

### **Joe Steiner Explains How a Boiler Works (Chapter 4)**

The most expensive component in the system was the hot water source. Most plumbers used low-pressure boilers because they were familiar with them. But Bill had found a high-efficiency water heater that was less expensive than a boiler and more energy-efficient. He was not sure if it would work, so he'd turned to an old friend, Joe Steiner, who was the top engineer at Templeton. Bill had worked closely with Joe on several projects and thought very highly of his technical skills.

Bill explained what he was doing, and found Joe eager to help. As it turned out, Joe was working on the design of a new home and had looked into radiant heating. He really liked the system but had been discouraged by the high bids he received. So when Bill called, he was already familiar with the technology and eager to hear Bill's ideas for a lower cost system.

They met on a Saturday morning in Bill's living room, and over coffee and bagels, Joe explained the physics of radiant heating and why it was so much more efficient and comfortable than forced air. He then described how residential heating systems were designed and how they worked. Then, after a lengthy review of alternate ways to configure a system and numerous calculations that were alien to Bill, Joe concluded Bill's water heater would probably work. For residential applications, it was a cheaper and more efficient source of hot water.

This was all Bill wanted to hear, but Joe, being an engineer, insisted on providing a more complete and detailed explanation. He wanted to make sure Bill got his coffee and bagels worth.

His lecture began with an explanation of why boilers are not well suited for residential use. Boilers, he said, are very efficient, heavy-duty workhorses used to heat large volumes of water to very high temperatures. Steam produced by a boiler was typically used for heating or drive generators or other heavy equipment. But to operate at maximum efficiency, boilers had to run constantly under heavy load. That is why they are so well suited for commercial and industrial applications, where the demand for steam or very hot water (e.g., 140+ degrees) is high and constant.

But the demand for heat in a residential environment is much different. Here the demand is sporadic and only warm water is needed (i.e., 80°-85° F degrees). Unless there is a severe cold spell, a boiler typically operates for only a few minutes each hour. It works like this:

- The temperature in one of the zones drops, causing the thermostat to signal for more heat,
- In response, the radiant heating system controller opens the valve for that zone and starts pumping warm water,
- When the desired temperature is restored, the thermostat signals the controller again and the water valve is closed,

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- Cool water returning from the zone flows into the boiler holding tank; the water temperature in the tank drops and the boiler fires up to reheat it,
- When the water reaches the desired temperature, the boiler shuts down and does not fire again until the tank temperature drops.

This fire-up and shutdown of the boiler can happen many times each hour. It is called "short cycling" and is very harmful to the boiler. The equipment never runs "all out" and so it never reaches its peak operating efficiency. The result is wasted energy and often, premature failure of boiler components. An analogous situation is a car driven only on short trips around town; the engine never fully warms-up. This kind of driving fouls the fuel and electrical systems, creates slug in the oil, and dramatically shortens the life of the engine.

On the other hand, he said, high efficiency water heaters are better able to meet these intermittent needs for relatively low temperature water. They can heat water very rapidly and supply it "on-demand," in other words, the heater only turns on when there is demand for hot water. It can turn on and off many times each hour without any abnormal wear; in effect, the units are designed to short-cycle. Also, since they do not waste energy maintaining the temperature of water that just sits in a tank, they consume less fuel. Last, but perhaps best of all, these water heaters cost a lot less than boilers.

Bill was gratified that his hunch had been right. If he used one of these new hot water heaters and made a few other changes suggested by Joe, he could remove a thousand dollars or so from the cost of a system. And he could do it without sacrificing quality or reliability. In fact, it was just the opposite; he would be able to deliver a better system to his customers.