What Do Consumers Want from Their Hot Water Systems?

A SERIES ON HIGH PERFORMANCE HOT WATER SYSTEMS

PART ONE: CONSUMER EXPECTATIONS

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Let’s talk about high performance hot water systems. We’ll discuss the mechanics of making the heat for hot water and how much of it we may need in a moment, but first we’d better figure out what customers actually care about. To provide context for this discussion, since the mid-1990s I have spoken with and interviewed more than 20,000 people from all walks of life throughout the United States and from many countries around the world to learn what they want and expect from their hot water systems. In this series, I will be sharing with you what I have learned from these hot water users and from research that has been conducted in the lab and in the field, and later how we can apply this knowledge to define the characteristics of high performance hot water systems.

What People Want and Expect

The first question we should ask any prospective client is “What do you want from your hot water system?” What they have told me they want are clean clothes, clean hands, dishes, body, relaxation, enjoyment — in other words, the service of the hot water. Well, these are the things that people actually want, in the simplest of terms: warm house, cold beer. They don’t really care how the house gets warm or the beer gets cold, they just want it to be that way when they want it.

The next question we need to ask is, “What do you expect from your hot water system?” The customer expects safety, reliability and convenience.

- **SAFETY:** Customers expect the water to be neither too hot, nor too cold. They also expect it to contain no harmful bacteria or particulates, although quite a large number of people put up with hard water and other physical water issues. In food service and health services, customers expect sanitation.

- **RELIABILITY:** Customers expect that the entire hot water system will require little or no maintenance, that it will last forever and that it will be low in cost, both when they buy it and to run and maintain it over its operational life.

How many of you have a water heater in your facility or your home? Have you ever maintained the water heater in your facility? Drained it out, checked the anode, made sure that the temperate and pressure relief valves were working properly? You know, if you do that you can make a water heater last a really long time, but if you put the water heater in the back corner and ignore it, well, it probably won’t last as long as you might like it to.

- **CONVENIENCE:** Customers also expect the ability to adjust both temperature and flow, although most showers only give the option of adjusting temperature. They expect that the system will be quiet — no water hammer, no sounds in the middle of the night from their recirculation system, no significant noise from a water heater (gurgling or fan noise from power vented systems). They also expect to
never run out of hot water — a problem that many have experienced, but which actually seems to happen relatively infrequently. While it would be nice to have the ability to have several hot water devices operate simultaneously, this is not usually expressed as a big concern. They already have that ability, although tank volume and the burner or element capacity limits the duration of simultaneous events; and they generally schedule their hot water use so that big hot water uses do not overlap.

In addition, faucet, shower and appliance flow rates have been declining, effectively increasing the water heater’s ability to sustain simultaneous events for a longer time.

Finally, they expect that hot water will arrive very quickly after they turn on a tap, although the vast majority complain about the length of the time-to-tap, which they describe as a random event, varying from 10–15 seconds at fixtures near the water heater to well more than two minutes at the fixture furthest from the water heater. Less than five percent of the people say they get hot water everywhere in less than five seconds after they turn on the tap. Most of these have a recirculation system; the others have a small house with a short distance from the water heater to the fixtures. In commercial buildings, such as restaurants, most people do not actually expect to get hot water in the public bathrooms, even though it is required by health codes!

Depending on the specific application, I suspect you and your customers want most, if not all, of these same services and have very similar expectations, too. Of all of the issues raised above, what the people I have interviewed want the most is to reduce the time-to-tap, followed by never running out in their shower — theirs, not their children’s!

Typical Hot Water Event

*Figure A* shows a typical hot water event. There’s a delivery phase, a use phase and a cool down phase. People would like the delivery phase to be short. According to those I have interviewed, a few want hot water to arrive immediately after they open the tap, which I explain is possible, but rather expensive. Well more than 90 percent say they want the time-to-tap to be between two and three seconds. We will see later on that this level of performance is achievable at reasonable costs.

The use phase is the use — washing dishes, taking showers, whatever it might be.

