Automatic Temperature-Based Water Flow Control System for SLOAN Solar Powered Faucets

Prepared for:
Ms. Jewel Persad, The Green Initiative Fund, UCSB

Prepared by:
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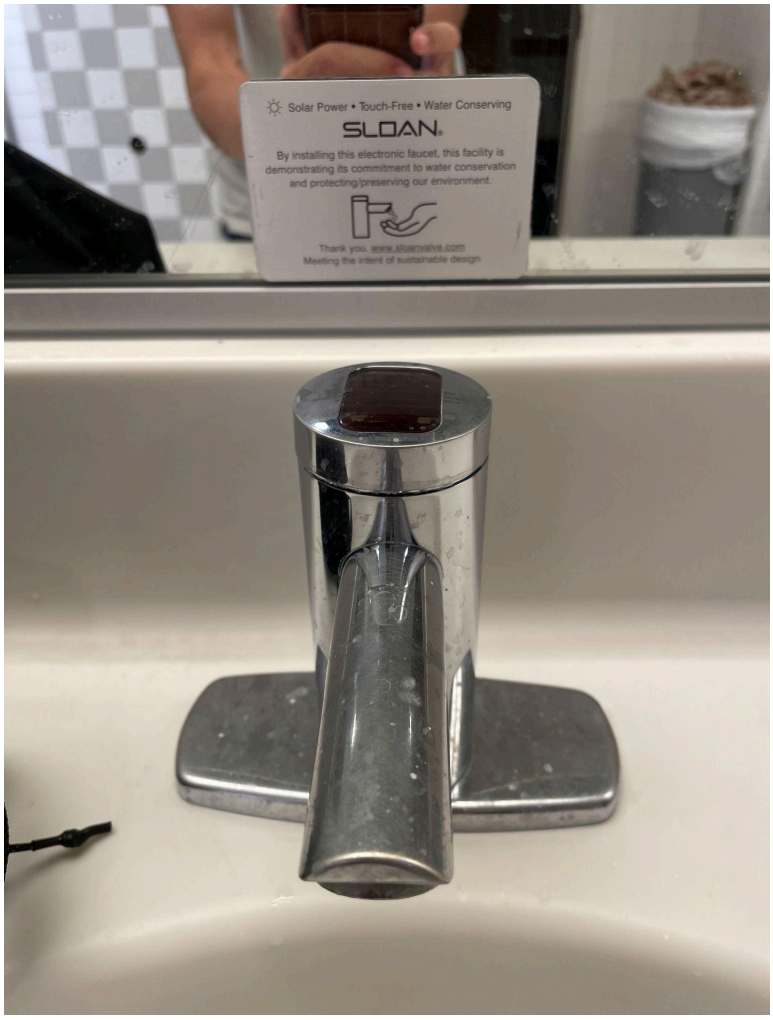
October 29th, 2024



MEMO

To: Ms. Jewel Persad, The Green Initiative Fund
From: Lucas Zhou
Date: October 29, 2024
Subject: Temperature-Based Water Flow Control System

I am writing to inform you of a project that addresses an issue regarding the SLOAN Solar Powered Faucets at UCSB.

In communal bathrooms around campus, the water inside the solar powered faucets reaches temperatures that are too high. The problem is that the faucet water remains at a high temperature, even after a long period of time. One key factor that may result in this issue is the improper mixing of hot and cold water. The flow rate of hot water may be higher than that of cold water. Additionally, the temperature of the water seems to be affected by the ambient temperature.

If I install a temperature regulation control system into the mixing area of the faucet that adjusts the water temperature based on the surroundings, then the water temperature will not rise above a certain temperature. In effect, the faucets will be easier to use. Also, people will be more comfortable with the faucet water. Feel free to contact me if you have any questions. My email is lucaszhou@ucsb.edu.

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EXECUTIVE SUMMARY

This report addresses the issue of uncontrolled temperatures in SLOAN Solar Powered faucets. Sometimes, the temperature of the water coming out of these faucets is too high because of improper mixing. One possible flaw in the current design is that the flow rate of hot water is faster than that of cold water. As a result, the hot water quickly overtakes the cold water when mixing occurs, causing the temperature of the water to increase as soon as the faucet is turned on. To solve this problem, a temperature control system must be implemented in order for the water to feel more comfortable to users.

INTRODUCTION

This report examines the problem of SLOAN Solar Powered faucets getting too hot in terms of water temperature. Possible methods to implement a temperature control system will be provided, and analyses of the pros and cons of each method will be given. A final result will be proposed. This introduction includes a brief description, the scope of the problem, and the report format.

Project Description:

My project is to install a temperature control system that controls the water temperature that comes out of SLOAN Solar Powered faucets after hot and cold water mix. It would be best to implement it in the mixing valve so that the temperature of the mixed water can be automatically adjusted to match with the ambient temperature. For example, the system will detect if the temperature of the mixed water is above a certain limit, and the temperature of the mixed water will be adjusted automatically, according to the temperature of the surroundings. This way, people using the faucets will experience a more comfortable water temperature at all times.

