Tempered water systems

Warming up to a good idea

The need to supply warm water to emergency drench showers is not an issue to which many employers have given much thought. But without tempered water, chemical splash victims are unlikely to flush as thoroughly as they should; they even risk hypothermia. Using one of the four options available for supplying tempered water can help prevent a bad situation from turning even worse.

By Matthew Stein

Imagine the trauma of being splashed with a corrosive chemical and then activating an emergency shower that poured ice-cold water all over you. It certainly would not encourage you to stay the recommended 15 minutes under the shower. In fact, it could even add to the harm you have already suffered by inducing hypothermia.

This scenario is a real possibility where emergency showers are used in cold climates. That is why, in climates subject to freezing temperatures, all emergency showers — both indoors and out — should be supplied with tempered (i.e., warm) water or heated enclosures.

Why supply emergency showers with tempered water? — for the protection of both the employee and employer. Drench showering with very cold water poses a health hazard to employees and a liability problem to employers. Cold water lines in cold climates typically run from 2°C - 7°C (35°F - 45°F). Yet, in order to completely flush away hazardous chemicals, it is recommended that contaminated body parts be flushed for a minimum of 15 minutes and that contaminated clothing be removed.

Even in a heated environment, cold water discourages victims from meeting these requirements. But in shower areas exposed to cold air and wind, showering with very cold water not only discourages proper flushing, but can also rapidly lead to hypothermia — a condition characterized by numbness, confusion, disorientation and uncontrolled shivering. The possibility of inducing hypothermia has serious implications, especially in remote locations.

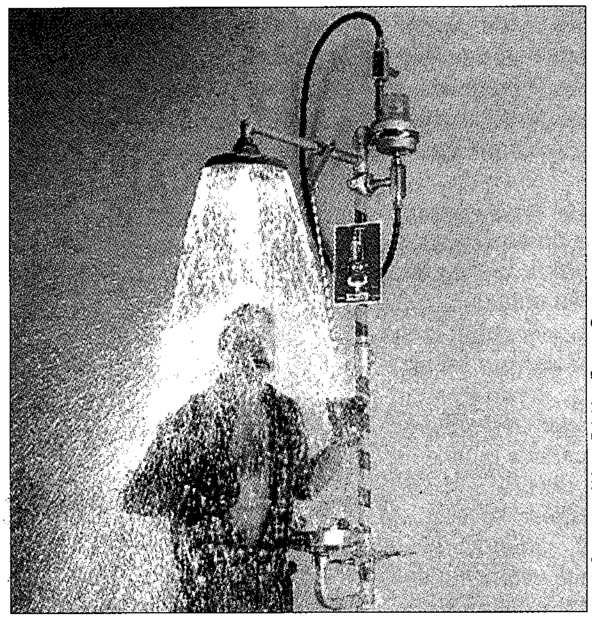

Photo: Courtesy of Haws Drinking Faucet Co.

Tempered water encourages chemical splash victims to flush contaminated body parts for the full recommended minimum of 15 minutes.

The problem can be overcome with the use of tempered water or heated enclosures. Tempered water encourages proper use of drench showers during emergency situations and helps prevent excessive bodily heat loss, which could result in a dangerous hypothermia condition. Heated shower enclosures create a sheltered, warm environment that may shield wet or injured workers from the elements until help arrives.

To determine the need for tempered water, the following should be evaluated: anticipated cold water supply temperatures; local environmental conditions; shower location; and the type of hazard. The U.S.-based American National Standards Institute (ANSI) in its voluntary standard Z358.1-1990, *American National Standard for Emergency Eyewash and Shower Equipment*, recommends a comfortable water temperature of 15°C-35°C (60°F-95°F). In circumstances where a chemical reaction may be accelerated by water temperature, a medical adviser should be consulted to determine the optimum temperature for each application. Even sub-tropical locations may have cold water supply temperatures that

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warrant the installation of tempered water systems. Shower temperatures in the 27°C-32°C (80°F-90°F) range help keep users comfortable in colder climates where even 16°C (60°F) showers may not be adequate.

Emergency drench showers consume large quantities of water, typically 114 litres (30 gallons) per minute; home showers use in the range of 11-19 litres (3-5 gallons) per minute. Tempered water systems must safely and reliably provide for these large volume flows. In all cases, scalding water temperatures and flow loss must be prevented. Emergency wash users do not have the luxury of adjustable wash temperatures.

