Free report on three designs to improve water conservation

Environment, Water

1. 0 Introduction

Only 2% of the water on earth is fresh water (Symons, 2001). The rest is primarily saline and hence cannot be used for consumption, or other applications in the home (e. g., cleaning or washing). Most households rely on piped water from municipalities (Kahramaa), whereas others are sourced from independent water purifications plants, private wells or even from rain water. With a growing global population there are increasing pressures on the world's fresh water supply. As such, water conservation has become critically important, particularly in regions where the water table is low, and other fresh water sources are scarce. In addition to conservation, solutions should also look to minimize waste of water as much as possible.

The ideal water temperature for bathing is about 2°C above normal body temperature. Personal preference, however, dictates that temperatures are often far warmer. Such preferences should come with warning; high temperatures can lead to unsuspecting body burns and other physical as well as psychological health complications. Temperature of water heaters that is more than 50°C can cause burns. In the case of the skin of very young children, which is soft and less resilient to adult skin, it takes less than a second to be scalded by hot water (Wells, 2008). In order to ensure safety standards, one must turn off the hot water before turning off the cold water when finishing a shower.

Taken conservation and safe temperature together, this report presents design specifications of an Automatic water control system. The aim of the report is to address the problems of water wastage and to calibrate the appropriate and/or safe water temperature for bathing. It will be particularly

of interest to regions that are in short supply of fresh water. China, and the Middle East, in particular are regions where such a system would be of tremendous value.

1. 1 Problem Statement

This project outlines the design of an automatic water control system for residential bathrooms. The goal of the design system is to reduce water waste, and to reduce the time that is required to achieve a desired and safe water temperature.

1. 2 Background

Qatar is facing a scarcity of water resources. In the online journal The Edge, Barry Mansfield stated that Qatar will spend $6. 9B USD in the coming years on sea water desalination. There is a short supply of clean water, due to the lack of natural water resources available in Qatar (Mansfield, 2012). Exacerbating this problem are the statistics that reveal the percentage of water consumption per capita in Qatar is very high. Dr. Adil Sharif was quoted in the Gulf Times stating that daily water usage in Qatar is " four times higher than most European countries and 10 times higher than many other countries around the world" (Varghese, 2013). There are many reasons for this high usage of water. One unusual reason is the inability to achieve the desired water temperature during summer and winter months. It takes approximately 30-60 seconds of free flowing water from the tap to reach a desired temperature. Consequently volumes of water is wasted.

The Better Health Channel has reported that children around the world below the age of four are at risk of being scalded by hot tap water in the bathroom. Some children reach the water taps and open them without realizing the

dangers they may face from hot water. This scenario occurs due to a lack of control by their parents or nannies (Better Health Channel, 2014). What results from this lack of supervision are burns that range from simple to serious. These burns can cause severe damage to the skin due to children’s sensitive skin, and require long periods of treatment.

What is proposed is an automated water control system that is easy and affordable. The aim is simple – to combat the problem of wasted water. Control in this context refers to the modification, influence or interference of a process. The interference occurs when parts are organized together to form what is known as a control system. Control systems are grouped into two: the manual control system and the automatic control system. The automatic control system is preferred in this report since it has the advantages of being accurate and more reliable in terms of regulating parameters such as temperature and flow rate.

2. 0 Methodology

2. 1 Design #1

Design 1 relied on the same parts of the existing system with the addition of a digital thermostatic valve. In the beginning using the same water heater tank as a heater and chiller was considered. This is possible by turning on the water heater only during winter months. In the summer months the tank would be turned off. When turned off during the summer months, the tank will serve as the cold water supplier. This, however, proved to be an ineffective solution as only limited cold water is provided. At this stage a better solution was presented. The second solution was to use a water heater tank with a larger volume capacity to handle the number of people

who use the bathroom. Before this final solution was considered another problem emerged. The tank is isolated and needs 4-6 hours or longer to decrease the internal temperature from 65°C to 32°C. If the tank runs out of water, consumers will needs to wait for the water to cool down or discharge the water. Also, the controller requirements are less than the minimum temperature that the water heater can reach.

