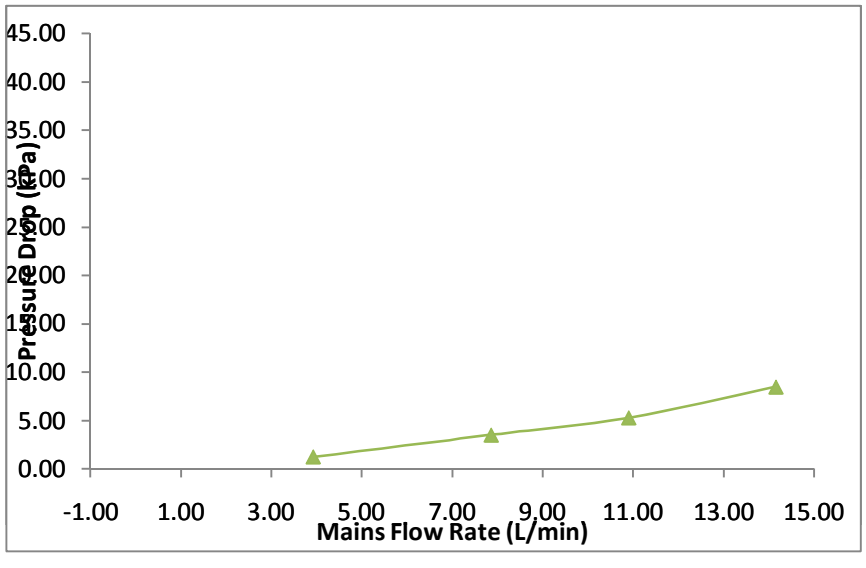
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.496 | | | |
| Heat Recovery | 9.27 | kW | 31644.3 | BTU/hr |
| Pressure Drop | 4.47 | kPa | 0.65 | PSI |

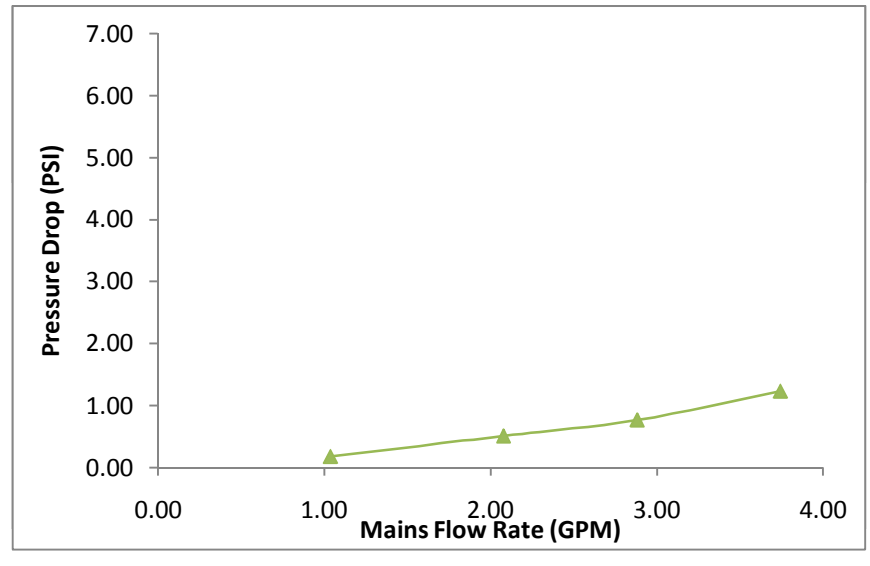


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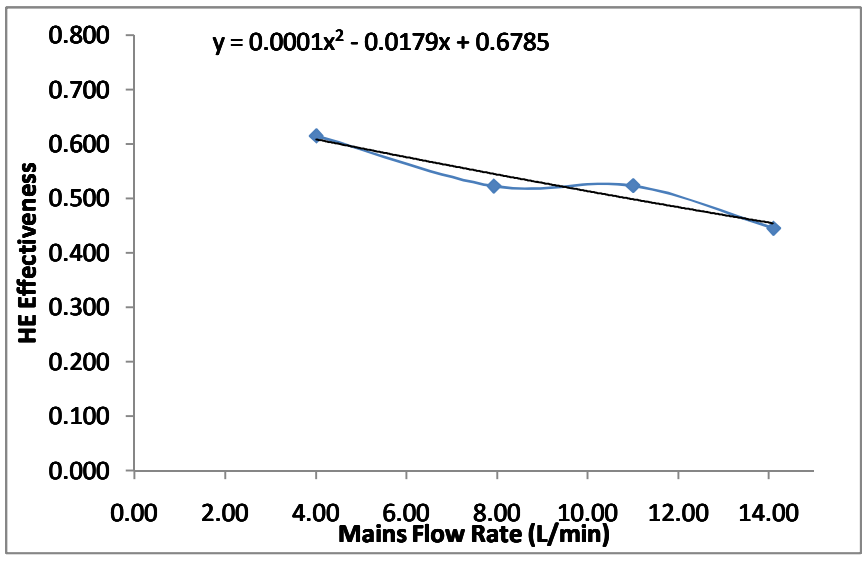
**Product:** 66in C4in
**Manufacturer:** Renewability
**Test Date:** February 22 /2011

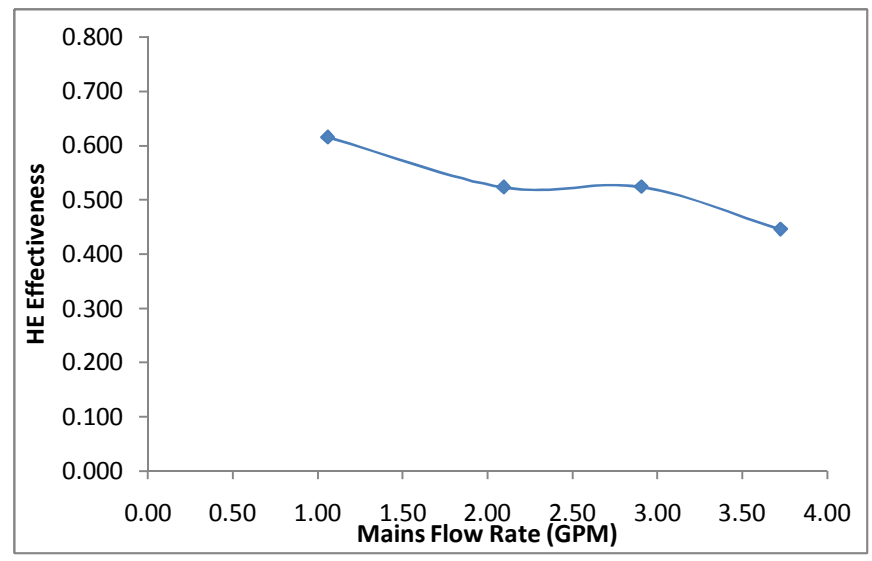
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.01 | 0.615 | 4.66 | 1.72 |
| 7.93 | 0.523 | 8.04 | 3.60 |
| 11.00 | 0.524 | 11.15 | 6.22 |
| 14.10 | 0.446 | 12.41 | 8.98 |

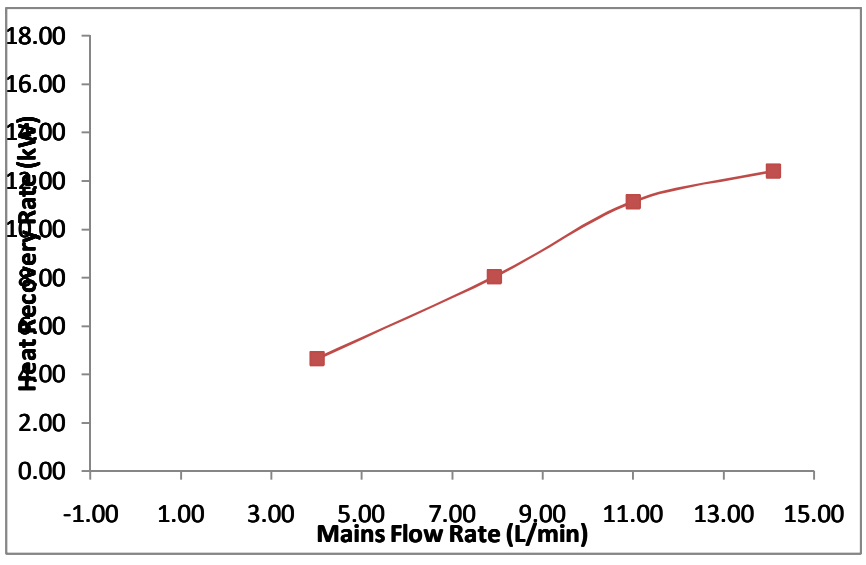
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.06 | 0.615 | 15914.73 | 0.25 |
| 2.09 | 0.523 | 27458.04 | 0.52 |
| 2.91 | 0.524 | 38079.25 | 0.90 |
| 3.72 | 0.446 | 42382.37 | 1.30 |