There are four basic methods for producing the large volumes of tempered water required to supply drench showers. Each of these methods may be applied in a variety of ways, and each has its advantages and disadvantages

METHOD A: LARGE STORAGE TANKS

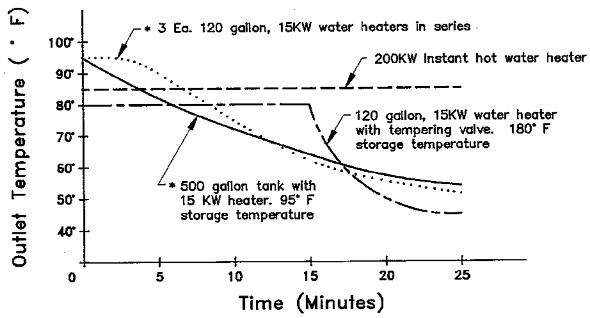
Warm water may be stored in large tanks for direct use in drench showers. The water may simply be stored in uninsulated tanks in a heated area or in tanks with thermostatically controlled heaters. Like all other safety systems, this system should be tested and flushed weekly to ensure proper function. In remote locations where a pressurized water supply is lacking, this method can be used in combination with pressurized gas bottles to provide warm water to drench showers.

The major disadvantages of this method are:

• the space required to house the tanks. Storing warm water in one large tank or several smaller tanks requires considerable space. A single, 15-minute drench shower using 114 litres (30 gallons) per minute consumes 1,700 litres (450 gallons) of water.

• the drop in outlet water temperature as the shower is used. Cold water rushing into the tanks to replace the warm water being used will turbulently mix with the warm water remaining in the tank. This causes the tank water temperature to continuously drop while the shower is in use. Using several smaller water tanks in a series can help decrease this mixing effect and will keep the outlet water temperatures warmer until substantial amounts of cold water have travelled from the inlet tank to the outlet tank. (See Figure 1 above, which shows a rough comparison of shower water temperatures using a variety of tempered water methods.)

Figure 1: Tempered water comparison



• the system recovery time. For uninsulated tanks without internal heaters, it takes a long time for the system to recover — i.e., for the water in the tanks to once again reach a comfortable temperature. Recovery time for tanks with internal heaters is usually several hours, depending upon the heater output and design. Caution: Tanks with internal heaters must offer failsafe protection against over-heating.

• the potential for bacterial growth in warm water tanks. Legionnaires' disease may propagate in warm-water tanks. Tank temperatures of 60°C (140°F) will eliminate *Pneumonia legionella* in a few seconds, but must be used with Method B.

Method A has the advantage of being a simple and reliable system that does not need mixing valves or sophisticated scald-protection safety equipment.

METHOD B: SMALLER STORAGE TANKS

Hot water may be stored in a smaller heating tank and mixed with cold water using a thermally activated mixing valve (tempering valve) in order to provide warm water to drench showers. This method uses smaller, more economical water tanks than Method A, but requires some system to mix the hot and cold water together. Tempering valves, commonly used for institutional multiple-shower rooms, can work well in this situation.

Since these tempering valves are not 100-percent reliable, some kind of safety system should be incorporated that causes the cold-water line to bypass both the hot water heater and tempering valve in the event of a blocked flow or scalding water. Two systems that can be used to accomplish this are shown in Figures 2 and 3 (see page 26). Figure 2 shows a thermo-mechanical failsafe bypass system. Figure 3 shows an electro-mechanical failsafe bypass system.

The thermo-mechanical system relies upon a thermally activated high-limit valve, which senses the warm water outlet from the mixing valve. In order to maintain a maximum outlet temperature, this valve throttles the incoming hot water when it senses a water temperature above a pre-determined high limit. A pressure-relief bypass valve is required to allow cold water to bypass the mixing valve in the event of a primary mixing valve failure.

The electro-mechanical system relies upon a temperature switch and flow switch to signal one solenoid valve to shut off the flow of incoming hot water and a second solenoid valve to open up the cold water bypass when high-temperature or low-flow conditions exist. The temperature switch and flow switch are hooked in series with a normally open, continuous-duty bypass valve and a normally closed, continuous-duty, hot shut-off valve. A pressure relief bypass valve is recommended.

The thermo-mechanical system does not react quite as quickly as the electro-mechanical system. However, it performs well during power outages, as opposed to the electrical system, which shuts off the hot water and opens up the cold-water bypass during a power outage. Furthermore, the thermo-mechanical system does not cycle into and out of bypass mode as the electrical system tends to do when confronted with a low-flow or high-temperature condition.