2. 2 Design #2

Figure 2. Automatic water control system Design #2. Source: Author

The second design used in this project worked better than the first design. The same parts of the first design were used. Added was a small water chiller inside the bathroom and near the water heater tank. The water temperature was the same as was needed for the controller to mix water properly. Initially the design proved to be the better solution for reducing water discharged in the bathroom. Yet, two main disadvantages were immediately noticed. The first disadvantage was the limitation of cold water on the system. The water capacity is enough only for a limited number of people. The second disadvantage is the installation area inside the bathroom. A better way to solve discharging water problems is ongoing.

2. 3 Design #3

Figure 3. Automatic water control system Design #3. Source: Author

The final design for this project included using the same parts from design one and design two. In addition, a large water chiller was added to the main water tank. This water chiller provided a water temperature between 20-23°C. The volume capacity of water covers the consumption habits of all people within the house. With this design the set point can vary smoothly

between a low and a high level. The lower level temperature is 23°C and the upper level temperature is 46°C. This upper temperature is at a warm and comfortable level, yet is not so hot as to cause scalding if a child turns on the tap. Recommended water temperature is 2°C above normal body temperature.

2. 4 Testing the Existing System and New System

The existing system is wastes water while maintaining a particular water temperature. Two bathrooms were used to support the engineering analysis. Water readings were collected from each bathroom. One of the main measurements for the project was to calculate the time required to achieve a desired water temperature. This was accomplished by using two scenarios in two different bathrooms. One bathroom was equipped with a water heater installed on the inside and the other bathroom was equipped with a water heater installed on the outside.

The water flow rate for both bathrooms was first calculated. An empty bottle (1 liter in volume) and a basic timer were used to get the water flow. Then, a table was built to represent the water that is used and discharged per person. With this in place data collection began each day.

The test gave information on the time required to acquire a desired temperature and the time required for water to be discharged from the bathroom. During data collection the ambient air temperature in Qatar was between 18-30°C. It was determined that the bathroom equipped with a water heater installed internally discharged less water than the bathroom with a water heater installed externally. The long distance from the heater increased the time required to get a certain temperature. This increased the

amount of water discharged in the system.

In the beginning many attempts were employed to reduce the amount of water waste to nearly zero. More sensors and a bypass line were used to recirculate the discharged water to the main tank. The sensors were connected to the solenoid valves to maintain the amount of recirculated water. This could ensure that the water would not pass through the water tap until it reached the setpoint. This would solve the water discharge problem. But, these sensors would also increase the system price and require more maintenance. To avoid the cost and maintenance problems the amount of discharged water was deemed acceptable. The assumption was that one person is using the water taps in the bathroom six times per day. The minimum amount of water discharge in the existing system is 5. 32 liters and the maximum can reach 20. 54 liters. More importantly, the maximum discharged water for the new system is 2. 28 liters per day. The new system will save up to 1126 liter per month for one person compared to the existing system. This result will reduce the amount of waste water and the time required to get a desired water temperature.

References

Better Health Channel (2014). Burns and Scalds – Children. State Government of Victoria. Retrieved from: http://www. betterhealth. vic. gov. au/bhcv2/bhcarticles. nsf/pages/Burns_and_scalds_chldren

Mansfield, B. (2012, Jul. 10). Qatar’s Fresh Water Challenges. The Edge. Retrieved from: http://www. theedge. me/qatars-fresh-water-challenges/

Varghese, J. (2014). Daily per capita water usage in Qatar: 500 litres. Gulf Times. Retrievedfrom: http://www. gulf-times.

com/Mobile/Qatar/178/details/372827/Daily-per-capitawaterusage-in-Qatar%3A-500-litres

Symons, J. M. (2001). Plain Talk about Drinking Water: Questions and Answers about theWater You Drink. American Water Works Association.