Troubleshooting Water Heaters

by Larry & Suzanne Weingarten

No hot water? Check thermostats and controls first.

Most water heater problems are caused by lack of maintenance. To prevent trouble, check the sacrificial anodes regularly, remove excess sediment, and make sure the temperature-and-pressure relief valve is operating properly.

Our company specializes in servicing conventional and solar water heaters. Many times, the failure to recognize a small, easy-to-repair problem leads to an expensive — and unnecessary — replacement. Recently, for instance, a client who wasn't getting enough hot water "solved" the problem before consulting us by purchasing a bigger water heater. To make room for it, he had to move a wall. When the framing, drywall, and painting were finished, he called us in to hook it up. Afterward, we examined the old water heater. His cold water dip tube had broken off, so cold water had been entering at the top, diluting the hot water. A little troubleshooting could have solved this problem with a $5 replacement part.

Maintenance is the best way to avoid problems (see "Maintaining Water Heater,"). When troubles arise, though, it helps to be familiar with the components of a water heater (see Figure 1), and to try a few simple fixes before you replace the heater.

Before you start. Always turn off the power before troubleshooting an electric water heater (assuming you've determined that the problem isn't electrical). For gas heaters, it's usually sufficient to turn the control valve down to the "pilot" setting.

Next, shut off the water supply to the water heater; you can turn it back on later if you need to perform a test. Most installers provide a shutoff at the cold water supply inlet; otherwise, use the main house shutoff. To prevent backflow into the water heater and to remove any pressure buildup in the tank, open a hot water faucet at any fixture in the house. Finally, drain a gallon or so of water out of the tank through the drain valve on the bottom. (When it's time to refill the tank, leave the house faucet open until all of the air is out of the system.)

Now you're ready to explore the symptoms of trouble.

No Hot Water

Only two things cause no hot water: Either the energy supply has been interrupted, or there's a control problem.

Electric heaters. If an electric heater has no hot water, look first at the upper thermostat (Figure 2). Use a volt-ohm meter or a "pigtail" tester to check for

