Sensor Faucets, Flush Valves and the Reduction of Waterborne Pathogens

Technical advances help improve outcomes and minimize risk.

By Lowell Manalo and Andrew Warnes

Automatic sensor-operated faucets and flushometers were invented in the late 1970s and since then have become a significant segment in the commercial restroom market. During the recent COVID-19 pandemic, their touch-free function led to a surge in new installations that continues to increase.

Despite the reduction in frequently touched surfaces these products support, some sites, particularly those in health-care applications, resisted the push to replace manual faucets with automatic sensor faucets because of confusion, out of an excess of caution or because a since-discredited study published more than a decade ago appeared to indicate that automatic faucets harbor more bacteria than manual faucets.

This article seeks to advise facility owners and managers regarding automatic sensor technology developments over the past several decades, identify the potential advantages these fittings and fixtures can offer, and reduce confusion regarding best-practice applications of touch-free technology.

Selection Regulations, Standards and Best Practices

Several codes, standards and regulations govern the selection of faucets in health-care applications, as well as a number of best-practice guides published by experienced and authoritative experts. Most make no distinction between the selection of manual or automatic sensor faucets in health care or other applications. However, most pertaining specifically to health-care applications do mandate hands-free operation and specifically call for sensor operation on scrub sinks.

These guides tend to recommend nonaerated (laminar) flows. The list below contains extracts of guidance and best practices from codes, standards and best-practice guides that are current as of the writing of this article. For further details, we recommend accessing the full code and standard documents directly.

The U.S. Centers for Disease Control and Prevention, *Universal Plumbing Code, International Plumbing Code* and the Veterans Health Administration provide no distinction between manual and automatic faucets.

The Americans with Disabilities Act requires that operable parts shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. The force required to activate operable parts shall be 5 pounds (22.2 N) maximum.

California's Office of Statewide Health Planning and Development (OSHPOD) requires that handwashing fixtures used by medical and nursing staff, patients and food handlers shall have fittings such that all controls can be operated without the use of hands. Sensor-operated fixtures shall be capable of functioning during loss of normal power.

Faucets shall not be equipped with an aerator but may be equipped with a nonaerating laminar-flow device. Handwashing and scrub sink fixtures shall not be equipped with wrist or elbow blades but shall be equipped with sensor controls or controls that do not involve contact with the upper extremities.

The Facility Guidelines Institute's (FGI) "Guidelines for Design and Construction of Hospitals and Outpatient Facilities" recommends handwashing station sinks used by medical and nursing staff, patients, the public and food handlers shall have fittings that can be operated without using hands. Single-lever or wrist blade devices are permitted on handwashing stations — the blades shall be at least 4 inches in length and the location and arrangement of the fittings shall provide proper clearance for operation of blade type handles.

Sensor-regulated water fixtures shall meet user needs for temperature and length of time the water flows and be capable of functioning during loss of normal power. The use of sensor-regulated faucets with manual temperature control shall be permitted. Freestanding scrub sinks shall be trimmed with foot, knee or electronic sensor controls. Note that the term "hands-free" does not refer to faucets operated using wrist blades or single-lever faucets.

Public Health Ontario's "Best Practices for Hand Hygiene in All Health Care Settings" recommends controls (faucets) shall be hands-free. Electric eye operation or foot-, elbow- or knee-operated handles/blades are acceptable. Faucets shall not swivel or be fitted with aerators or similar aspirating devices.

The U.S. Department of Homeland Security, Science and Technology Directorate's "Desk Reference for COVID Recovery and Future Pandemic Preparation" recommends touchless fixtures (e.g., faucets, trash cans) and self-cleaning bathrooms in its list of material interventions in built environments.

Manual Vs. Automatic Sensor Operation

Prior to the COVID pandemic, many facilities had begun the transition to touch-free sensor fittings and fittings operation to conserve water and prevent run-ons. Codes and standards such as Cal-Green, California Energy Commission and Leadership in Energy and Environmental Design made water conservation and sustainability a primary objective in most commercial facilities; sensor-operated devices supported them.

In some facilities, touch-free operation was viewed as a method for reducing normal wear-and-tear and vandalism. The same touch-free aspect was highlighted during the pandemic and led to a surge in replacements and retrofits from manual to automatic sensor operation.