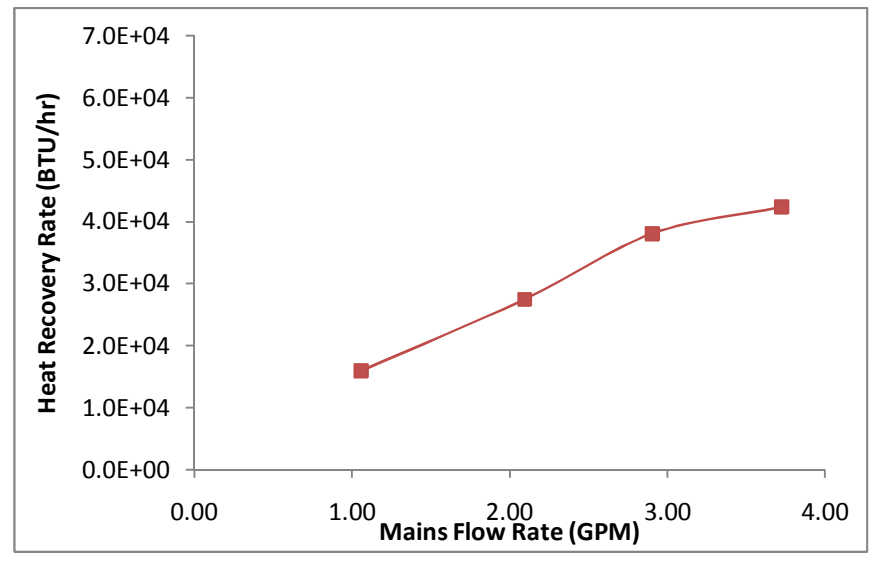
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

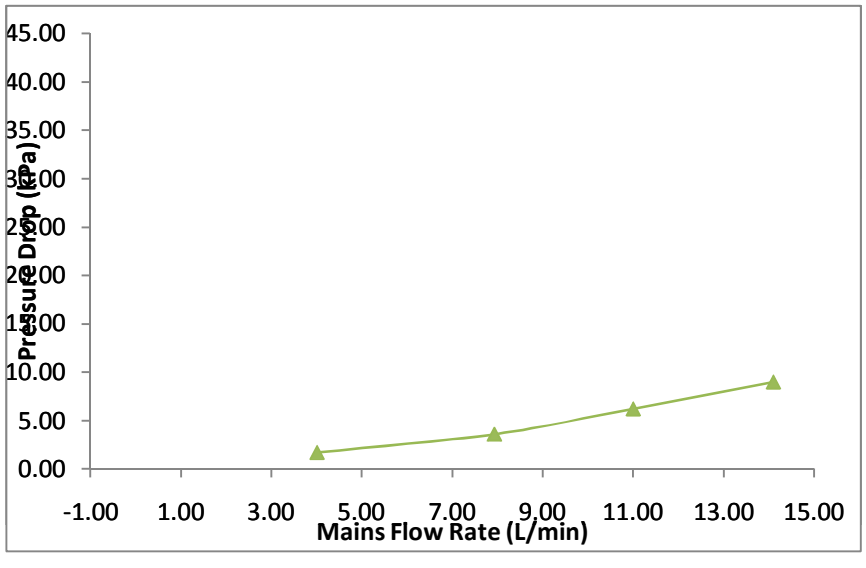
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.517 | | | |
| Heat Recovery | 9.63 | kW | 32889.7 | BTU/hr |
| Pressure Drop | 4.94 | kPa | 0.72 | PSI |

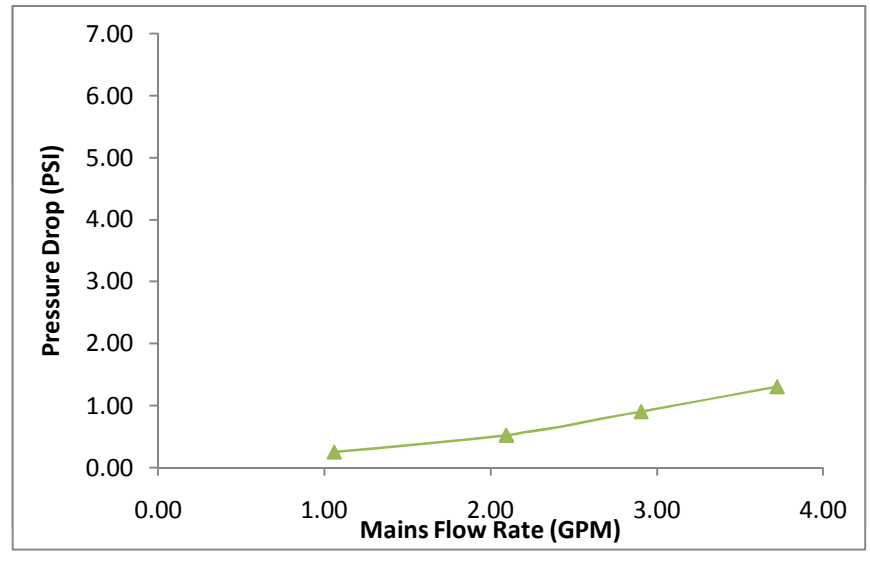


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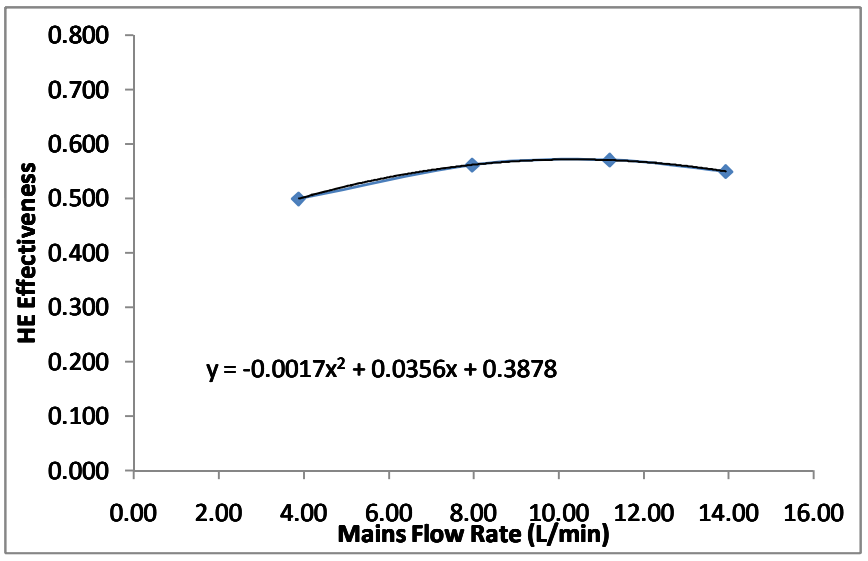
**Product:** 72in C4in
**Manufacturer:** Renewability
**Test Date:** February 22 / 2011

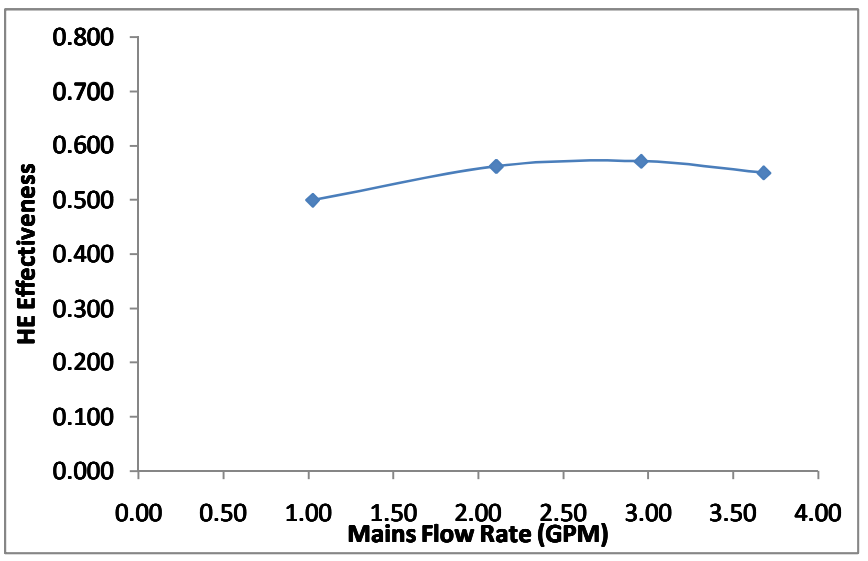
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.88 | 0.500 | 3.68 | 1.21 |
| 7.97 | 0.562 | 8.75 | 4.33 |
| 11.20 | 0.571 | 12.60 | 7.17 |
| 13.93 | 0.550 | 15.18 | 10.03 |

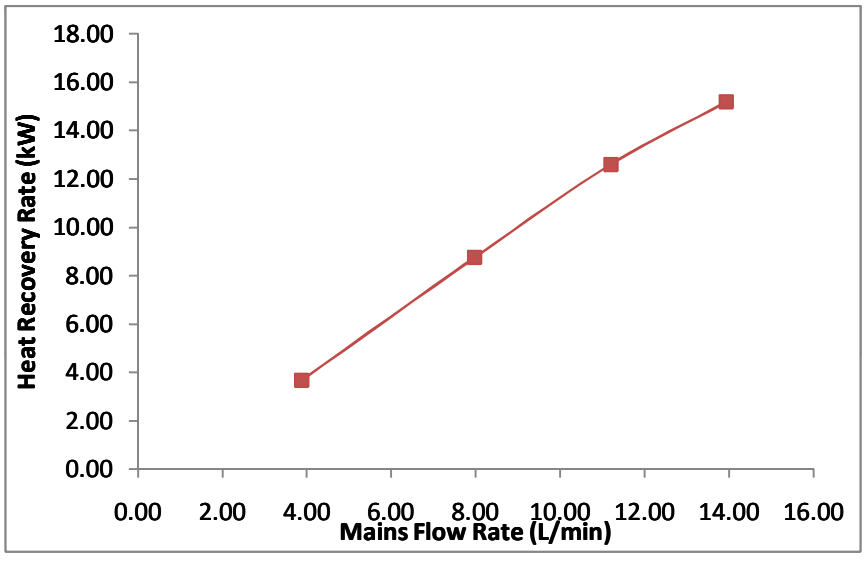
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.02 | 0.500 | 12567.86 | 0.18 |
| 2.11 | 0.562 | 29882.82 | 0.63 |
| 2.96 | 0.571 | 43031.26 | 1.04 |
| 3.68 | 0.550 | 51842.42 | 1.45 |

