click here for the SLOAN web site

Lavatory Water Consumption

A Study Conducted on Behalf of Sloan Valve Company
at Texas A&M University

Research conducted by:

Dr. Paul Woods
Construction Science, MS 3137
Texas A&M University
College Station TX 77843-3137

Additional Research Personnel
Hoonsik Seo – PhD
Woo Sung Jung – MS COMAG
Salilla Lertbannaphong – MS COMAG
Ken Parker - PhD

Policy Statement

Sloan Valve Company is in the business of developing plumbing systems. In our practice, we build informational data in order to extract knowledge. We research extensively with individuals involved in the construction industry.

Lavatory Water Consumption

A Study Conducted on Behalf of Sloan Valve Company at Texas A&M University by Dr. Paul K. Woods.

Water is increasingly becoming a scarce resource. In order to understand water consumption levels of lavatories, a study was commissioned by Sloan Valve Company at Texas A&M University. The study director, Dr. Paul K. Woods, presented his findings to Sloan Valve Company in 2003. This is a summary of those findings and the study methodology for lavatories (faucets). Additional studies will be conducted.[1]

The subject property where the study was conducted was the College of Architecture main building on the Texas A&M University campus at College Station. Four women's restroom and four men's restrooms on four floors were part of the study. There were 8 each men and women lavatories, total of 16 lavatories.

The study made certain assumptions, including:

- The use of average lavatory gpm across all fixtures will yield accurate gallons per day lavatory consumption.
- The relationship between metered and measured gpf is constant over all phases.
- Unobserved fixtures will have little effect on the outcome.

---

[1] This research study on acoustic monitoring of plumbing fixtures was recently awarded a U.S. patent #6,839,644 (attachment A). The entire study monitored not only lavatory fixtures but also flushometers. Since the study was

Acoustic Information Retrieval System

A new method to measure the frequency of use and calculate the amount of water consumed by plumbing fixtures in a public restroom was developed by Texas A&M University researchers and used in this research. This new technology identified through the column of water unique sound signals generated by plumbing fixtures.

Called AIRS, (Acoustic Information Retrieval System) the system consists of multiple acoustic sensors that are attached to the water supply risers for each restroom. Shielded cable transmits a signal from the sensors to a set of audio mixers, which outputs to a computer. AIRS software identifies fixture actuations and delivers this information to an Excel spreadsheet, recording the time and duration of a specific fixture actuation.

Using this method, water-use data was collected for approximately two weeks during the regular semester for three phases of the study. (These phases are identified as "Tune up," "Low Con," and "Automatic.") The fixture flow rate in gallons was tabulated from the fixture flow volume (gallons) and flow duration (seconds). The system wide average was computed for each lavatory. All these calculations were performed for each phase for comparison.

There were limitations to the study in terms of both the measurements, as well as the unobserved fixtures. For example, there were three service sinks, eight water fountains, four janitorial sinks and exterior hose bibs that were not accounted for or observed, and therefore, could have an impact on the findings. Additionally, there was no way of checking the accuracy of the Rosemont brand digital water meter over the expected flow range for the subject building.

---

conducted within a single building all water demand within that isolated structure could be accounted for on the

Due to their nature, manual lavatory valves deliver water at different rates depending on the user and how much volume any given user opened a manual faucet to. Of course this was not a problem with the automatic valve sets. Second, unlike the other fixtures, the duration of a lavatory event could vary from one second to several minutes. Therefore it was necessary to measure not only their frequency of use but also their duration. This meant measurement of the duration of each event required digital recording for data collection.

In addition, the acoustic signal produced by the automatic lavatory was unusually difficult for AIRS to recognize. It is believed that the automatic lavatory sets were much quieter. The lack of water turbulence meant there was little acoustic difference between them individually. Therefore, a pressure switch was installed that actuated a buzzer each time a lavatory was used. The lavatory event log was then constructed from the recording, since the recording had to be used to measure the duration in any case. While some sacrifice of individual flow was experienced in certain phases, aggregate usage was reasonably accurate.

---

building water meter. This summary reports on the lavatory results of that study.

Establishing Flow Rates

For lavatories, consumption is calculated as a function of duration and average flow rate in gallons per second. The flow rate in gallons was measured for each fixture in the building for each phase of the study. The measurement process was completed at least three times for each fixture and the average use rate was equated as a baseline.

As far as the study's experimental setup, data and methodology are concerned, the following steps were followed for each lavatory faucet:

- A graduated plastic bag was secured around the lavatory outlet.
- The lavatory was opened on command (stopwatch).
- The lavatory was closed on command (stopwatch).
- The gpm was read from the graduated plastic bag.
- The reading was adjusted by three times.
- Each lavatory faucet was measured at least twice.