Automatic sensor-operated fittings and fixtures always require a power supply, be it battery, solar cells, miniaturized turbines or a connection to the building electrical grid. The use of power supplies has permitted the development of several features that simply cannot be added to manually operated products. Some of these enhancements include functions that can help reduce waterborne pathogens in ways that can improve outcomes and minimize risk.

Hard-wired technology uses the building electrical system as the energy source to operate touch-free, sensor-operated products. With this technology, there is minimal use of batteries and the need for facility staff to spend time and effort replacing batteries is significantly lower. Hard-wired fittings and fixtures are considered the most sustainable option because they minimize the use and disposal of batteries.

It's important to note that in order to ensure compliance with OSHPOD and FGI guidelines mandating the ability to function during a power loss, these devices should be specified with battery backup capability. Most high-quality, sensor-operated fittings and fixtures include this feature built into them.

With a loss of power, these units will function normally until power returns to the facility. This feature is highly recommended in areas prone to seismic activity and severe weather that can potentially interrupt power supplies.

To avoid the cost and complexity of installing hard-wired power supplies to each fixture and fitting in a facility, it is common to use battery-powered sensor devices. This is particularly true in existing facilities that are being upgraded from manual to sensor operation that do not wish to complicate a project by installing hard-wired power supplies.

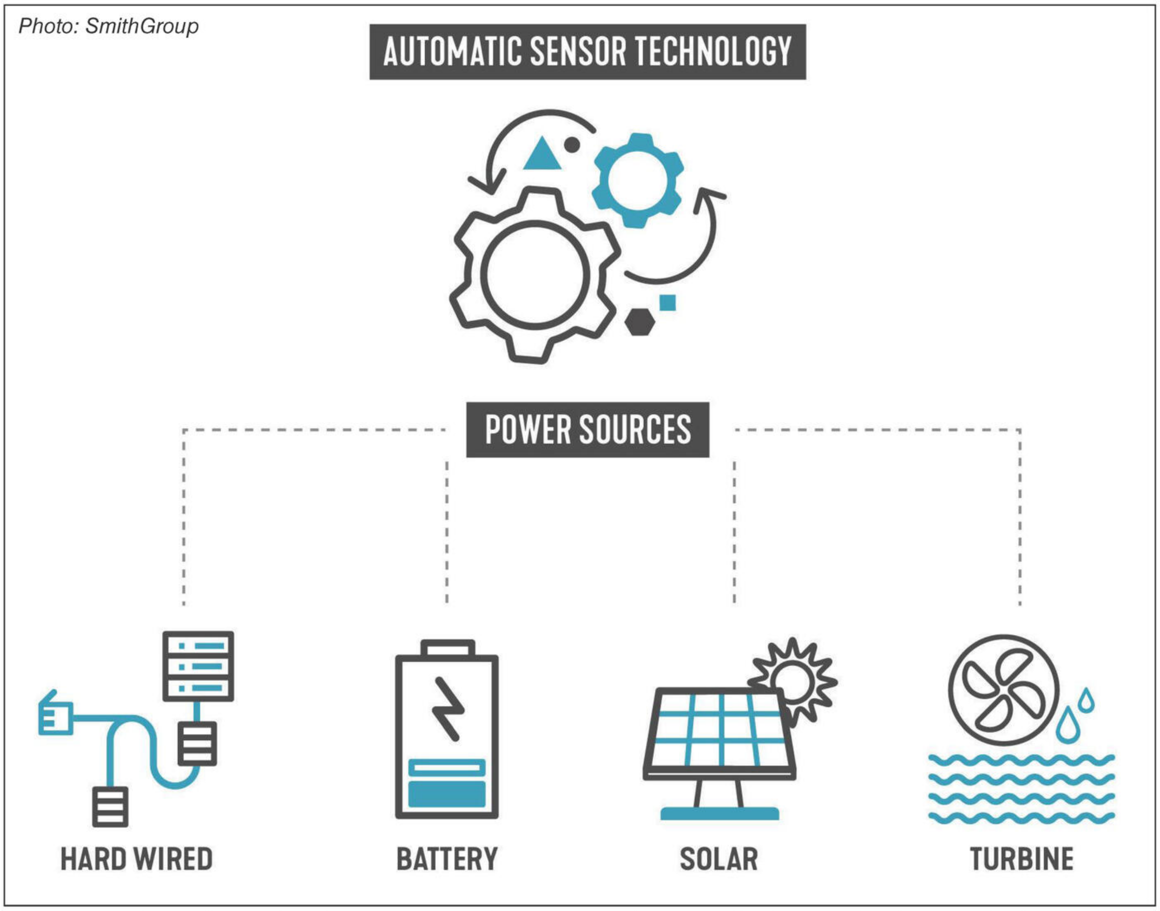
The benefits of using just batteries alone are a reduction in project cost and the time required for project completion. Unfortunately, this is the least sustainable power solution over time because of ongoing battery replacement and disposal. Time and money saved during the installation phase do not translate into a lower total cost of ownership over time for the facility — particularly when the time and labor needed to replace batteries are considered.

