

## **WATER TEMPERATURE MANAGEMENT SYSTEM**

### **FIELD OF THE INVENTION**

5 The present invention relates to the regulation of water temperature in a hot/cold water mixer system, particularly for use in a domestic setting. It is envisaged for particular use in regulating shower water temperature in an environment where many users are connected to the same water supply, such as in an apartment complex or hotel.

### **BACKGROUND TO THE INVENTION**

10 Consistency of water temperature can be difficult to achieve where more than one user is connected to a single source of water. This problem is commonly experienced where several showers are connected to a single source of water. Typically, a user sets the water temperature of their shower to be at a desired level. When a subsequent user turns on a shower or other tap from the  
15 same water source, the temperature of the water at the first user suddenly increases or decreases. This problem recurs each time a subsequent shower is turned on. As a corollary, the turning off of a shower or other tap in the system leads to a temperature rise or drop in the other showers. Such temperature changes can have severe effects on water users, especially in children. A  
20 considerable amount of water is also wasted during the re-adjustment to optimal temperature.

It is therefore desirable to provide a water inlet/outlet system that reduces the effect of changes in water outlet temperature which may otherwise result from changes to upstream water usage.

### **25 SUMMARY OF THE INVENTION**

In a broad form, a pressure release valve is connected to the hot/cold mixer chamber of a hot/cold water mixer system, the valve operational to recirculate some of the water within the mixer chamber prior to exiting the chamber. In one aspect of the invention, a hot/cold water mixer is provided, which  
30 includes a hot/cold water mixing chamber having: a hot water inlet; a cold water inlet; a water outlet; and a pressure release system, the pressure release system including: a pressure release outlet in the mixing chamber; a pressure release inlet adjacent the water outlet; and a pressure release valve extending between

the pressure release outlet and the pressure release inlet, the valve adapted to recirculate a portion of the water within the mixing chamber into the pressure release system.

5 In another form, there is provided a system for regulating water temperature in a hot/cold water mixer the system including: a hot/cold water mixer according to claim 1; a first water flow regulating device connected before the cold water inlet; and a second water flow regulating device connected before the hot water inlet, the water flow regulating device comprising a flow restricting member axially moveable within a water flow chamber, the flow restricting member including at  
10 least one of a tapered portion or a stepped portion, and wherein the size of a gap between the flow restricting member and internal walls of the water flow chamber varying according to an axial position of the flow restricting member, the water flow chamber having at least a first region and a second region whereby movement of the flow restricting member from the first region to the second  
15 region results in a step-change in the size of the gap between the flow restricting member and the internal walls of the water flow chamber.

Ideally, the desired temperature range at the water outlet is between 0 and 5, ideally 0 and 3, degrees Celsius of a user's selected outlet temperature.

In one form, the pressure release valve comprises an inlet connected to a  
20 body having an aperture for permitting water flow there through, the valve operational such that upon a decrease in water pressure upon the valve inlet, the valve assumes a closed position, increasing the pressure of the water flowing through the valve aperture, the increased pressure resulting in the water flowing through the valve to re-enter the water mixer chamber. To maintain the water  
25 temperature at an acceptable level, preferably the predetermined pressure level is between about 1.0 and 5 bar, ideally about 1.5 bar.

The present invention provides a mixer and a system for maintaining a substantially constant water outlet temperature in a hot/cold water mixing system following undesired changes in upstream water input. The system is particularly  
30 advantageous in environments where many users are connected to the same water supply, such as in an apartment complex or hotel. The system results in an added safety mechanism to ensure that users, in particular children, are not inadvertently scalded by a sudden increase in water temperature. Including both

a pressure regulating device and water flow regulating device assists in maintaining both a near constant pressure and temperature at the mixer outlet.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

5 An illustrative embodiment of the present invention will now be described with reference to the accompanying figures. Further features and advantages of the invention will also become apparent from the accompanying description.