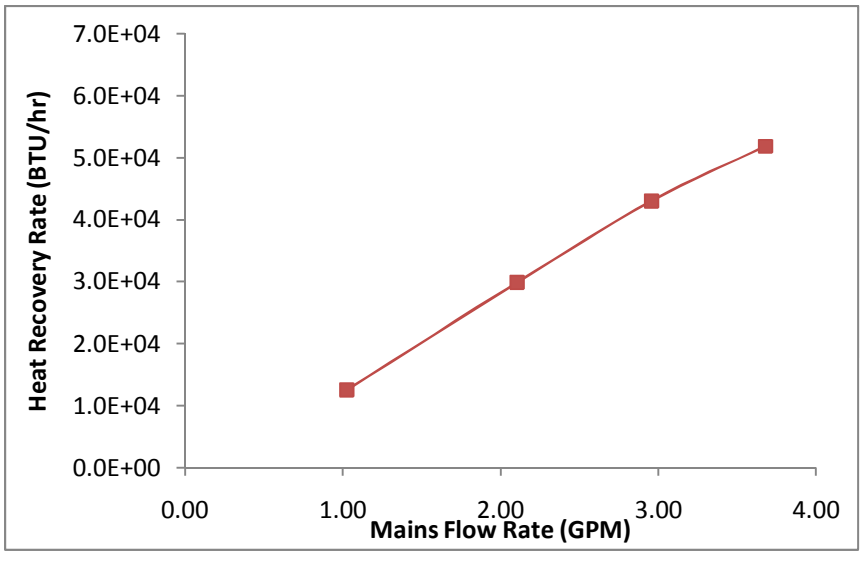
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

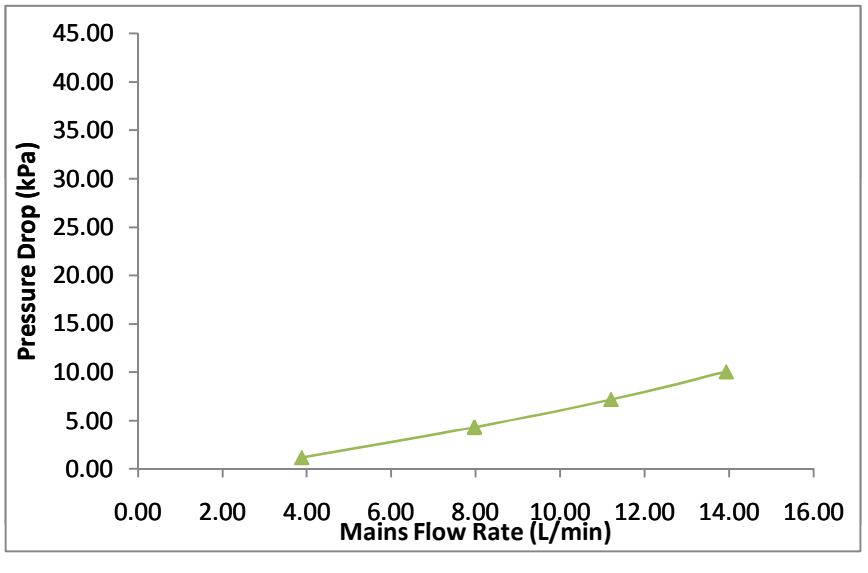
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.573 | | | |
| Heat Recovery | 10.57 | kW | 36111.0 | BTU/hr |
| Pressure Drop | 5.68 | kPa | 0.82 | PSI |

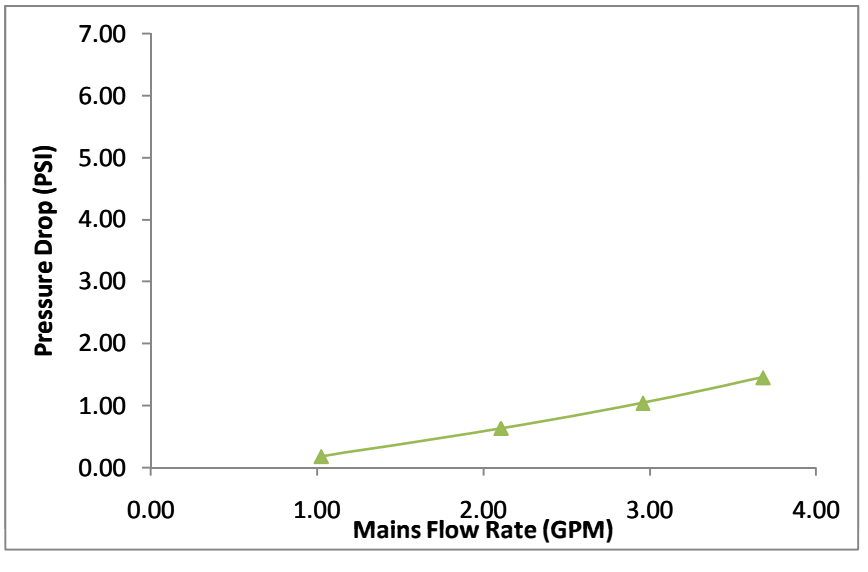


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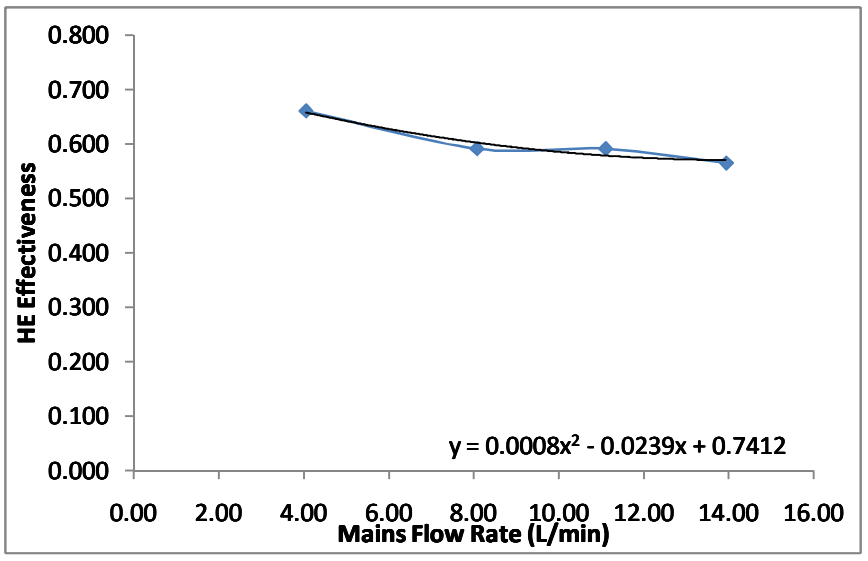
**Product:** 78in C4in
**Manufacturer:** Renewability
**Test Date:** February 14 / 2011

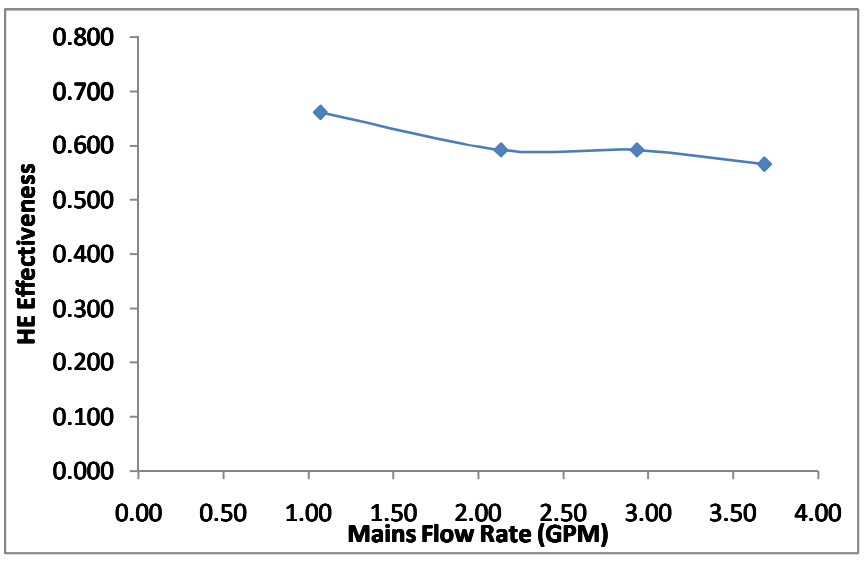
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.05 | 0.661 | 5.25 | 1.83 |
| 8.07 | 0.592 | 9.13 | 4.57 |
| 11.10 | 0.592 | 12.36 | 7.49 |
| 13.94 | 0.566 | 15.59 | 10.71 |

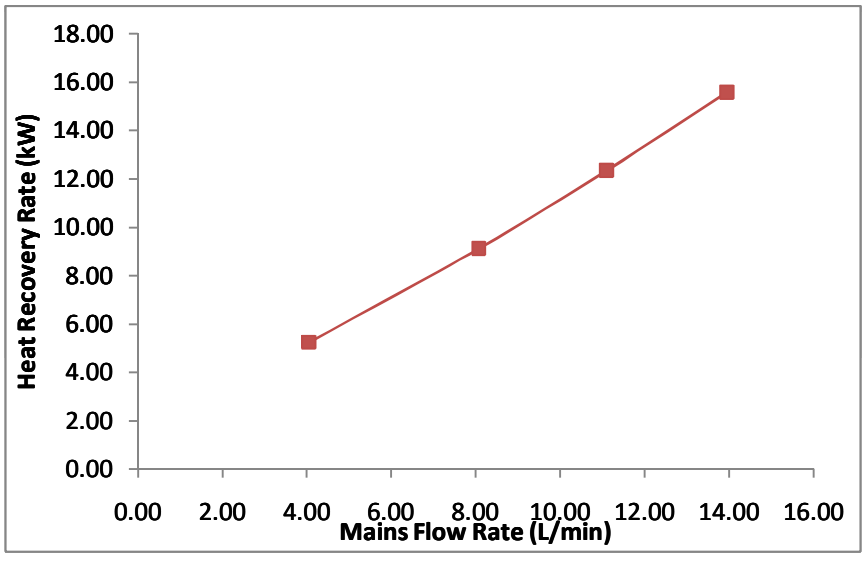
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.07 | 0.661 | 17929.69 | 0.27 |
| 2.13 | 0.592 | 31180.58 | 0.66 |
| 2.93 | 0.592 | 42211.61 | 1.09 |
| 3.68 | 0.566 | 53242.64 | 1.55 |