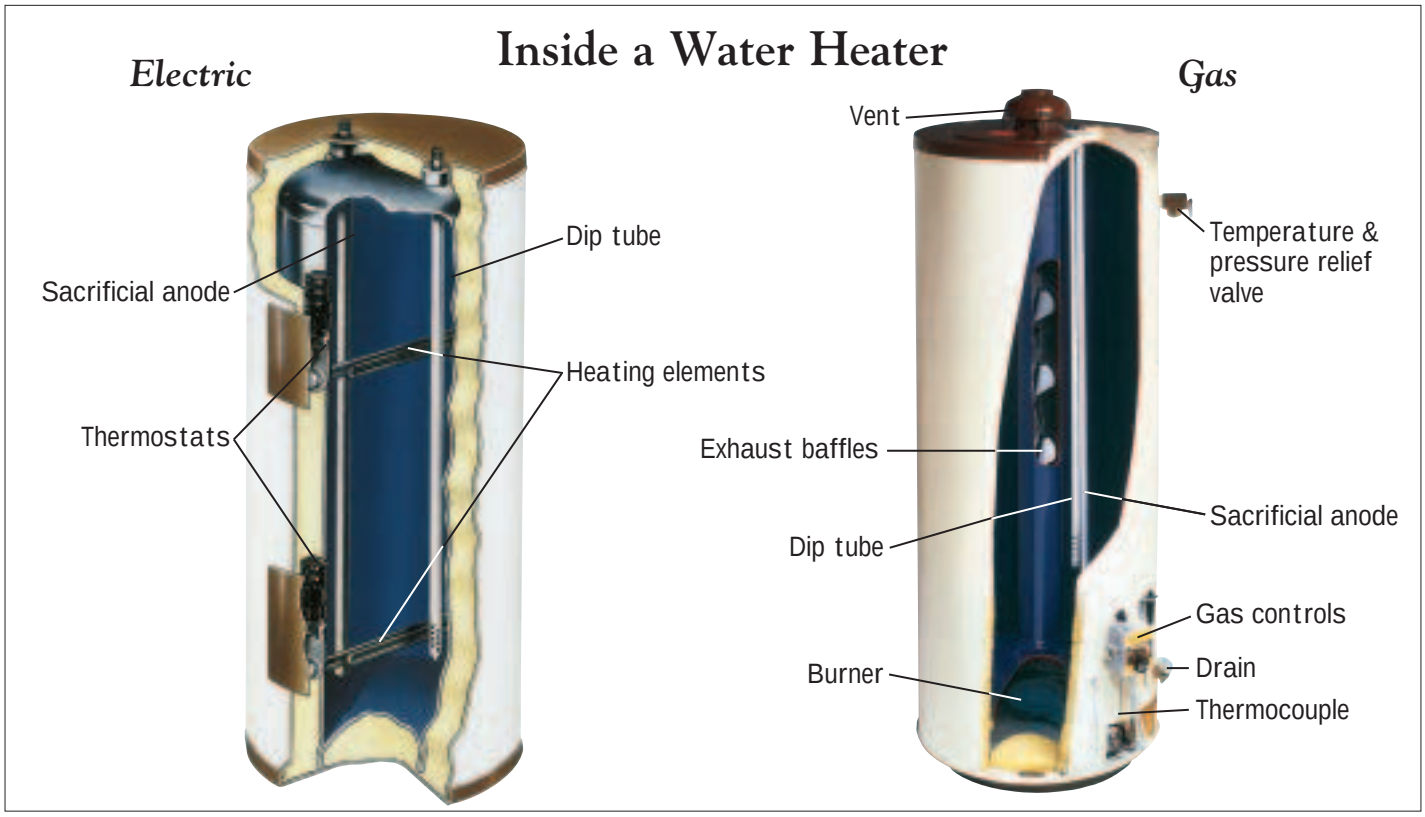

Figure 1. *Electric heaters (left) have one or two immersed electric elements and thermostats; in gas models (right), the water is heated by flue gases traveling through the baffled center vent. In both types of heaters, a supply connection on top delivers cold water to the bottom of the tank through a plastic dip tube; a sacrificial metal anode prevents rust.*

power at the top two screw connections. If you find no power at these screws, there's no power getting to the heater: The problem is somewhere between the water heater and the main panel.

If you do have power at these two screws, but not at the two screws just below the red reset button, then the high-limit switch has turned the power off. If the red button clicks when you press it, power will be restored.

A tripped high-limit switch, however, is a symptom of very high temperatures, and unless the culprit is found, the problem will recur. One possible cause is fusing of the contacts in either the upper or lower thermostat. This prevents the heating elements from shutting off and leads to overheating. Also, a thermostat that is not mounted firmly against the tank wall, or one that is missing its insulation cover, may not read temperature correctly.

In dual-element heaters, the upper thermostat controls the operation of the lower element, so lack of hot water can also be caused by a burned-out upper element. With the power off and one wire disconnected, use a volt-ohm meter to check for continuity in the suspect element. Replacing the bad element will restore hot water.

Gas heaters. In gas heaters, the problem is usually either a worn-out thermocouple or a faulty gas control (Figure 3). First, look to see if the pilot flame actually touches the end of the thermocouple, as it's supposed to. Then check to see that the thermocouple is firmly screwed into the control. If you have doubts about this connection, unscrew the thermocouple, use extra-fine sandpaper or a knife to polish the contact point, and re-install. Special thermocouple testers are also available, but it may be easier (and cheaper) to replace the thermocouple and see if that revives the heater. (A thermocouple costs about $15 and takes ten minutes to replace.)

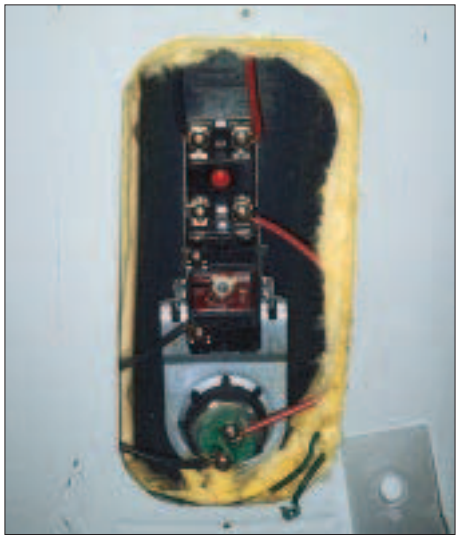

Figure 2. *Lack of hot water from an electric water heater is often caused by a failed upper thermostat. Use a volt-ohm meter or pigtail tester to check for power at the two pairs of screws above and below the red reset button.*

If the heater was supplying very hot water before there was no hot water, the energy cutoff switch, which is built into the gas control, was probably activated. With modern heaters, once this has tripped, the control valve must be replaced (about $150).