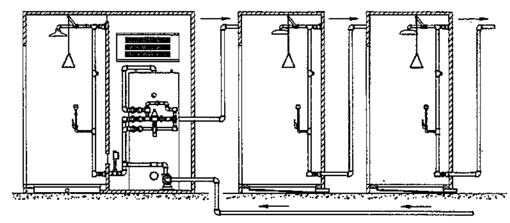
Method B lends itself to pre-fabricated, self-contained shower units. Single heater units may be hooked up to multiple showers. Special consideration should be given to multiple-shower hookups due to the typically long hot water tank recovery times and the large storage tank size required to provide more than one 15-minute shower within one recovery period. Shower water temperatures are generally stable until the storage tank temperature drops below the tempering valve set point (see Figure 1 on page 24). Tank size, stored water temperature, heater output, inlet water temperature and the tempering valve set point determine how much warm water will be available at any time.

A large tank may provide warm water to a number of showers, either through a recirculating line or a heat-traced and scald-protected line.

METHOD C: INSTANTANEOUS WATER HEATER

An instantaneous hot water heater of proper size may be used to provide the required warm water for drench showers. These heaters may provide warm water directly to the shower or provide hot water that must be tempered using a thermally activated mixing valve. In either case, an anti-scald safety bypass system should be installed. Water flow that is too hot, a power failure or a low-flow situation should open the cold-water bypass.

Figure 4: Multi-shower system with recirculating loop



Where steam is available, instantaneous heaters generally offer the best performance at a reasonable cost. Gas or electric instant water heaters, typically used to heat swimming pools, cost more than equivalent steam heaters, but may be used if steam is not available. To raise 114 litres (30 gallons) per minute of water from 5°C to 27°C (40°F to 80°F) requires approximately 176 kilowatts (600,000 BTUs) per hour.

Instantaneous water heaters never run out of hot water. They are particularly effective in multiple shower installations where one heater serves several showers. One main station with an instantaneous water heater may be hooked up to a loop containing a number of showers. The system (shown in Figure 4 above) uses a continuous-duty pump to circulate warm water between the showers and the main station. This circulating water prevents pipes from freezing and maintains fairly even water temperatures throughout the loop.

Figure 2: Thermo-mechanical bypass system

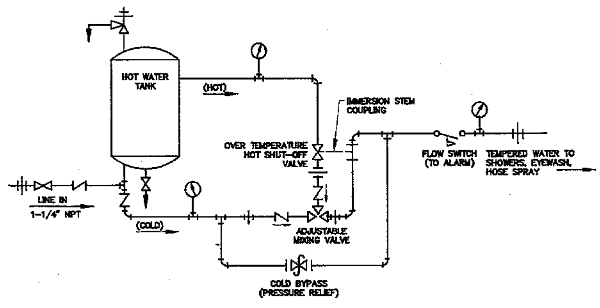
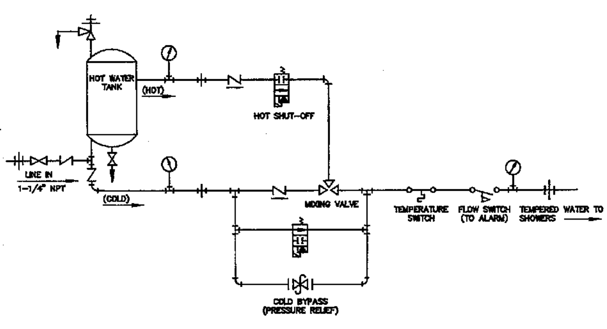


Figure 3: Electro-mechanical bypass system



ANSI specifies that emergency showers be accessible — in locations that can be reached by a chemical-splash victim in no more than 10 seconds and within a travelling distance no greater than 30.5 metres (100 feet) from potential hazards. The use of instantaneous hot water heaters can be very cost-effective in installations where several shower substations can be hooked up to one main station. Main stations are usually rated to supply tempered water to one or two showers at a time. The use of more showers at the same time would result in colder shower temperatures and reduced water flow. Individual applications should be evaluated to determine the likelihood that the need would arise for use of several drench showers in one area at any one time.

METHOD D: HOT TAP WATER

Where large amounts of hot water are readily available, hot tap water may be mixed with cold water using a thermally activated mixing valve (tempering valve) in order to provide tempered water to emergency drench showers. Before choosing this method, institutional hot water systems should be carefully evaluated to ensure they have the capacity to supply the large volumes of hot water required by the proposed design. Failsafe anti-scald protection must be installed to protect against mixing-valve malfunction.

Tempered water systems require significant capital investments and engineering expertise to install safely. But when supply water or air temperatures are cold, supplying tempered water is often not a luxury but a necessity. The sight and health of workers are precious; they deserve protection. •HS