Water or Slime? A platform for automating water treatment systems

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Abstract

Worldwide, the availability of water is increasingly becoming a political and environmental concern. With a quarter of the world's population living downstream of the receding Himalayan glaciers [1], tensions over availability of fresh water supplies will only rise in the coming years. Surprisingly, few technical solutions have arisen to rein in wasteful water consumption or pollution. In fact, society has a poor understanding about the causes of wasteful consumption and pollution patterns at the heart of these concerns. With Emonix H_2O, we aim to provide a platform for municipalities in developing and developed regions to identify and control sources of waste in water distribution and treatment systems. Emonix H_2O provides users with a high-level understanding about water consumption patterns by tracking flow rate and water quality across multiple locations in real time. In a pilot deployment, we demonstrate that simply making system maintainers aware of malfunctions in treatment equipment can drastically reduce waste and pollution.

Categories and Subject Descriptors

C.3 [**Special-Purpose and Application-Based Systems**]: Real-time and embedded systems

Keywords

Smart Energy; Sensor Platforms; Water Treatment

1 Introduction

Regional water politics are increasingly putting pressure on local governments to reduce their fresh water consumption and water pollution [4]. For this reason, the availability of fresh water will set limits on population expansion in urban centers as well as the productivity of arable land, both in the United States and abroad.

In the Madison area, water softeners are a primary source of Sodium and Chloride ion pollution [2]. Pollution of fresh water sources is a major concern because it threatens the supply of potable water on which urban populations depend. Salt waste produced by softeners is discharged into waste water treatment facilities. Once dissolved, it is difficult and expensive to remove.

Water softeners stop lime buildup in pipes and equipment by removing dissolved minerals – Calcium and Magnesium ions – from tap water. This is typically accomplished by exchanging Calcium and Magnesium ions with Sodium ions.

Softeners use table salt, NaCl, as a source of Sodium ions, but the ion exchange process is not efficient. For every pound of Calcium removed from the water supply, water softeners discharge approximately thirty pounds of salt to the sewage system[1]. Subsequently, the waste eventually finds its way to the local lakes, rivers, and drinking water supply.

In our pilot deployment in a UW residence hall (Chadbourne), we used Emonix H_2O to identify a misconfigured softener system that was unnecessarily generating large volumes of saline waste water. As a result, *we reduced the salt used in that building by approximately 46%*.

1.1 Sources of Inefficiency in Existing Water Softener Systems

Variations in the incoming water hardness, the softener system itself, or the water usage pattern of the building can make the system unstable.

Misprogrammed controllers can cause inefficiencies in the softener system by allowing either too much or too little water to flow through the resin bed before it is flushed. Unfortunately, many existing softener controllers are difficult to program. Even experienced maintenance personnel can make mistakes in programming the softener controllers, resulting in over-softened or under-softened water.

Low flow rates through a softener tank can result in uneven flow through the resin bed, causing part of the resin to deplete quickly. For this reason, it may be necessary to regenerate the water softener more frequently during periods of low consumption.

2 Online Monitoring

By installing real-time web-based monitoring on water softeners, we can remotely track a building's water and salt usage as well as detect configuration problems that may

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[1] 1 grain = 64.79891 milligrams. 10 lb salt (= 4.53592 kg) removes 2358 grains of Ca2+ (.336 lbs = 0.152796 kg). Efficiency = 3.37%

	Salt Purchased	Weight	Cost	
Winter 2012	24 pallets	58,800 lb	$8984	no monitoring
Winter 2013	13 pallets	31,850 lb	$4866	Emonix H_2O
	11 pallets	**46% Less Salt**	**$4118 saved**	

Table 1. Comparison of salt consumed in Chadbourne Hall during two consecutive winters