Insufficient Hot Water

When there's not enough hot water, first check to see if the heater is correctly sized for its demand. A heater should deliver about 75% of its volume as hot water. You can measure flow at fixtures such as the showerhead to determine how much the tank is capable of delivering. (Empty five-gallon drywall buckets work well for this test: Count the number of buckets you can fill with hot water, then compare the result with the tank's capacity.)

Cross connections. If the tank is not

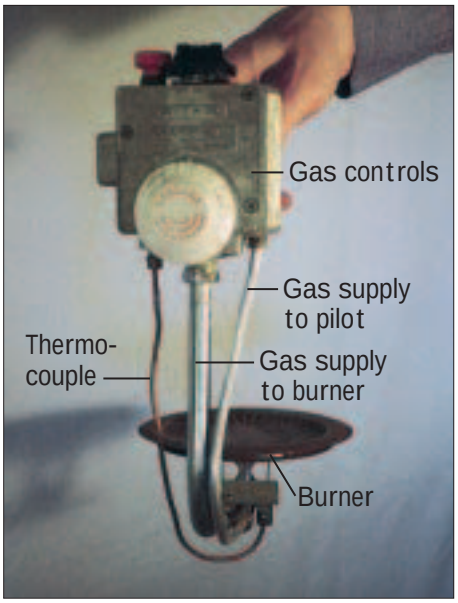

Figure 3. *In a gas water heater, the burner will not operate unless the pilot flame is touching the thermocouple. To operate properly, the thermocouple must also be firmly screwed into the gas control.*

overtaxed, check for cross connections. Turn off the water supply to the heater and turn on any hot tap. If you continue to get a flow of hot water, there is a cross-connection somewhere between the hot and cold plumbing. Cross connections can be found in clothes washers, tempering valves, and many single-handle faucets and shower valves.

Sometimes hot and cold lines are inadvertently switched at the water heater when it is hooked up. This delivers cold water to the top of the tank and causes warm water to be drawn through the dip tube from the bottom.

Faulty dip tube. Split, broken, or missing dip tubes may allow cold incoming water to mix with hot water at the top of the tank. To check the condition of the dip tube, undo the cold inlet and remove the pipe nipple from the tank. Insert a straight pliers handle or a wooden dowel into the dip tube and, using a circular motion, pull up and "walk" the dip tube up high enough to grasp. Pull it out to check for damage. Replace it, if needed, with another plastic dip tube (a copper tube will increase corrosion).

Gas supply and controls. Gas heaters may not produce enough hot water because of gas supply or control problems. Start your diagnosis by watching the main burner in operation. Is the flame sooty or too small? Poor draft, inadequate combustion, or low gas pressure may be at fault. If the temperature

Troubleshooting Checklist

No Hot Water	
Cause	*Remedy*
Faulty electric thermostat; faulty electric heating element	Check power to thermostat; if okay, trace power back to panel. Replace thermostat or element.
Inoperative gas thermocouple; failed gas control valve	Reposition, tighten, or replace thermocouple. Replace controls.

Not Enough Hot Water	
Cause	*Remedy*
Damaged dip tube	Replace dip tube.
Incorrect plumbing	Eliminate cross connections at faucets and water heater. Check operation of tempering valve.
Check-valve on recirculating line is missing or stuck open	Repair or replace check valve (use a spring-loaded valve on pumped systems).

Water On Floor Near Heater	
Cause	*Remedy*
T&P valve leak due to excessive pressure	Install T&P on house side of pressure reducer (set to release at 20 pounds higher than pressure reducer). Install expansion tank.
T&P valve leak due to overheating	Adjust or replace thermostat. Lower thermostat setting to prevent overheating from frequent small draws.
T&P valve leak due to stuck valve	Operate valve to flush debris. Replace valve if leak persists.
T&P valve leak due to surge from washing machine or dishwasher	Install water hammer arrestor.

Rusty Water	
Cause	*Remedy*
Glass lining is failing	Replace sacrificial anode; test water for iron content.

Sulfur Odor	
Cause	*Remedy*
Bacteria growth due to excessive sediment	Flush sediment; treat tank and water lines with hydrogen peroxide solution; use zinc-alloy anode.