When a facility has no option to install hard-wired, sensor-operated products and must rely upon battery power, two hybrid power-generating technologies are designed to generate their own power onsite and, therefore, extend the life of batteries. These hybrid power solutions come as optional features on battery-powered devices and include solar cells and miniaturized hydroelectric turbines.

Solar-powered units collect natural and artificial light as the energy source from a built-in solar cell. The cell converts ambient light into usable energy that the device will use to avoid expending battery power whenever possible, extending and potentially doubling the life of the batteries. If a facility has poor water quality with higher levels of hardness, sediment, turbidity or iron, the selection of a solar cell is desirable because it has no moving parts that are in contact with the water supply.

While solar cells are very efficient and can operate under low light conditions and in conjunction with occupancy sensors, they will supply only a fixed amount of hybrid power regardless of the frequency of use. In very high-use scenarios — such as airports, stadiums, concert halls and large schools — the use of turbines might be the best hybrid power choice.

Touch-free, sensor-operated devices with turbines use the pressure and flow of the water to create hybrid energy, much like the turbines in a hydroelectric dam,



but on a much smaller scale. The movement of water through the unit spins a turbine that generates electricity to supplement battery usage.

In facilities with high usage, the advantage of turbines is that the more often these devices are used, the more energy they generate and the more battery power they can supplement. Because the turbine is immersed within the incoming water supply, it is often recommended that turbines be specified only in locations that have a known, consistent, good-quality water supply. Most municipally supplied water systems in the United States and Canada will meet this criterion.

Both solar and turbine hybrid power-generating technologies have the potential to double the life of batteries, though this can vary due to factors such as usage patterns, water and ambient temperatures, water quality and other variables. When there is no choice and no hard-wired connection is available, the use of batteries in conjunction with hybrid power supplies is more sustainable and more cost-effective in the long run than just batteries alone.

Touch-Free Sensor-Operated Fittings and Waterborne Pathogen Risk

The drive toward lower water consumption in fittings and fixtures (both manual and sensor) had a significant environmental impact relative to water savings, but at the same time also led to concerns about water stagnation in distribution lines and drain carry issues. Older facilities designed when the average faucet flow was 2.2 gallons/minute (8.3 liters/minute) and the typical toilet flush volume was 5.0 gallons/flush (19 liters/flush) had much larger piping sizing to match the increased water consumption.

As the facility converts to today's 0.5 gpm (1.9 lpm) faucet flows, 1.28 gpf (4.8 lpf) toilet flush volumes, and 0.125 gpf (0.47 lpf) urinal flushes, the larger piping becomes a potential liability due to slower water velocities and longer residence time for water in the pipe.

Water conservation and water efficiency in commercial restrooms and in health-care facilities have been encouraged for over a decade. With these efforts becoming more commonplace and successful, new technologies should be considered for the overall water health of the building. Stagnant water is a real problem, but these technologies offer real solutions.