Scope and Format of Study:

The analysis will focus on the feasibility and practicality of implementing an improved temperature control system for SLOAN Solar-Powered Faucets in UCSB Bathrooms.

This report will emphasize the following topics:

1. Investigation of Solar Faucets
2. Possible Solutions
3. Pros and Cons of Each solution
4. Costs

How Do Solar Faucets Work?

SLOAN EAF-275 solar powered faucets convert energy from the sun into electrical energy, which is used to charge the faucet so that it never runs out of battery. An automatic hand sensor is built into the device so that water flows when you move your hand near it. Faucet water flows through two valves: a hot valve and a cold valve. The water is then mixed in a mixing valve and sent to the faucet where the mixed water comes out.

The Problem:

The main problem resides in how fast the hot and cold waters are moving per second. For example, the hot water may be flowing faster than cold water, which, over time, may cause the amount of hot water to overtake the amount of cold water when the waters are mixed together. In extreme cases, the hot water flows so fast that mixed water comes out to be too hot right from the start of handwashing, making it seem like the water never cools down properly.

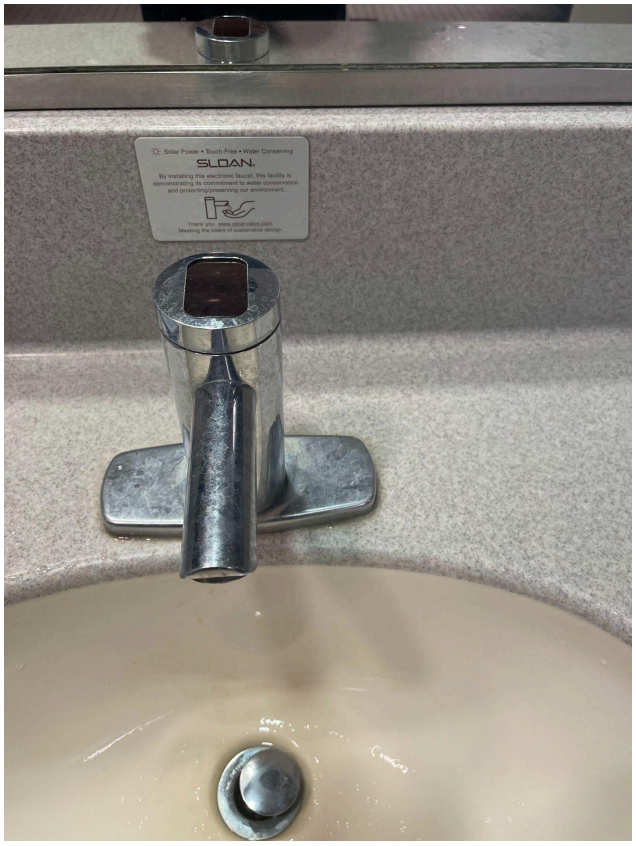

Figure 1: SLOAN Solar-Powered Faucet at Carrillo Dining Commons

POSSIBLE CAUSES FOR CONCERN

From my investigation of SLOAN EAF Solar-Powered Sensor Faucets, I found three potential sources of error. Here is my analysis on the validity of these sources.

1. Temperature of the Outside:

Initially, I thought that the temperature of the water that comes out of this faucet was affected by the temperature of the surroundings. I predicted that the water temperature would be naturally higher during hot weather, especially in the summer months. Clearly, this was not the case. For example, the faucets at Carrillo Dining Commons were still hot, regardless of how hot the outside was.

2. The Mixing Valve:

The mixing valve may be a cause for concern since it does not control the flow rates of hot and cold water. When both hot and cold water are mixed, the temperatures of the mixed water may vary. The temperature of the mixed water, as a result, is not controlled properly.

3. Orientation of Pipes:

How the pipes are set up may, at first glance, be a source of error since the pipes affect how water is flowing from both hot and cold valves. Pipes that are not symmetrical may naturally cause more hot or cold water to come into the mixing valve because of the length of these pipes. From my observations, the problem has more to do with how the hot and cold water are mixed. A few flaws in the orientation of pipes may only cause rounding errors in the temperature of the water that enters the mixing valve.