Rumbling or Popping Noise (gas heaters)	
Cause	*Remedy*
Sediment buildup	Remove sediment.

"Singing" (electric heaters)	
Cause	*Remedy*
Scale buildup on elements	Clean scale from tank and elements; install low-watt density element.

of the water leaving the tank varies widely, the on and off set points in the control may have drifted; a new control may be needed. Another possibility is that heavy sediment buildup in the tank is covering the control's probe and slowing response time.

Heating element and thermostat. Not enough hot water in electric heaters is usually caused by problems with the lower element or either thermostat. Use a volt-ohm meter or pigtail to check for power at the element. If there's power, then check for continuity. A burned-out lower element was probably buried in sediment and overheated. Remove the sediment before installing a new element. Consider using a low-watt density element in hard-water areas to slow sediment buildup.

If the element is good, check the upper thermostat as described earlier. If it tests okay, lower the setting until it's below the water temperature (about 130°F). At that point, the thermostat should switch power to the lower thermostat. If it doesn't, the upper thermostat is bad and needs to be replaced. If power does switch but the lower element still isn't getting juice, replace the lower thermostat.

Subtle Symptoms

Some water heater problems are less obvious, but can cause everything from mild annoyance to panic when they are finally discovered.

Water on the floor. This symptom may be reason for panic, but only after ruling out several simple problems. With a gas heater, the water you see on the floor may only be condensation. Water is one of the main byproducts of combustion, and it will condense out of the flue gases if the tank is cold, especially after a heavy hot water demand.

If there's always a puddle, check for leaks in the line running from the temperature and pressure (T&P) relief valve. A faulty valve may be constantly dripping water that then runs down the pipe alongside the tank, creating the puddle.

If neither of these is the problem, look at every threaded fitting on the tank, especially the plastic drain valve. Don't rule out overhead plumbing: Flex-line connections and packing nuts on gate valves are notorious seepers. (If you tighten up flex-line unions when they are about six months old, you'll head off trouble.) In electric tanks, check for leaks where the elements attach to the tank wall.

If you still haven't uncovered a problem, go ahead and panic. With a little contortion and a dental-type mirror, you can look up through the combustion chamber to the bottom of the tank and the base of the flue. If you see any

Maintaining Water Heaters

Figure A. *Leaking at unions in the overhead plumbing caused this corrosion to accumulate on top of the water heater. Because the leaks went unnoticed for several years, repairs were made too late and the heater had to be replaced.*

Like all heavily used appliances, water heaters need maintenance. You can often spot early signs of trouble simply by looking at the tank. A great ooze of calcium and corrosion debris piling up on top of the heater (Figure A) usually signals leaky unions in the plumbing overhead.

Some maintenance items, however, are less obvious. Here's a list of simple checks to include in the homeowner's manual you prepare for your clients.

Check the Anode

All glass-lined tanks come with a sacrificial anode rod screwed into a separate port at the top of the heater (Figure B). The anode is about 3/4 inch in diameter and formed around a steel wire that extends down nearly to the tank's bottom. If the original anode cannot be found or unscrewed, a second type of anode uses a pipe nipple that can be installed in the hot water outlet. Where overhead clearance is restricted, flexible-link anodes can be bent and "snaked in."

Figure B. *The slow corrosion of a magnesium or aluminum anode rod protects glass-lined tanks from rust. Check the anode every few years and replace it if 6 inches or more of the steel core wire is exposed or if the rod is coated over with a brittle scale. Use a flexible-link rod where overhead clearance is restricted.*

The magnesium or aluminum anode rods are meant to corrode slowly as part of an electrochemical reaction that prevents rusting in the tank, and which in turn prevents leaks. We prefer to use magnesium anodes, especially until aluminum is proven innocent of contributing to Alzheimer's Disease. (You can tell these metals apart by bending the anode: Aluminum is soft, while magnesium is somewhat springy.)

Anode replacement. You need the right tool to get the anode out. Usually, a 12-point socket on a breaker bar will do; other times you'll need a 6-point socket and a torque multiplier to free stubborn anodes.

It's best to find a source for replacement anodes before opening up your tank. Most hardware stores and plumb-

water marking or heavy rusting, or if you find water inside the combustion chamber, start shopping for a new tank. If the combustion chamber is dry, it has to be a leak. Double-check those fittings.