Figure 1 is a schematic diagram of a hot/cold water mixer system including a pressure regulating device according to an embodiment of the invention;

10 Figure 2 is a side view of the hot/cold water mixer showing the pressure regulating device according to an embodiment of the invention;

Figure 3 is a cross sectional side view of the hot/cold water mixer of Figure 2;

Figure 4 is a top view of the hot/cold water mixer of Figure 2;

Figure 5 is a perspective view of the hot/cold water mixer of Figure 2;

15 Figure 6 is a cross sectional perspective view of the hot/cold water mixer of Figure 2; and

Figure 7 is a perspective view of the pressure release valve according to one embodiment.

## **DESCRIPTION OF PREFERRED EMBODIMENT**

20 The following description is presented to enable any person skilled in the art to make and use the invention, and is provided in the context of a particular application and its requirements. Various modifications to the disclosed embodiment will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other embodiments and applications  
25 without departing from the spirit and scope of the present invention. Thus, the present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

Figure 1 shows a hot/cold water mixer system 10. The system comprises  
30 a hot water inlet 12 and a cold water inlet 14. Hot water and cold water pumps may be connected to the respective inlets 12, 14 to assist with water flow into the mixer chamber 20 and water outlet 22.

Connected between the hot water inlet 12 and mixer chamber 20 is a water flow regulating device 24. An identical water flow regulating device 26 is connected between the cold water inlet 14 and the mixer chamber 20. The water flow regulating device 24, 26 is disclosed in PCT/SG2009/000324, the contents of which are herein disclosed in its entirety by cross-reference. The water flow regulating device 24, 26 maintains the pressure in the respective hot and cold water chambers 28, 30 at a predetermined level to overcome the drop in water pressure of a first users shower upon a second user turning on a tap connected to the same water source. The water flow regulating device 24, 26 comprises a flow restricting member axially moveable within a water flow chamber, the size of a gap between the flow restricting member and internal walls of the water flow chamber varying according to an axial position of the flow restricting member, the water flow chamber having at least a first region and a second region whereby movement of the flow restricting member from the first region to the second region results in a step-change in the size of the gap between the flow restricting member and the internal walls of the water flow chamber.

Within the hot/cold water mixing chamber 20 is a pressure regulating device 32. The pressure regulating device 32 is ideally located downstream of the hot and cold water chambers, just before water exits the water outlet 22.

Figures 2 to 7 show the pressure regulating device 32 in greater detail. The pressure regulating device 32 extends from an outlet 34a in the mixing chamber 20 just before the water outlet 22 back to an inlet 34b to the mixing chamber 20 just downstream of the hot and cold water inlets to the mixing chamber 20. Within the device 32 is a pressure release valve 36. The pressure regulating device 32 is connected at each of its ends via screw thread to the mixer chamber.

Preferred (non-limiting) dimensions of the device 32 include:

Diameter of water flow regulating device outlet (24, 26): 12 mm

Dimensions of hot/cold water mixing chamber (20): 34mm by 30mm

Diameter of mixing chamber outlet (34a): 10mm

Diameter of mixing chamber inlet (34b): 10mm

Diameter of water outlet (22): ½ inch

Dimensions of pressure regulating device (32): 30mm by 80mm by 25mm

The valve 36 (preferred diameter 14mm) comprises a cylindrical body 38 (preferred diameter 15mm) having a central aperture 40 (preferred diameter 10mm) for permitting water flow through the valve 36 with a chamber screw connector 42 (preferred diameter 12mm) for connecting the valve 36 to the backflow tubing 34. The cylindrical body 38 is formed of a first portion 44 (preferred diameter 14mm) and a second portion 46 (preferred diameter 14mm). The first and second portions 44, 46 are connected to each other via a screw thread. The first portion 44 and second portion 46 are constructed from a resilient material, such as rubber, resulting in a slight axial movement between the first 44 and second 46 portions upon an increase or decrease in pressure throughout the surrounding pressure chamber 32.

In use, the water in the hot and cold water chambers 28, 30 will change in pressure depending upon the amount of water entering through the respective inlets 12, 14. In a traditional system, when the amount of cold water drops, for example because a second user has switched on a tap from the same water source, the pressure in the cold water chamber decreases (yet the hot water pressure stays constant), forcing less water through the mixer, resulting in a higher water temperature at the outlet. With the present embodiment, as the water pressure in the hot and cold water chambers drops to a predetermined level, the water flow regulating device 24 constantly stabilises and maintains the volume flow rates entering the mixing chamber, providing a consistent water outflow and an almost consistent temperature. Trials have shown that temperature variation of within 2 degrees Celsius is achievable, despite a drop or rise in the incoming hot water of 7 degrees Celsius.