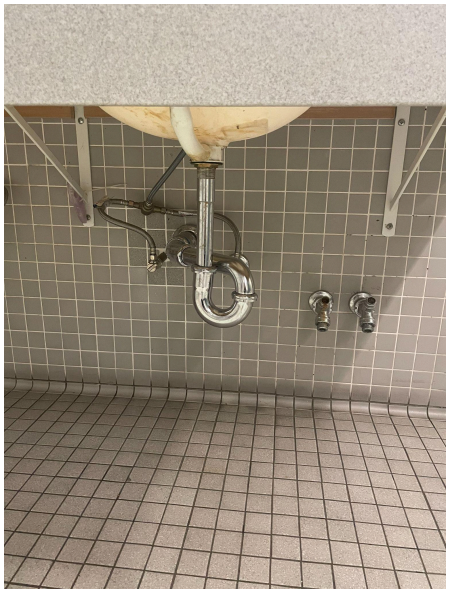

Figure 2: Pipe at Carrillo Dining Commons Bathroom

IMPLEMENTATION

From my investigation, I thought about a few possible solutions to the faucet mixing problem. Below is a list of improvements:

Possible Innovations/Solutions

1. Automatic Temperature Sensor w/ Thermostat:

It would be helpful to install a temperature sensor inside of the mixing valve in order to detect whether the temperature of the mixed water is above a certain temperature. The sensor would have a built-in thermostat that automatically lowers the temperature to a comfortable range if the temperature is above the limit. This way, the temperature of the mixed water stays consistent over an extended period of time.

2. Thermostat System Inside Water Heater:

The root of this problem may result from the fact that the water is being heated uncontrollably. It may be sufficient to install a thermostat system into the water heater itself. This way, the temperature of the hot water before mixing will already be in a comfortable range. As a result, the water that comes out of the faucet may be just right. The water temperature can also be manually adjusted through a few clicks of buttons.

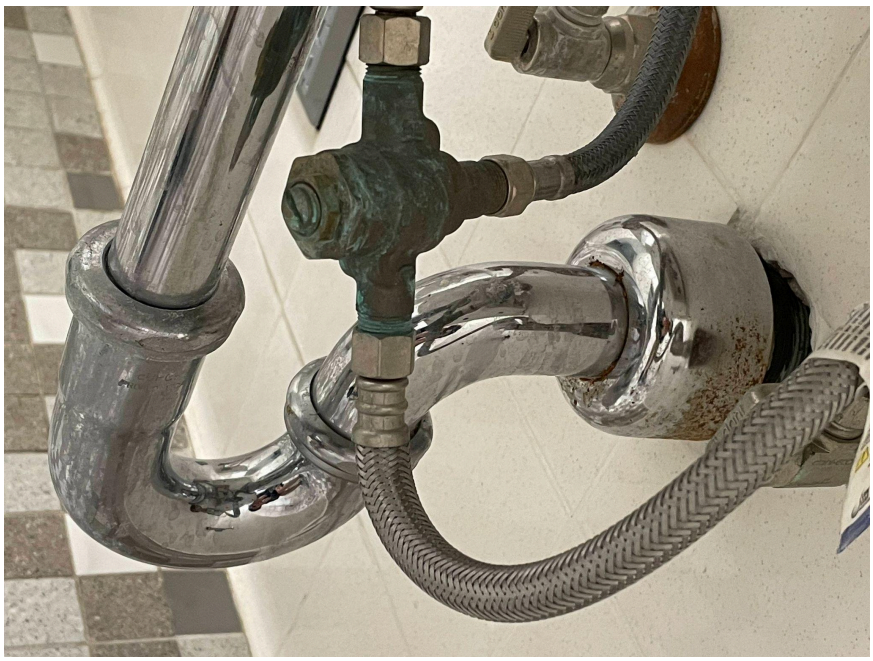

Figure 3: Mixing Valve at Anacapa Residence Hall Bathroom (Downstairs)

COSTS

Below is an analysis of the potential costs that are part of my project. Some of these may or may not be considered when the final project is complete.

1. **Time**
   It may take about 1-2 months just to get the sensor built, but the implementation may only take a couple of hours. The sensor I'm trying to build will be relatively small compared to the large pipes. Installing one sensor into each faucet should take approximately a few minutes. The project would take approximately 2-3 months to complete, which would be a reasonable time frame.

2. **Money**
   A temperature sensor typically costs around a few dollars to over 100 dollars, and I don't know what sensor works best. Further research on the various sensors is needed. This project may also require a circuit board, which may cost $50 total. More investigation is needed to determine the necessary materials for building the sensor. The project may or may not be practical in the long term, depending on how much total money is spent. Additionally, hiring the engineers to build the systems mentioned above may cost over $1000 in total. However, these costs will be spread out over many faucets in the long term.

CONCLUSION AND RECOMMENDATIONS

Further research on technical aspects of the SLOAN faucet mixing problem is necessary to determine the best solution. The overall goal of this project is for UCSB students to have a comfortable handwashing experience in which the water temperature is just right, depending on the temperature of the surroundings. Sustainability will be improved since more people would be using the faucets. Also, users would have less complaints.

Recommendations:

I am no expert on this subject, so I recommend UCSB hiring a qualified engineer to solve this faucet mixing problem. Additionally, UCSB should continue to gather resources that may be useful in improving faucet systems. Wouldn't it be great if everyone's faucet water comes out just right?

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