Sulfur odor. The rotten egg odor that some heaters develop occurs when hydrogen gas generated by the action of the anode feeds anaerobic bacteria in the tank. The bacteria take up residence in the sediment, where the warmth of the water encourages growth. Hard or salty artificially softened water will speed anode consumption and generate even more hydrogen. Things get really bad when the tank sits unused for any length of time.

The cure lies in making the tank less hospitable for the bacteria. First, flush out any sediment to remove the breeding ground. Then oxygenate the water with hydrogen peroxide (one or two pints of 3% peroxide per 40 gallons of water) to kill off the remaining bacteria in the tank. Also, run some of the treated water into the plumbing to clean the pipes. Allow the hydrogen peroxide solution to sit for at least one hour in both the tank and the pipes. This treatment is nontoxic and does not require rinsing the way bleach does.

If the odor returns, replace the anode with one that contains a small percentage of zinc. Turning the heat down or off when the tank is unused will also help. Should the problem persist after all this, then a plastic-lined tank (which has no anode) or an instantaneous heater are the only options.

Bothersome noises. A rumbling or popping noise can occur in gas heaters when sediment builds up on the bottom. This sediment slows heat transfer from flame to water, causing overheating of the bottom. Overheating causes boiling and the noise you hear. Every time hot water is used, water pressure is lowered; this allows boiling to occur more readily, and the noise begins to sound like a bowling alley. Getting rid of the sediment is the key.

For many of us, water heaters are memorable for all the wrong reasons, but it doesn't have to be that way. Given a little attention from time to time, water heaters will give dependable service without complaint for decades. ■

Larry and Suzanne Weingarten are partners in Elemental Enterprises, a Monterey, Calif., company that supplies and services conventional and solar water heaters. They manufacture a sediment-removal tool and have written The Water Heater Handbook: A Hands-On Guide to Water Heaters. *Address any questions to them at P.O. Box 928, Monterey, CA 93942; or call 408/394-7077.*

ing supply houses stock anodes, which cost $18 to $30.

It's time for anode replacement when 6 inches of the steel core wire is exposed, or if the rod is coated over with a brittle scale. Check anodes every three to four years (more often if you have hard, softened, or acidic water).

Control Sediment

Sediment is the curse of water heaters. Accumulated sediment slows heat transfer in gas heaters, and the elevated temperatures weaken the steel and dissolve the glass lining. Sediment also provides a breeding ground for bacteria. In gas heaters, sediment can cause annoying noise, and in electric heaters it can cause the lower element to burn out.

Getting rid of sediment. You can remove sediment by dissolving, vacuuming, or flushing it out of the tank. I recommend against trying to dissolve sediment. The process takes several hours, and it may need to be repeated if not initially effective. It also involves using citric acid or lye, two very dangerous compounds.

We like to vacuum sediment using a tool we developed called the Muck-Vac, which pulls water and sediment off the bottom and returns filtered water to the tank (Figure C). In electric heaters, you can pull out the bulk of the sediment using a wet/dry shop vac with a piece of 3/4-inch pipe for a nozzle. Go in through the element port after draining the tank.

The third method, flushing, is effective only if water pressure and flow are good, and the sediment buildup is not too heavy. For flushing to work, a heater must have a ball-valve drain and a dip tube with a curve on the end. Some heaters come from the factory with curved dip tubes already installed; if not, you can replace a straight tube with a curved one on standard tanks.

Figure C. *The author designed the Muck-Vac to pull sediment off the bottom of the tank, filter it, and return clean water through the dip tube.*

To flush the tank, attach a hose to the drain, open the ball valve, and let water run out full force for three to five minutes. The curved dip tube creates a swirling action in the tank that stirs up sediment and rinses it out the drain.

Prevent sediment buildup. Softening the water helps to reduce sediment accumulation, as does lowering the water pressure; high pressure (over 60 psi) tends to cause more sediment. If you can adjust the gas pressure to the main burner of your gas heater, turn it down: The smaller flame will slow sediment buildup.

Inspect Relief Valves

The temperature and pressure (T&P) relief valve kicks in at temperatures over 210°F and pressures of more than about 150 psi. If the valve is blocked with scale or rust, neither water nor steam will be able to escape, and you'll have a very dangerous problem. The valve should be checked every six months.

Checking the T&P operation is easy. Lift the lever on the valve. Be sure there is good water flow and that it shuts off when you let the lever flip back down. If it drips or doesn't reseat, replace it.

— L.W. & S.W.