The pressure regulating device 32 is a secondary mixing stage. As much as 25% of the water flowing into the mixer chamber 20 is back flowed via the pressure release valve back into the mixing chamber for another mixing process. The continuous mixing and remixing in the mixing chamber enables better water temperature stabilization. Trials have shown that using the pressure regulating device 32, temperature variations at the water outlet 22 are reduced to within 2 degrees Celsius. Additionally, the constant backflow and channelling dynamics between the two points assist in maintaining the volume flow rate in the event of sudden pressure drop.

The inventor's testing of the system yielded the following results:

Example 1 – No water flow regulating device or pressure regulating device

At a pressure of 4.5 Bar in the cold water chamber with 8.6 L/min of cold water volume, the output temperature was 36.8 °C. The cold water chamber pressure was dropped to 1.5 Bar with 0 L/min of cold water volume, and the water outlet temperature increased to 44 °C, a 7.2 °C increase.

Example 2 – With water flow regulating device and pressure regulating device, hot water kept at constant while varying the cold water pressure

Table 1: Pressure settings for Example 2

| Test 1<br>Constant Hot Water Pressure<br>(Variable Cold Water Pressure) |                             |                              |
|-------------------------------------------------------------------------|-----------------------------|------------------------------|
| Set                                                                     | Hot water Pressure<br>(bar) | Cold Water Pressure<br>(bar) |
| 1                                                                       | 2                           | 2                            |
| 2                                                                       |                             | 3                            |
| 3                                                                       |                             | 4                            |
| 4                                                                       |                             | 5                            |
| 5                                                                       | 3                           | 2                            |
| 6                                                                       |                             | 3                            |
| 7                                                                       |                             | 4                            |
| 8                                                                       |                             | 5                            |
| 9                                                                       | 4                           | 2                            |
| 10                                                                      |                             | 3                            |
| 11                                                                      |                             | 4                            |
| 12                                                                      |                             | 5                            |
| 13                                                                      | 5                           | 2                            |
| 14                                                                      |                             | 3                            |
| 15                                                                      |                             | 4                            |
| 16                                                                      |                             | 5                            |

Table 2: Results of tests in Example 2

| Test 1 - Constant Hot Water Pressure (Variable Cold Water Pressure) |                |                   |                  |                   |                  |                  |
|---------------------------------------------------------------------|----------------|-------------------|------------------|-------------------|------------------|------------------|
| Set                                                                 | Cold water     |                   |                  | Hot water         |                  | Mixer outlet     |
|                                                                     | Pressure (bar) | Flow rate (L/min) | Temperature (°C) | Flow rate (L/min) | Temperature (°C) | Temperature (°C) |
| Hot Water Pressure Constant at 2 bar                                |                |                   |                  |                   |                  |                  |
| 1                                                                   | 2              | 5.45              | 30               | 2.5               | 60               | 40               |
| 2                                                                   | 3              | 6.85              |                  | 2.5               |                  | 38               |
| 3                                                                   | 4              | 7.81              |                  | 2.3               |                  | 39               |
| 4                                                                   | 5              | 8.09              |                  | 2.5               |                  | 38               |
| Hot Water Pressure Constant at 3 bar                                |                |                   |                  |                   |                  |                  |
| 5                                                                   | 2              | 5.48              | 30               | 3.1               | 60               | 40               |
| 6                                                                   | 3              | 6.93              |                  | 3.5               |                  | 39               |
| 7                                                                   | 4              | 7.75              |                  | 3.3               |                  | 38               |
| 8                                                                   | 5              | 8.05              |                  | 3.2               |                  | 38               |
| Hot Water Pressure Constant at 4 bar                                |                |                   |                  |                   |                  |                  |
| 9                                                                   | 2              | 5.52              | 30               | 3.7               | 62               | 42               |
| 10                                                                  | 3              | 6.81              | 30               | 3.7               | 60               | 40               |
| 11                                                                  | 4              | 7.74              | 30               | 3.7               | 60               | 39               |
| 12                                                                  | 5              | 8.02              | 31               | 3.7               | 60               | 38               |
| Hot Water Pressure Constant at 5 bar                                |                |                   |                  |                   |                  |                  |
| 13                                                                  | 2              | 5.25              | 31               | 4.5               | 62               | 42               |
| 14                                                                  | 3              | 6.7               |                  | 4.3               |                  | 42               |
| 15                                                                  | 4              | 7.72              |                  | 4.4               |                  | 40               |
| 16                                                                  | 5              | 8.13              |                  | 4.4               |                  | 40               |