The risk of water stagnation due to lower flows (or less frequent use) involves the reduction in residual disinfectant (chlorine, for example) over time. The EPA recommends a free chlorine level of between 1.0 and 4.0

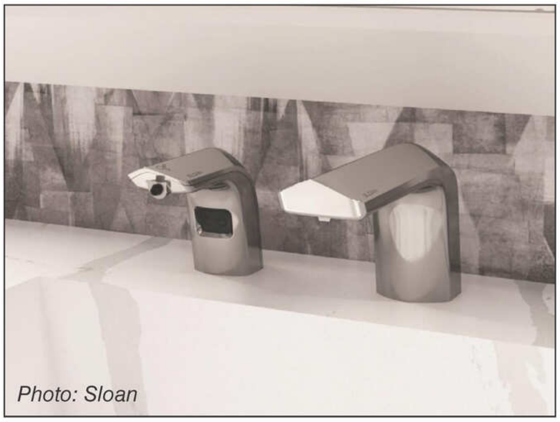


Photo: Sloan

parts/million (mg/L), but the estimated time it takes for free chlorine to diminish below recommended levels in stagnant systems is 1 1/2 days in galvanized piping systems, 4 1/2 days in unlined cast iron systems, and 10 to 14 days in lined systems.

Refreshing water supplies takes energy and must be programmable to occur on a regular basis. Today's sensor-operated fittings and fixtures can support that function and limit the potential for stagnation. They also can use programmable flushes to clear undesirable fluids and combat odors in drains, limit dwell times and resultant metals contamination, and ensure water is maintained in p-traps over time.

When considering touch-free units, the questions you should ask yourself and your team are:

• Does the touch-free device being specified include the ability to set a regular line-flush in order to bring residual disinfectant into the distribution system to avoid stagnation?

• Is the feature flexible enough to permit adjustment of both the frequency and duration of the line flush in order to meet the needs of a particular facility?

• To save time and minimize customer interruptions, can the settings of the devices be done wirelessly using a device similar to a smartphone?

• Are the devices set up to deliver data such as water usage and verification of line flushes?

All these are features available in today's sensor-operated devices were unavailable just a few years ago. They can offer key advantages in infection-control initiatives that are unavailable with manual devices. You also should ask if it's possible to upgrade older existing sensor-operated devices to include these features.

Key Variables and Features

Here are some key items to consider:

• Does the touch-free device come with the line flush features described previously?

• Verify the mountings of the products being upgraded. Faucets can be deck-mounted or wall-mounted using either a single hole, a 4-inch center set, or an 8-inch center set. Mountings for matching faucets and soap dispensers should be verified. Existing flushometers can be upgraded with side- or top-mounted retrofit kits.

• Verify the basin type, size depth, faucet-mounting setback and the location of mirrors and shelves. Some standards require a specific faucet height or flow in relation to the drain position. Smaller basins require lower faucets to avoid splashing, while scrub sinks might require gooseneck faucets with surgical bend spouts to ensure optimal use.

• Confirm temperature-mixing requirements. The faucets used may vary based on a pre-tempered supply, on separate hot and cold lines and on an ASSE 1070-compliant thermostatic mixing device. Consider the use of an optional side-mixer to give users temperature control.

• Consider the available room for the faucet controls. Verify if enough room is available under the sink deck to place a control module. If not, an above-deck faucet with all key components contained in the spout is an option to provide the same function.

• Match toilet and urinal flush volumes with the appropriate flushometer settings. A 5.0 gpf (19 lpf) toilet installed prior to the Energy Policy Act of 1992 may have pressure issues operating with today's 1.28 gpf (4.8 lpf) flushometers. This applies equally to manual and sensor-operated units.

Is the facility hard-wired to supply power to all new fittings and fixtures, or will batteries be required? Recall from the previous section that hard-wired products are more sustainable and require less service over time than battery-powered products but may need a backup battery for use during a power outage.

If batteries are the only option, the use of a hybrid power-generating type such as solar cells or turbines will extend battery life. The application of hybrid solutions should consider the frequency of use for the fixtures in the space as well as the incoming water quality.

The intent of this article is to advise facility owners and managers of automatic sensor technology developments, identify the potential advantages these fixtures can offer, and reduce confusion regarding best practices application of this technology.

In an upcoming article, we'll expand into options and best practices specifically for educational institutions. The availability of American Rescue Plan stimulus funding through September 2023 has led many schools to upgrade from manual to touch-free restroom equipment as part of their post-pandemic return to "normal." In that upcoming installment, we'll focus directly upon the need and considerations for that sector. ●

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