And then when you turn off the tap, the temperature of the water in the pipe starts to cool down, all the way from the water heater to the hot water outlet. It takes on the order of 10 to 15 minutes for the water in uninsulated pipes to cool from about 120º F down to 105º F when the pipes are located in air at a temperature between 65º F and 70º F, which is typical for most buildings. The water cools
down more quickly when the surrounding temperature is colder, such as in a basement or a crawl space, or when the pipes are located under or in a concrete slab. The water cools down more slowly when the pipes are in a hot attic in mid-summer or when they are insulated. We will discuss this further later in this series.

The water heater temperature must be higher than the mix-point temperature you’d like to have, and the useful hot water temperature needs to be less than the point at which you mix it. Why? You need to have some headroom from the mixing point down to the useful hot water temperature point because of variations in desired temperature for any given application on any given day.

The Hot Water System

Now, let’s talk about the hot water system. There are five components of hot water use in the building:

- Water heaters
- Pipes
- Faucets, showers, appliances and other fixture fittings
- Hot water running down the drain
- Behaviors

Which is the biggest variable in determining water and energy use? I ask this question of lots of people and get all sorts of answers, but the fact is behaviors are the single biggest variable and that is what’s going to determine water and energy use.

How much do behaviors make a difference? Well, let’s just pick on your home for a minute. Was today’s hot water use exactly the same as yesterday’s? Will it be exactly the same as tomorrow’s? I get up at about the same time everyday, but I don’t take a shower at exactly the same time, nor is it exactly the same length. I wonder if this happens to you in your home and in your facilities? I suspect it does.

Again, based on my large sample, there are probably an infinite number of hot water use behaviors and patterns. In homes, they often fall within “windows of opportunity” — morning rush hours and evening plateaus; and on weekends, all bets are off! The pattern varies depending on the facility you’re in, but the concept of windows of opportunity still applies.

All of these behavior patterns boil down to two possible results: when you turn on the tap, either hot water comes out pretty darn quick or it doesn’t. Which is it in your home, at your place of work, your favorite restaurants? I suspect for many of you and your customers, the answer is “it doesn’t.”

Another factor is how do the interactions among these components affect system performance? Imagine you have long uninsulated pipes between the source of hot water and the fixtures that are being used a lot. Do people wait a long time for hot water? What if you could move the water heater closer, make the pipes better insulated or deliver hot water quicker by use of a pump or electric heat trace? Do you think that that would improve system performance?
What about single lever valves on faucets or on showers where, when you turn on all hot, you actually get some hot and some cold? What if the valves performed differently so that when you wanted all hot water, you got all hot water? What about when you wanted cold water, you got all cold water? Well, all of these interactions affect the system’s overall performance and you as a consumer pay for the system inefficiencies or, conversely, its efficiencies.

Figure B shows a typical simple hot water system. You see it in single-family housing, or single unit applications in multi-family buildings. You see it in commercial facilities.

Fuel comes in, cold water comes in and it goes to a water heater. Hot water goes to fixtures or appliances; so does cold water. Some appliances use energy — dishwashers, washing machines — and there’s mixed temperature water running down the drain, ultimately into the sewer.

(When I started doing these kinds of analyses I began asking people “Why do we run hot water down the drain?” I understand why we run the water down the drain, but why do we run it down the drain still hot? What if we could capture some of the waste heat? Wouldn’t that be a good idea, too? We’ll discuss how to do that later in this series.)

Figure C is a typical central boiler hot water system. You generally see these in bigger buildings, whether they are residential or commercial. Often there is a boiler to make the heat, a hot water storage tank to store the heat for capacity and peaking, and then there’s a circulation loop, most often using a 24/7 pump (sometimes controlled with a timer or an aquastat) to deliver hot water out to the far reaches of the building.

What’s Next:
In future installments, we will discuss the hot water distribution system: how to improve existing ones and how to build them more efficiently to begin with; the uses of hot water; drain water heat recovery; the ways to make hot water more efficiently and effectively; and how all of these components come together in a high performance hot water system.