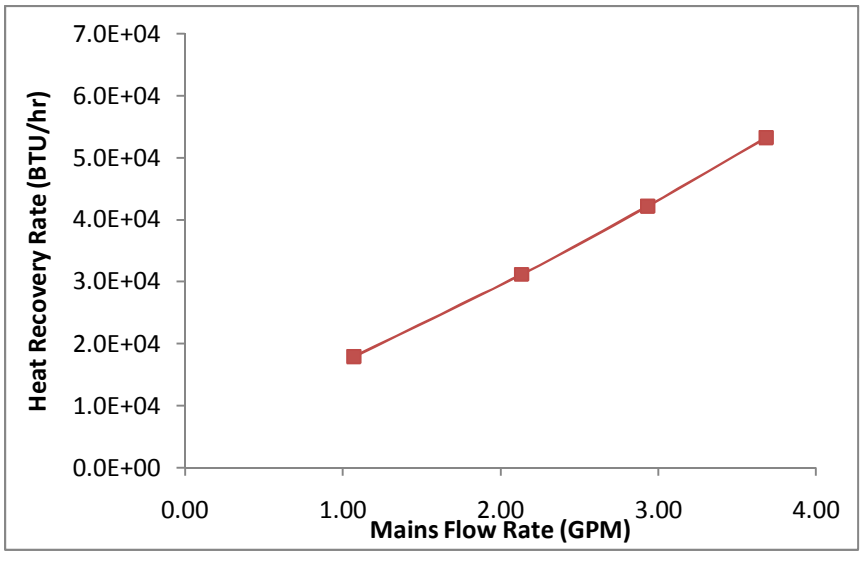
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

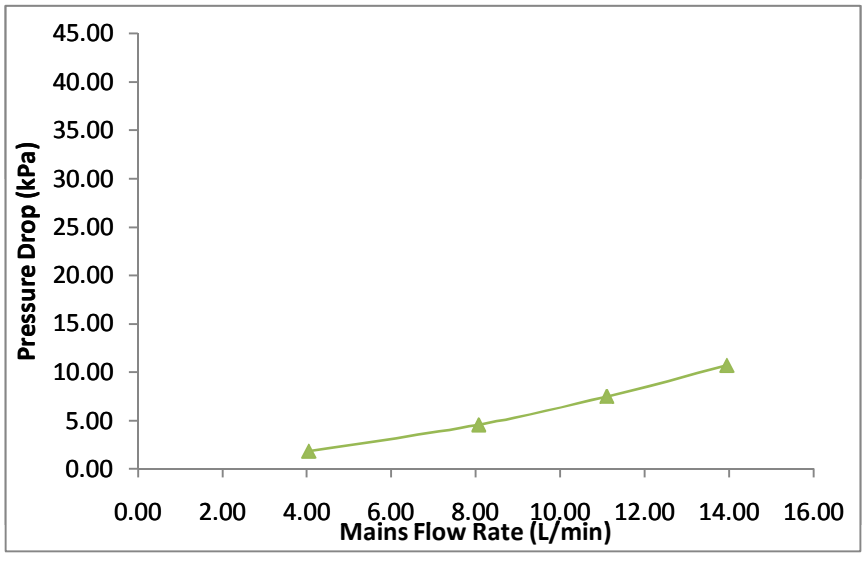
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.586 | | | |
| Heat Recovery | 10.65 | kW | 36386.6 | BTU/hr |
| Pressure Drop | 5.95 | kPa | 0.86 | PSI |

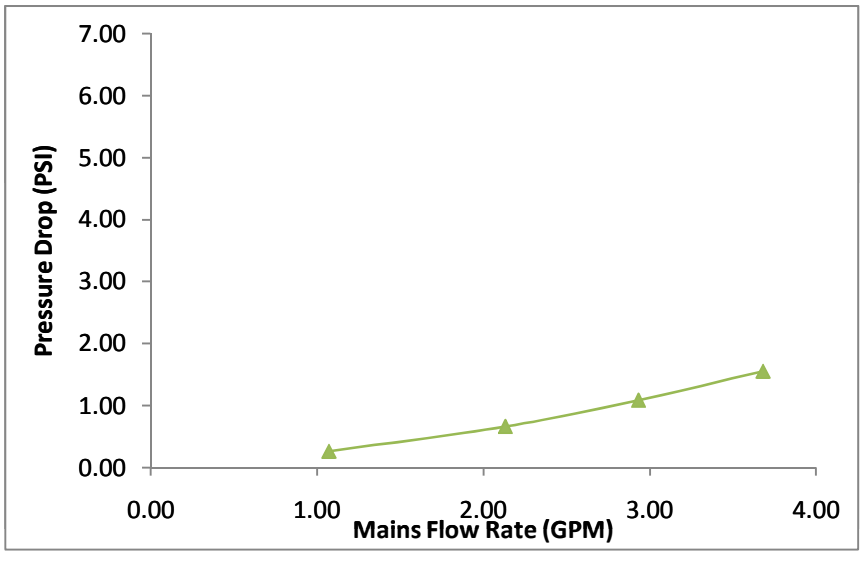


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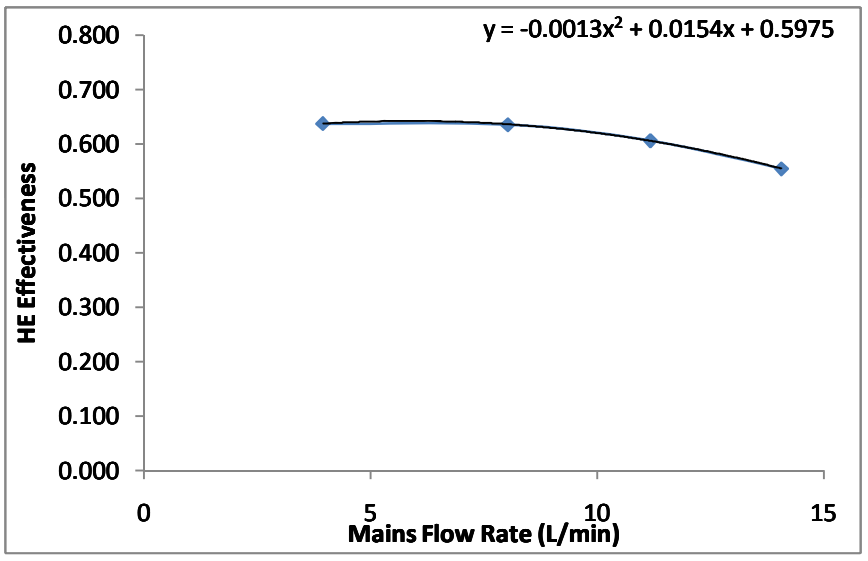
**Product:** 84in C4in
**Manufacturer:** Renewability
**Test Date:** February 14 / 2011

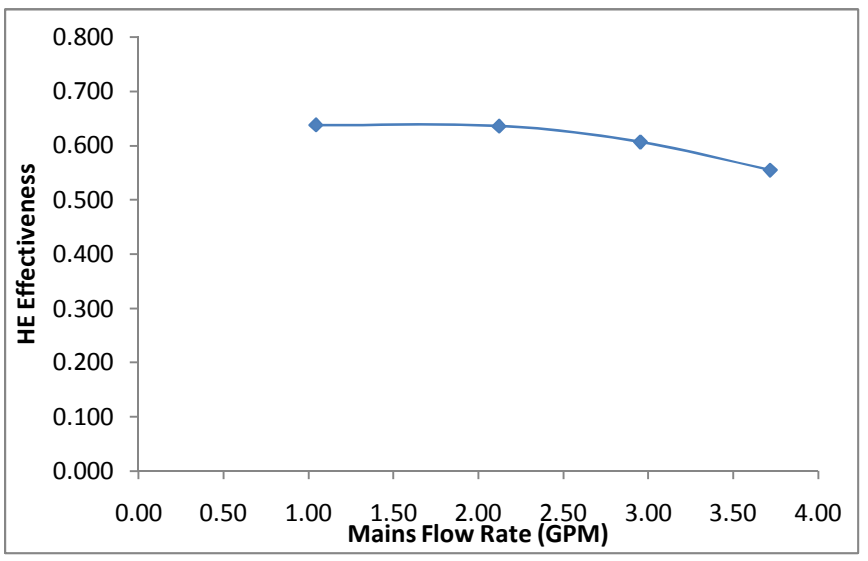
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.95 | 0.638 | 5.08 | 1.84 |
| 8.03 | 0.636 | 9.89 | 4.63 |
| 11.18 | 0.607 | 13.14 | 7.80 |
| 14.07 | 0.555 | 15.36 | 11.33 |