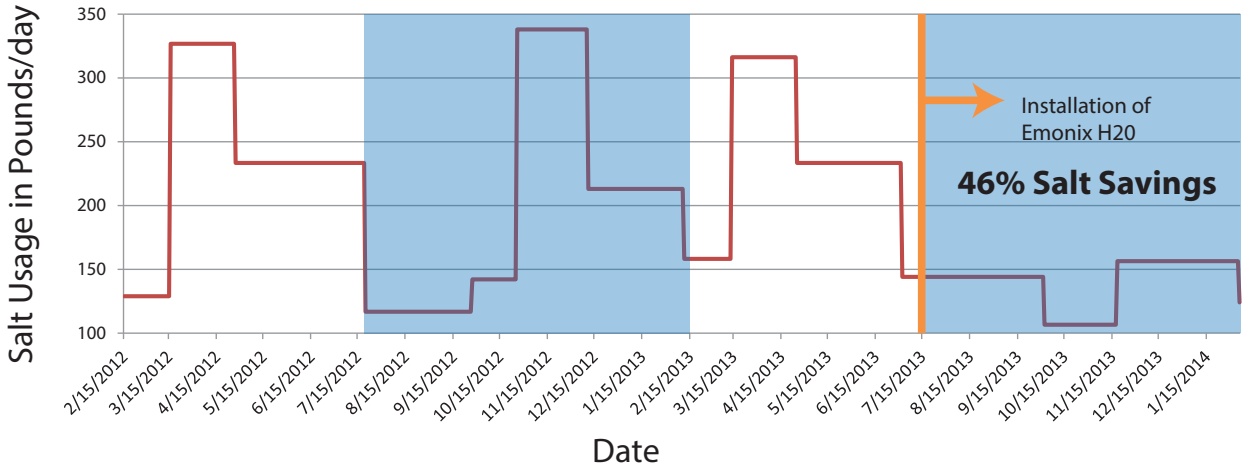

Figure 2. Salt usage in Chadbourne Hall over a two-year timespan. Regions highlighted in blue are comparable time periods of two years (2012 and 2013).

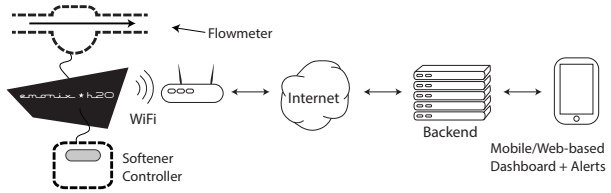

Figure 1. Dataflow diagram for the Emonix H_2O system. Components with solid lines are part of Emonix, and components with dashed lines are part of the existing softener system.

arise. Commercial water softeners do not track this data or make it available to users.

Figure 1 shows a diagram of the data flow used to collect data from Emonix H_2O sensors, which are based on the Emonix platform, an embedded platform originally designed by our lab to measure energy consumption [3].

2.1 Installation and Configuration

Installing a new Emonix H_2O flow sensor on an existing softener takes about ten minutes. The installation site must have a reliable WiFi network to provide the Emonix devices with access to the Internet. The Emonix sensor board listens passively to the signal generated by the flow meter and passes it on to the controller.

2.2 Notifications

Emonix H_2O can save time for maintenance staff by sending out email alerts when important events occur, such as low salt level detected in the brine tank. This feature reduces the effort of verifying that each softener system is in good working order.

2.3 Cost Savings

After Emonix H_2O identified a misconfiguration in the softeners in Chadbourne hall, *salt usage dropped by 46%*, resulting in a $4118 savings in salt purchases over a six-month period ending January 2014. Table 1 shows the salt savings achieved after installing Emonix H_2O.

Reduced Salt Usage: Figure 2 shows the average salt used by the softener system in Chadbourne over a two-year timespan starting in 2012. We used Emonix H_2O to identify a misconfiguration of the softener in July 2013, after which time the salt consumption of the building decreased dramatically.

Reduced Saline Pollution: With the reduced volume of salt used to flush the water softener system in Chadbourne, there was a proportionate decrease in Chloride and Sodium pollution.

3 References

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