One person would hold the mouth of the bag securely around the lavatory outlet and operate the lavatory knob (for manual faucets). A second person would operate the stopwatch and say when to open and close the lavatory valve. The valve was opened for 10 to 20 seconds. The bag was suspended by its corners while the fixture flow rate in gallons per minute was read from the water level in the bag and divided by the number of 5 second intervals in the observation. This measurement was performed at least three times for each lavatory fixture.

Experiment

The nature of the experiment involved correlating different study periods, in which consumption is compared.

In 2002:

1. Existing manual faucets were tested having been regulated to 1.0 gpm flow rates. Data collection began for two weeks in all eight restrooms to establish a baseline.
2. Low-consumption aerators (1/2 gpm) were installed (and lavatory flows measured) and data was collected for two weeks in all eight restrooms.
3. Installation of Sloan Optima® sensor-operated faucets (with 0.5 gpm aerators) took place, (lavatory flow was measured) followed by another set of data being collected for two weeks in all eight restrooms.

Occupancy

The total number of students, staff and faculty from semester to semester should give an indication of whether one could expect fixture event frequency to increase or decrease. Therefore, since there was about a 3% occupancy increase from Spring to Fall 2002, we also expect to see an increase in events over that period.

Analysis

We were surprised at how much water lavatories use overall. That made the savings much more noteworthy, especially with the automatic valves ("auto" phase): 70% relative to the original manual lavatory valves ("tune up".) and 39% relative to the manual low-consumption valve sets ("low con" phase) that had the same flow rate between auto and low con.

You'll see below that the consumption in the tune-up phase (1.0 gpm aerators standardized on all lavatories) is the highest, with standard, manual activation faucets being used after calibration to original flow rates.

Predictably, during the second phase ("low con" with 0.5 gpm aerators) that used low consumption manual faucets, there was a significant decrease in consumption.

The last phase – Automatic — incorporated the use of Sloan Optima low-consumption, sensor-operated faucets with 0.5 gpm aerators. This phase represents the least amount of overall consumption **(CHART 3)** while occupancy remained steady **(CHART 1)**. In fact, **CHART 2** documents decreased consumption in terms of average lavatory gallons per minute**.**

CHART 1

	Male and female occupants of building		
		Spring 2002	Fall 2002
Students	Women	584	611
	Men	1154	1182
	Total	1738	1793
Staff	Women	30	34
	Men	13	14
	Total	43	48
Faculty	Women	21	21
	Men	64	65
	Total	85	86
Combined	Women	635	666
	Men	1231	1261
	Total	1866	1927
Note: Students - All students registered at College of Architecture			
Staff & Faculty - Only with office in Building A			