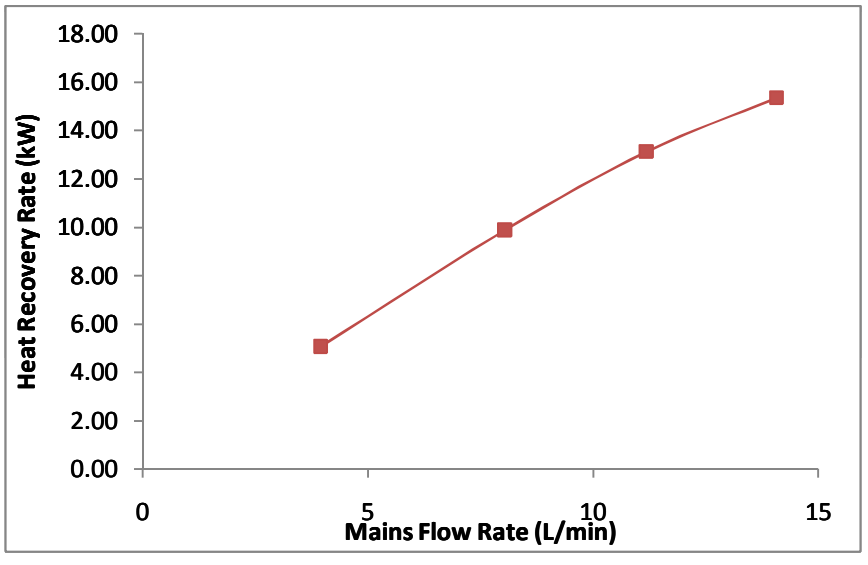
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.04 | 0.638 | 17349.11 | 0.27 |
| 2.12 | 0.636 | 33776.12 | 0.67 |
| 2.95 | 0.607 | 44875.45 | 1.13 |
| 3.72 | 0.555 | 52457.15 | 1.64 |

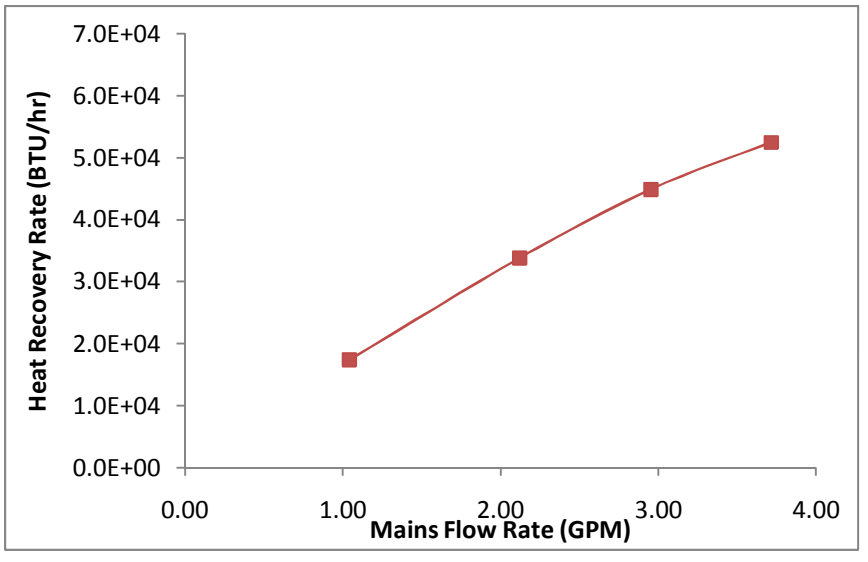
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

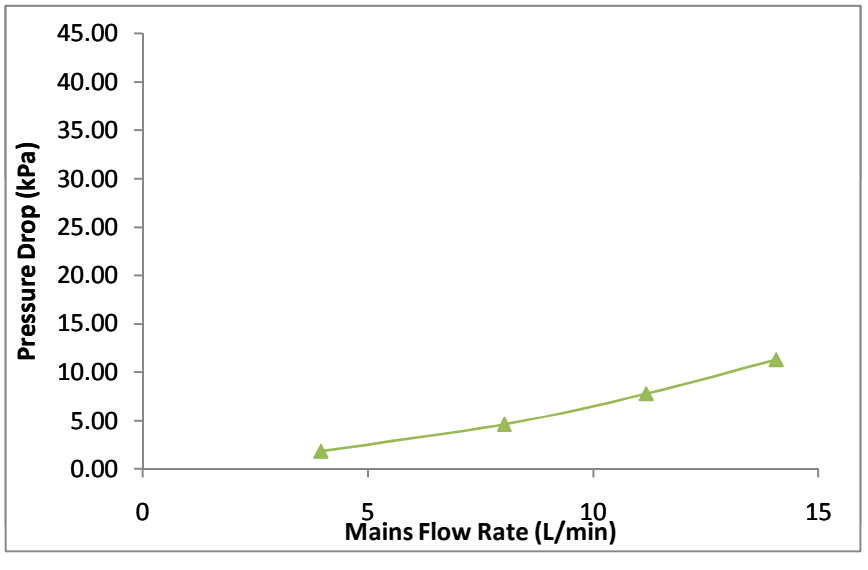
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.626 | | | |
| Heat Recovery | 11.41 | kW | 38955.8 | BTU/hr |
| Pressure Drop | 6.11 | kPa | 0.89 | PSI |

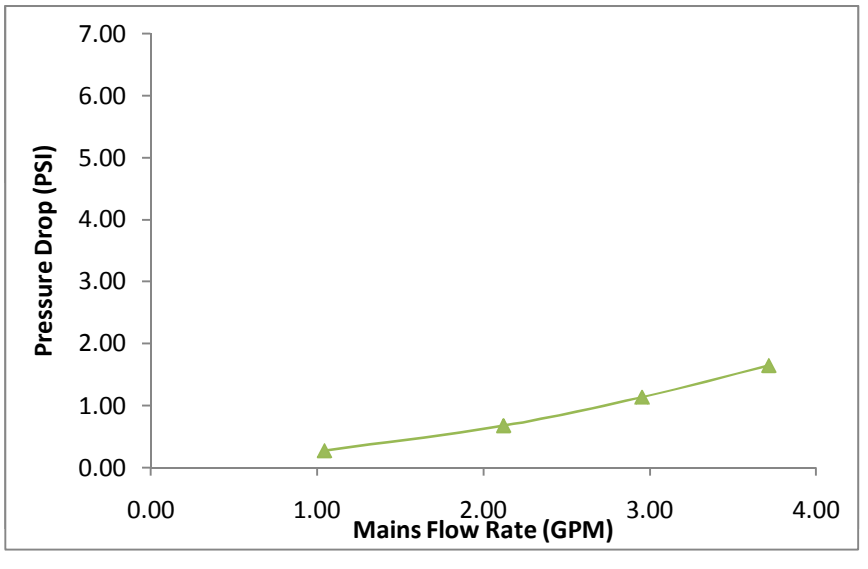


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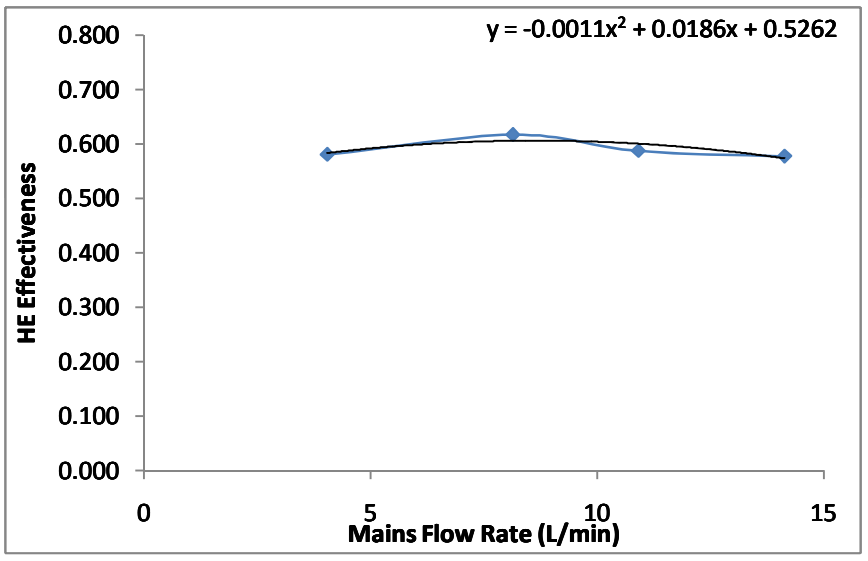
**Product:** 90in C4in
**Manufacturer:** Renewability
**Test Date:** February 14 / 2011

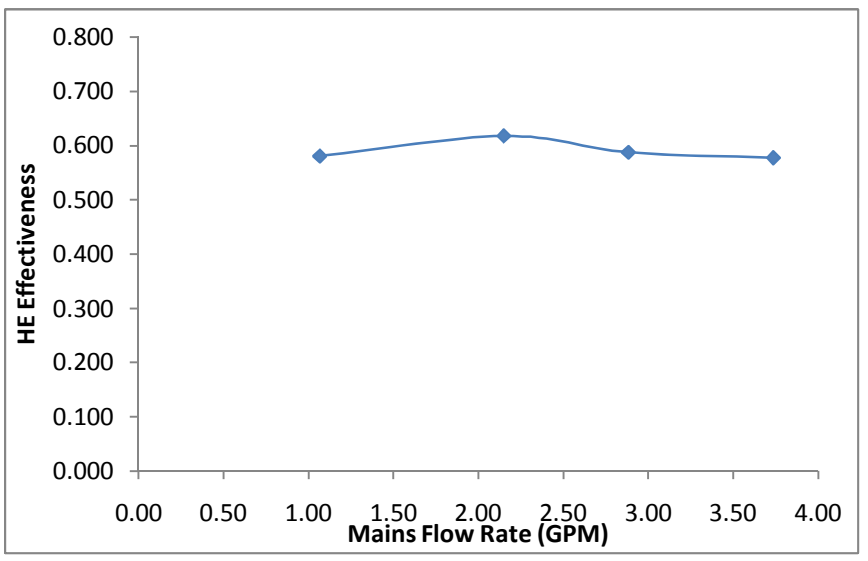
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.04 | 0.581 | 4.48 | 2.48 |
| 8.14 | 0.618 | 9.72 | 5.21 |
| 10.91 | 0.588 | 12.88 | 8.15 |
| 14.14 | 0.578 | 16.10 | 12.14 |