Example 3 – With water flow regulating device and pressure regulating device,  
5 cold water pressure kept at constant while varying the hot water pressure

Table 3 – Pressure Settings for Example 3

| Test 2<br>Constant Cold Water Pressure<br>(Variable Hot Water Pressure) |                    |                     |
|-------------------------------------------------------------------------|--------------------|---------------------|
| Set                                                                     | Hot water Pressure | Cold Water Pressure |
|                                                                         | (bar)              | (bar)               |
| 17                                                                      | 2                  | 2                   |
| 18                                                                      |                    | 3                   |
| 19                                                                      |                    | 4                   |
| 20                                                                      |                    | 5                   |
| 21                                                                      | 3                  | 2                   |
| 22                                                                      |                    | 3                   |
| 23                                                                      |                    | 4                   |
| 24                                                                      |                    | 5                   |
| 25                                                                      | 4                  | 2                   |
| 26                                                                      |                    | 3                   |
| 27                                                                      |                    | 4                   |
| 28                                                                      |                    | 5                   |
| 29                                                                      | 5                  | 2                   |
| 30                                                                      |                    | 3                   |
| 31                                                                      |                    | 4                   |
| 32                                                                      |                    | 5                   |

Table 4 – Results of tests from Example 3

| Test 2 - Constant Cold Water Pressure (Variable Hot Water Pressure) |                |                   |                  |                   |                  |                  |
|---------------------------------------------------------------------|----------------|-------------------|------------------|-------------------|------------------|------------------|
| Set                                                                 | Hot water      |                   |                  | Cold water        |                  | Mixer outlet     |
|                                                                     | Pressure (bar) | Flow rate (L/min) | Temperature (°C) | Flow rate (L/min) | Temperature (°C) | Temperature (°C) |
| Cold Water Pressure Constant at 2 bar                               |                |                   |                  |                   |                  |                  |
| F                                                                   | 2              | 1.5               | 60               | 5.79              | 31               | 40               |
| E                                                                   | 3              | 2.2               |                  | 5.84              | 32               | 40               |
| E                                                                   | 4              | 3.1               |                  | 5.68              | 32               | 42               |
| 20                                                                  | 5              | 3.5               |                  | 5.65              | 32               | 42               |
| Cold Water Pressure Constant at 3 bar                               |                |                   |                  |                   |                  |                  |
| 21                                                                  | 2              | 1.8               | 60               | 6.71              | 30               | 37               |
| 22                                                                  | 3              | 2.8               |                  | 6.71              |                  | 38               |
| 23                                                                  | 4              | 3                 |                  | 6.73              |                  | 39               |
| 24                                                                  | 5              | 3.5               |                  | 6.57              |                  | 40               |
| Cold Water Pressure Constant at 4 bar                               |                |                   |                  |                   |                  |                  |
| 25                                                                  | 2              | 1.5               | 60               | 7.94              | 30               | 38               |
| 26                                                                  | 3              | 2.3               |                  | 7.85              |                  | 40               |
| 27                                                                  | 4              | 3                 |                  | 7.79              |                  | 39               |
| 28                                                                  | 5              | 3.5               |                  | 7.75              |                  | 40               |
| Cold Water Pressure Constant at 5 bar                               |                |                   |                  |                   |                  |                  |
| 29                                                                  | 2              | 1.5               | 60               | 8.09              | 30               | 35               |
| 30                                                                  | 3              | 2                 |                  | 8.05              |                  | 37               |
| 31                                                                  | 4              | 2.8               |                  | 8.06              |                  | 38               |
| 32                                                                  | 5              | 3.2               |                  | 8.13              |                  | 40               |