CHART 2

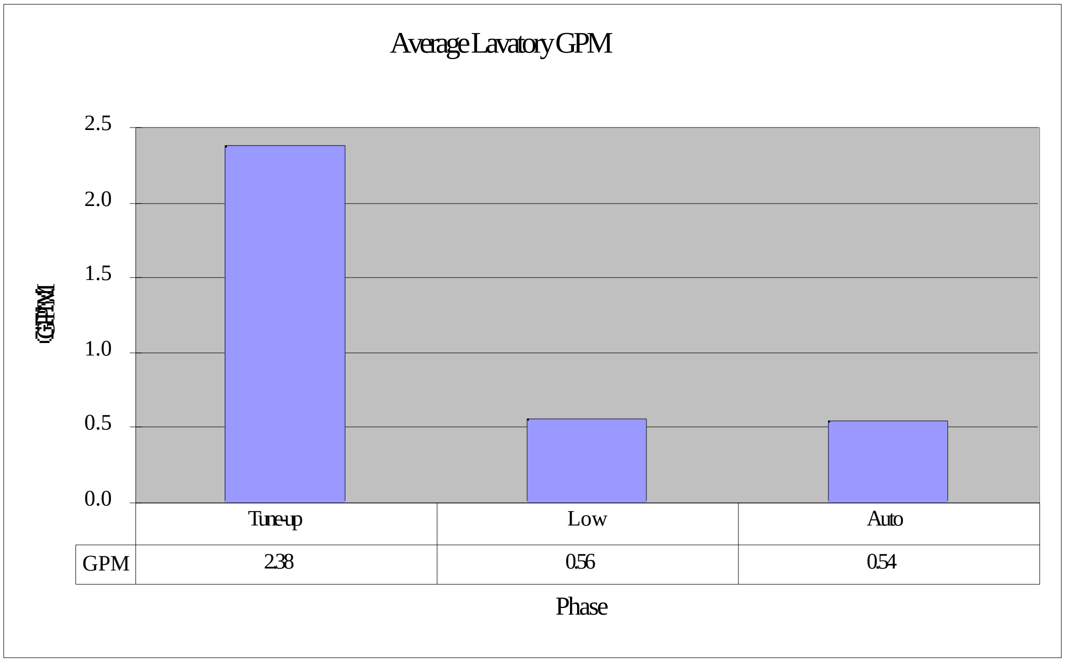
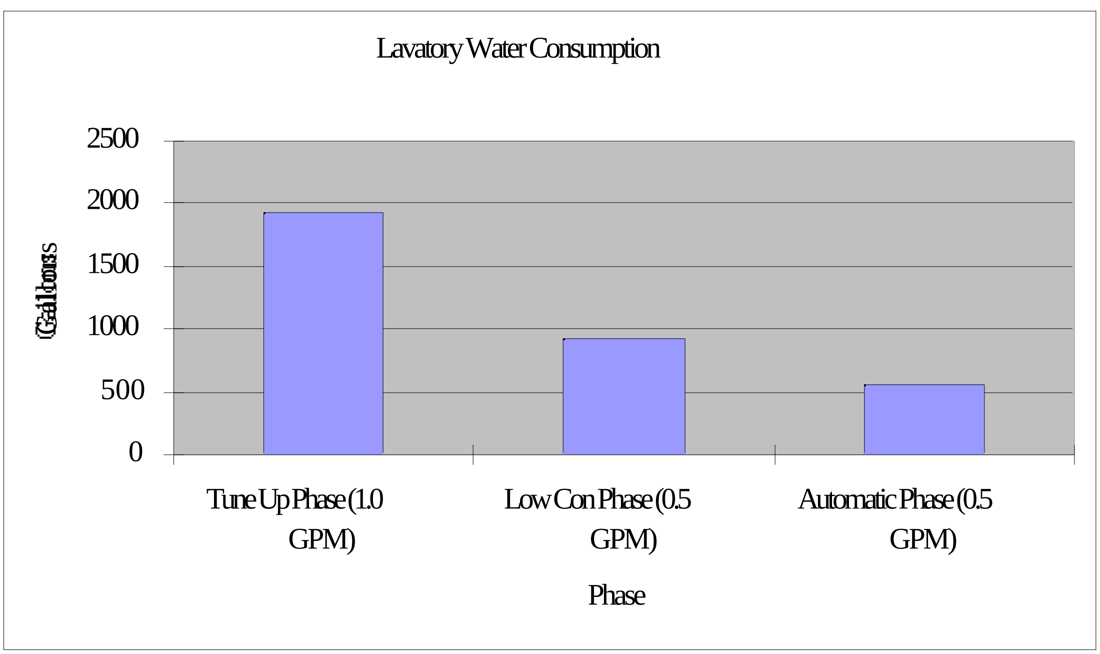


CHART 3



ATTACHMENT A

US006839644B1

(12) **United States Patent**
Woods et al.

(10) **Patent No.: US 6,839,644 B1**
(45) **Date of Patent: Jan. 4, 2005**

(54) **PLUMBING SUPPLY MONITORING, MODELING AND SIZING SYSTEM AND METHOD**

(75) Inventors: **Paul K. Woods**, Kurten, TX (US); **John A. Bryant**, College Station, TX (US); **Kenneth B. Parker**, Houston, TX (US)

(73) Assignee: **The Texas A&M University System**, College Station, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/405,074**

(22) Filed: **Mar. 31, 2003**

Related U.S. Application Data

(60) Provisional application No. 60/369,356, filed on Apr. 1, 2002.

(51) **Int. Cl.**[7] **G06F 15/00**
(52) **U.S. Cl.** **702/56**; 702/54
(58) **Field of Search** 73/1.48, 1.82; 702/33, 39, 45, 48, 50, 54, 56, 179, 182, 183

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,823,467 A * 11/1998 Spickes 137/14
6,236,953 B1 * 5/2001 Segal 702/127
6,250,601 B1 * 6/2001 Kolar et al. 251/129.04
6,301,973 B1 * 10/2001 Smith 73/861.357
6,336,233 B1 * 1/2002 Shaw et al. 4/604
6,601,005 B1 * 7/2003 Eryurek et al. 702/104
2002/0019709 A1 * 2/2002 Segal 702/45
2002/0073768 A1 * 6/2002 Joynes .... 73/40.5 A

* cited by examiner

Primary Examiner—John Barlow
Assistant Examiner—Douglas N Washburn
(74) *Attorney, Agent, or Firm*—Baker Botts L.L.P.

(57) **ABSTRACT**

A system for monitoring a plumbing system having a plurality of fixtures includes a sensor vibrationally coupled to the plumbing system and a processor. The sensor detects a vibration produced by the plumbing system, and generates a signal representative of the vibration. The processor receives the signal, compares the signal to a signal database that associates each of a plurality of stored signals with operation of one or more of the fixtures, and determines that the associated fixture or group of fixtures has been operated based on the comparison. The processor also stores a record of the operation of the associated fixture or group of fixtures.

17 Claims, 2 Drawing Sheets