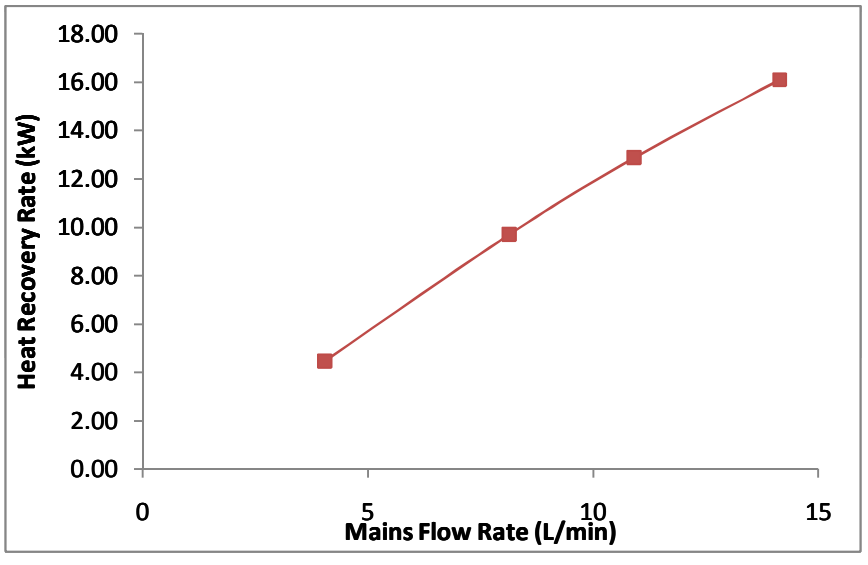
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.07 | 0.581 | 15300.00 | 0.36 |
| 2.15 | 0.618 | 33195.54 | 0.76 |
| 2.88 | 0.588 | 43987.51 | 1.18 |
| 3.74 | 0.578 | 54984.38 | 1.76 |

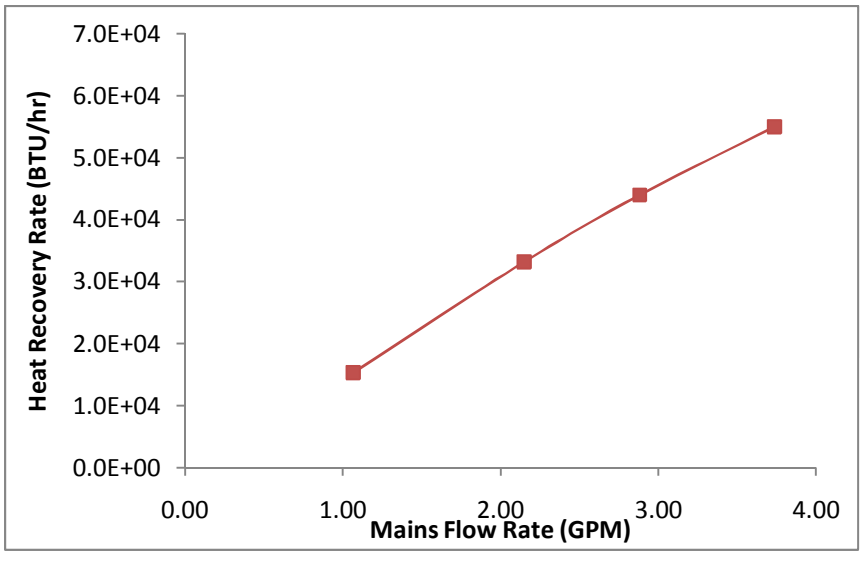
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

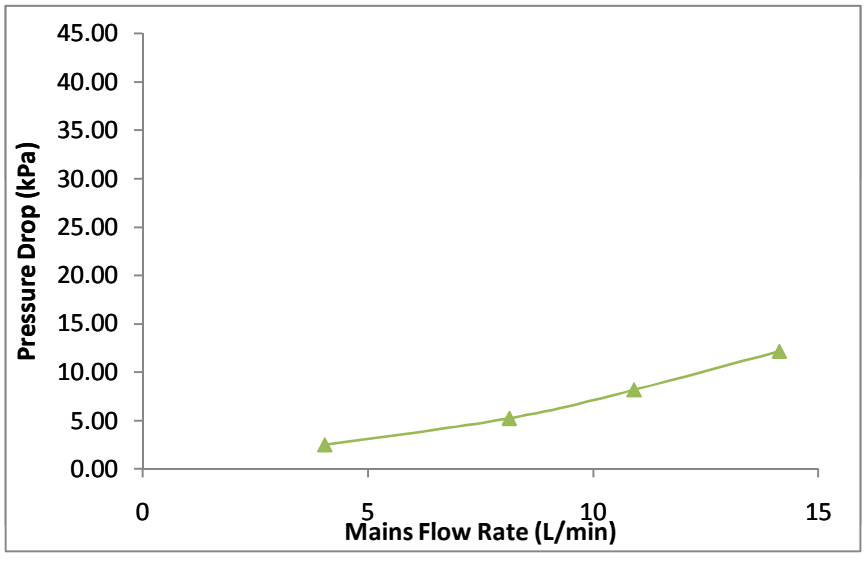
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.604 | | | |
| Heat Recovery | 11.27 | kW | 38494.1 | BTU/hr |
| Pressure Drop | 6.65 | kPa | 0.97 | PSI |

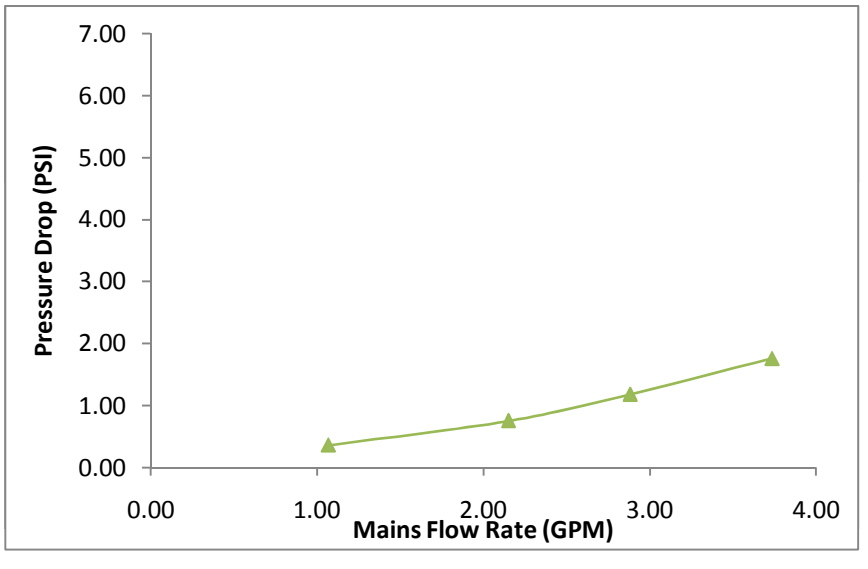


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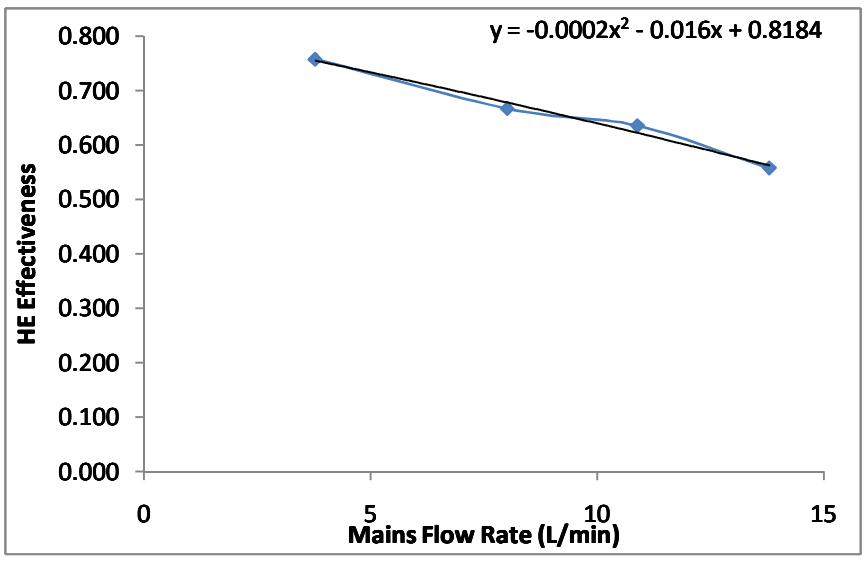
**Product:** 96in C4in
**Manufacturer:** Renewability
**Test Date:** February 10 / 2011

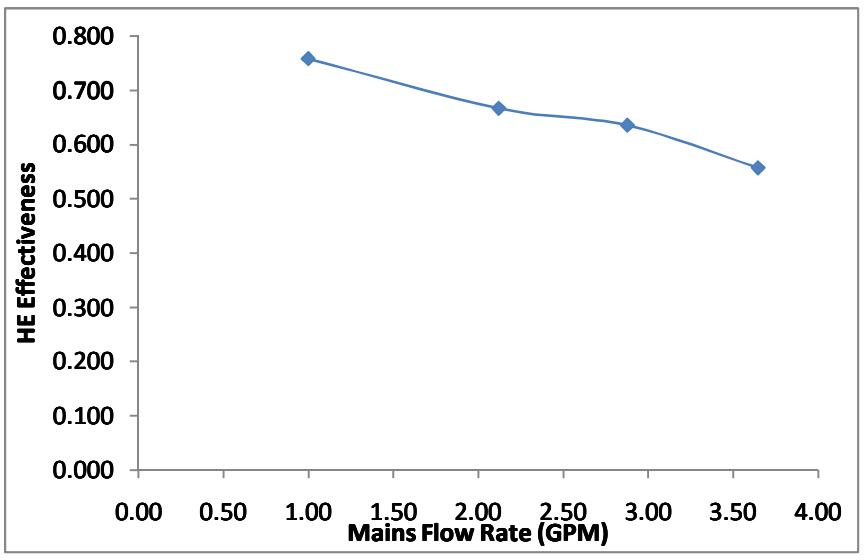
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.78 | 0.758 | 5.58 | 1.90 |
| 8.02 | 0.667 | 10.34 | 5.18 |
| 10.89 | 0.636 | 13.29 | 8.74 |
| 13.8 | 0.558 | 15.33 | 12.90 |