The test examples show that using the present embodiment, and maintaining a fixed mixer level position, varying the cold and hot water pressures from 2 to 5 bar, and fixing the cold and hot water temperatures at 30 degrees

Celsius and 60 degrees Celsius respectively, the outlet water temperature can be maintained at around  $39.2 \pm 1.5^{\circ}\text{C}$  in most cases.

The embodiment provides a system for maintaining a substantially constant water outlet temperature in a hot/cold water mixing system following undesired changes in upstream water input. The system is particularly advantageous in environments where many users are connected to the same water supply, such as in an apartment complex or hotel. The system results in an added safety mechanism to ensure that users, in particular children, are not inadvertently scalded by a sudden increase in water temperature.

Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearance of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment.

Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more combinations. It will be appreciated that persons skilled in the art could implement the present invention in different ways to the one described above, and variations may be produced without departing from its spirit and scope.

Any discussion of documents, devices, acts or knowledge in this specification is included to explain the context of the invention. It should not be taken as an admission that any of the material forms part of the prior art base or the common general knowledge in the relevant art, in any country, on or before the filing date of the patent application to which the present specification pertains.

## CLAIMS:

1. A hot/cold water mixer including:
  - a hot/cold water mixing chamber having:
    - a hot water inlet;
    - a cold water inlet;
    - a water outlet; and
  - a pressure release system, the pressure release system including:
    - a pressure release outlet in the mixing chamber;
    - a pressure release inlet adjacent the water outlet; and
    - a pressure release valve extending between the pressure release outlet and the pressure release inlet, the valve adapted to recirculate a portion of the water within the mixing chamber into the pressure release system.
2. A hot/cold water mixer according to claim 1, wherein the pressure release valve comprises an inlet connected to a body having an aperture for permitting water flow there through, the valve operational such that upon a decrease in water pressure upon the valve inlet, the valve assumes a closed position, increasing the pressure of the water flowing through the valve aperture, the increased pressure resulting in the water flowing through the valve to re-enter the mixing chamber.
3. A hot/cold water mixer according to claim 1, wherein the mixer maintains a desired temperature of water flowing through the water outlet at between 0 and 5 degrees Celsius of a user's selected outlet temperature.
4. A hot/cold water mixer according to claim 1, wherein the mixer maintains a desired temperature of water flowing through the water outlet at between 0 and 3 degrees Celsius of a user's selected outlet temperature.
5. A system for regulating water temperature in a hot/cold water mixer the system including:

a hot/cold water mixer according to claim 1;  
a first water flow regulating device connected before the cold water inlet;  
and  
a second water flow regulating device connected before the hot water inlet,

the water flow regulating device comprising a flow restricting member axially moveable within a water flow chamber, the flow restricting member including at least one of a tapered portion or a stepped portion, and wherein the size of a gap between the flow restricting member and internal walls of the water flow chamber varying according to an axial position of the flow restricting member, the water flow chamber having at least a first region and a second region whereby movement of the flow restricting member from the first region to the second region results in a step-change in the size of the gap between the flow restricting member and the internal walls of the water flow chamber.

6. A system according to claim 5, wherein the pressure release valve comprises an inlet connected to a body having an aperture for permitting water flow there through, the valve operational such that upon a decrease in water pressure upon the valve inlet, the valve assumes a closed position, increasing the pressure of the water flowing through the valve aperture, the increased pressure resulting in the water flowing through the valve to re-enter the mixing chamber.

7. A system according to claim 5, wherein the system maintains a desired temperature of water flowing through the water outlet at between 0 and 5 degrees Celsius of a user's selected outlet temperature.

8. A system according to claim 1, wherein the system maintains a desired temperature of water flowing through the water outlet at between 0 and 3 degrees Celsius of a user's selected outlet temperature.