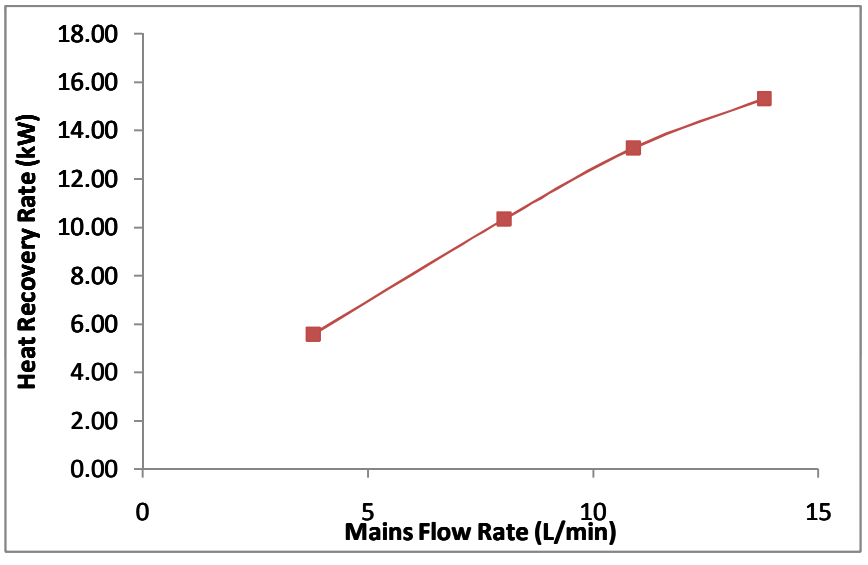
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.00 | 0.758 | 19056.70 | 0.28 |
| 2.12 | 0.667 | 35312.95 | 0.75 |
| 2.88 | 0.636 | 45387.73 | 1.27 |
| 3.65 | 0.558 | 52354.69 | 1.87 |

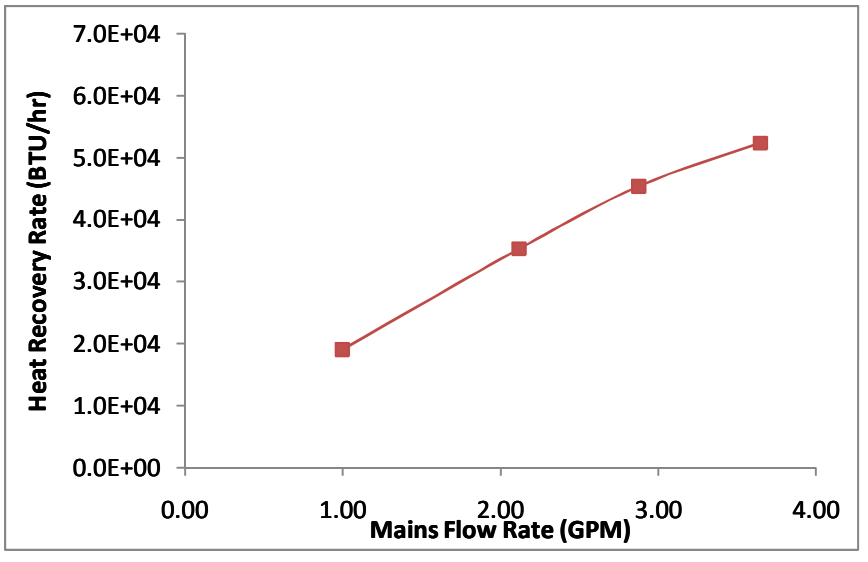
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

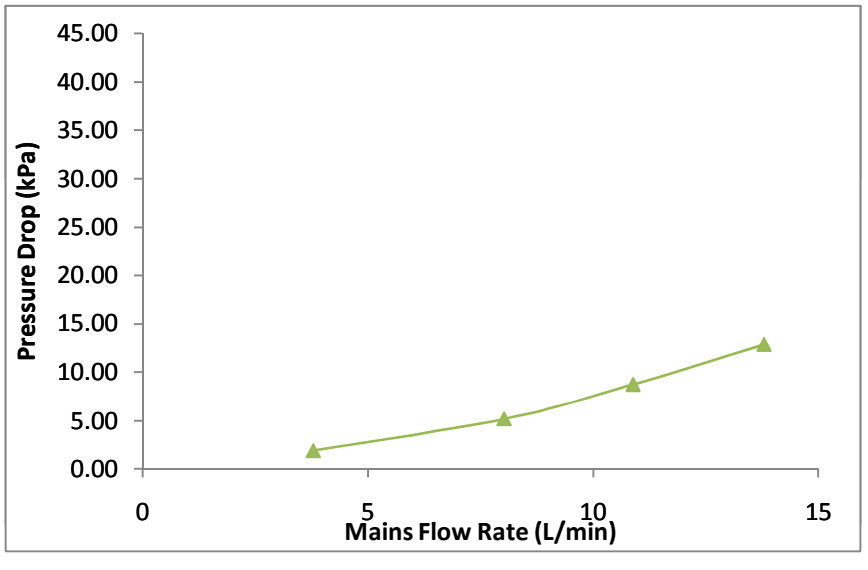
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.648 | | | |
| Heat Recovery | 11.86 | kW | 40508.3 | BTU/hr |
| Pressure Drop | 7.02 | kPa | 1.02 | PSI |

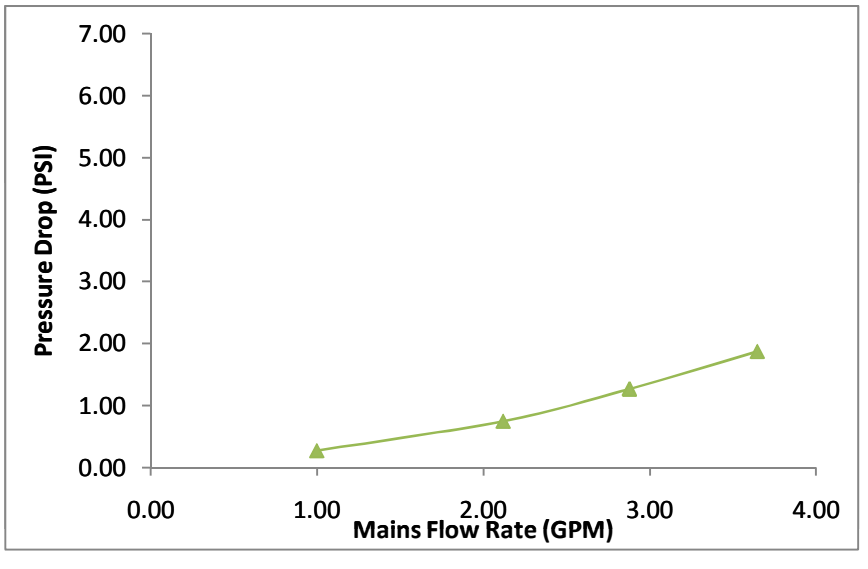


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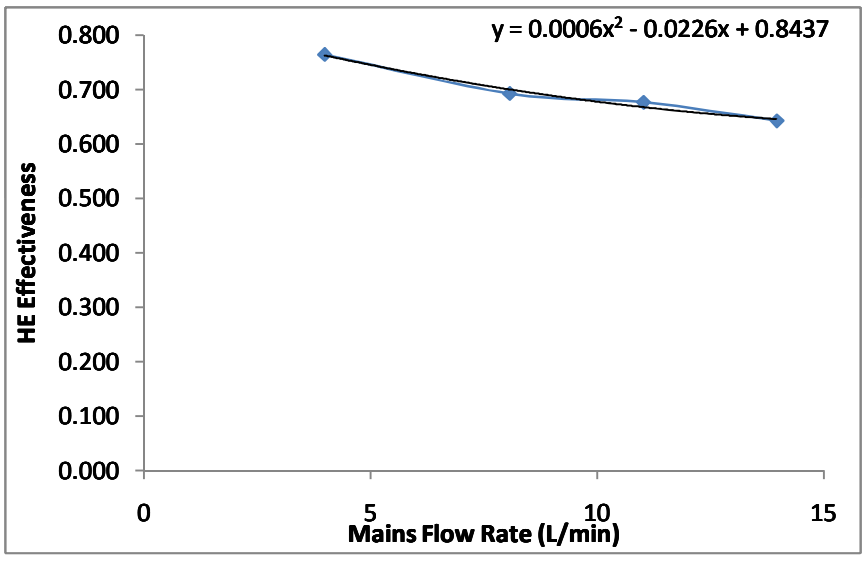
**Product:** 108in C4in
**Manufacturer:** Renewability
**Test Date:** February 10 / 2011

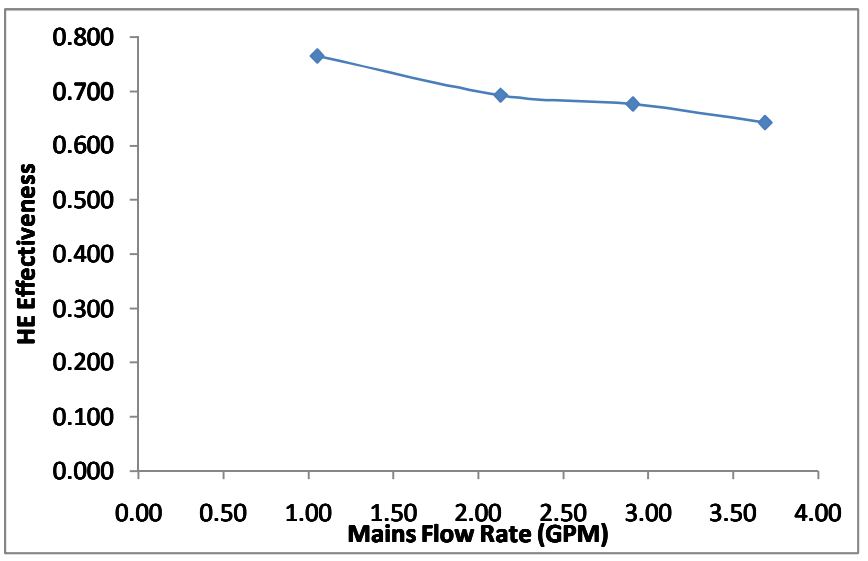
| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 3.99 | 0.765 | 5.85 | 1.96 |
| 8.07 | 0.693 | 10.94 | 5.78 |
| 11.02 | 0.677 | 14.32 | 9.65 |
| 13.96 | 0.643 | 17.53 | 14.24 |

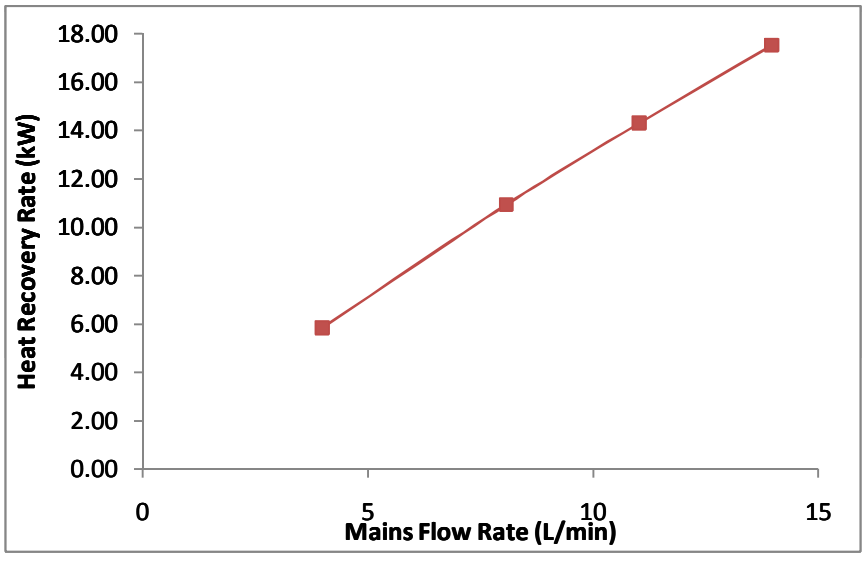
| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.05 | 0.765 | 19978.80 | 0.28 |
| 2.13 | 0.693 | 37362.06 | 0.84 |
| 2.91 | 0.677 | 48905.36 | 1.40 |
| 3.69 | 0.643 | 59868.09 | 2.07 |

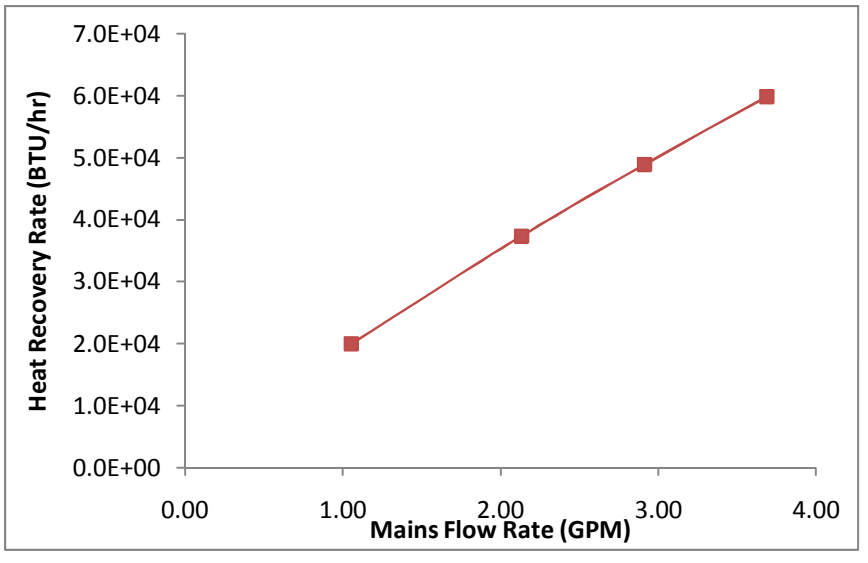
Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

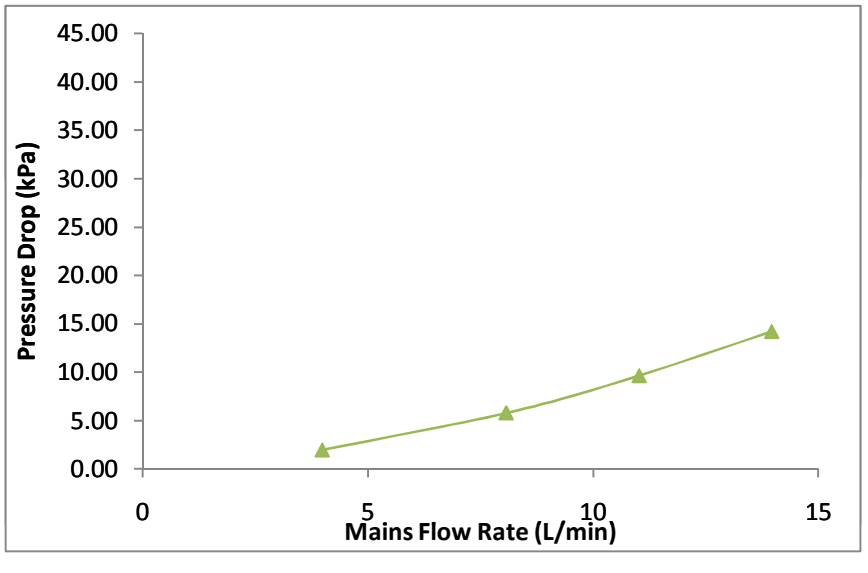
| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.683 | | | |
| Heat Recovery | 12.58 | kW | 42957.6 | BTU/hr |
| Pressure Drop | 7.66 | kPa | 1.11 | PSI |

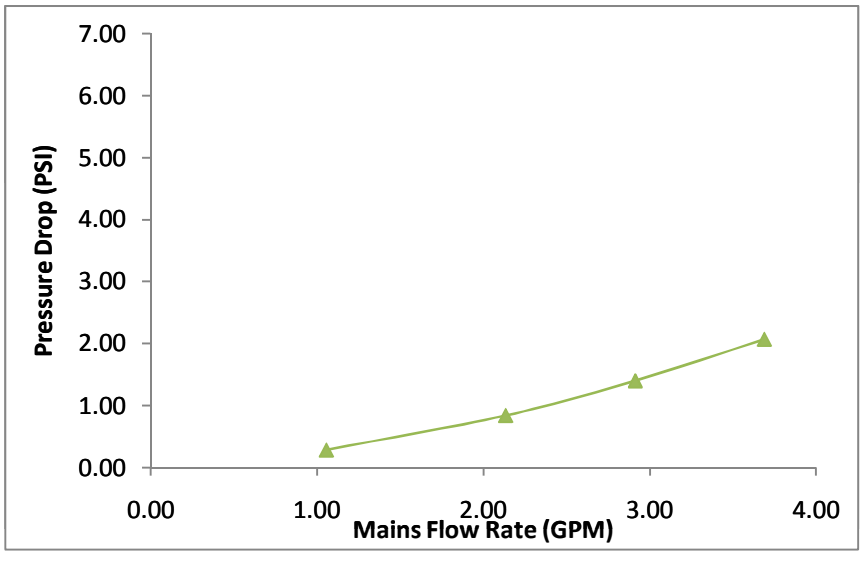


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**Product:** 120in C4in
**Manufacturer:** Renewability
**Test Date:** February 10 / 2011

| Flow Rate V' (L/min) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (kW) | Pressure Drop ΔP (kPa) |
|---|---|---|---|
| 4.08 | 0.690 | 5.49 | 2.46 |
| 7.99 | 0.702 | 10.82 | 6.37 |
| 10.87 | 0.705 | 14.00 | 10.59 |
| 14.04 | 0.671 | 18.20 | 15.51 |

| Flow Rate V' (GPM) | Effectivness ε | Heat Recovery Rate $q_{DWS}$ (BTU/hr) | Pressure Drop ΔP (PSI) |
|---|---|---|---|
| 1.08 | 0.690 | 18749.33 | 0.36 |
| 2.11 | 0.702 | 36952.24 | 0.92 |
| 2.87 | 0.705 | 47812.51 | 1.54 |
| 3.71 | 0.671 | 62156.26 | 2.25 |

Performance at Standard Conditions (9.5 L/min - 8 °C Mains, 36 °C Shower)

| | | | | |
|---|---|---|---|---|
| Effectiveness | 0.707 | | | |
| Heat Recovery | 12.49 | kW | 42646.3 | BTU/hr |
| Pressure Drop | 8.58 | kPa | 1.24 | PSI |