THE PST SYSTEM

HYDRONIC CIRCUITRY FOR HIGH EFFICIENCY

Prepared by Weinstein Taylor and Associates

Boiler piping design that worked well in the times of monster fire-tube boilers and cheap energy does not work for today's small high-efficiency boilers. The consequence of applying 1950's design practices to modern boilers has been poor control and wide spread equipment failure. We see a lot of boiler rooms. It is astounding how many high efficiency boilers end up in pieces, lying in dark corners of boiler rooms, because someone thought that a small, high efficiency boiler could be piped up like any other boiler.

Our PST system is the solution. PST stands for 'primary-secondary-tertiary' pumping. This is a way to pipe the boilers that:

1. saves energy . . . up to 25% over conventional systems;
2. allows for different send-out temperatures for different zones;
3. allows much low send-out temperatures which prevents overheating in mild weather for energy savings and greater comfort; and
4. keeps the return water to the boilers high, for long equipment life.

To understand why the PST system works so well, we have to take a look at a conventional system piping system (*Figure 1*). This basic layout has not changed since the 1950s, when energy was cheap and boilers were built like huge tubs of water. *Figure 1* shows a simple primary-secondary pumping system with pumps on each boiler. The temperature of the return water (the water entering the boiler) for most modern boilers must be at least 130°F. If the water comes back to the boiler any lower, it causes condensation. This combines with sulfur in the exhaust gases to make a strong acid that rots your boiler.

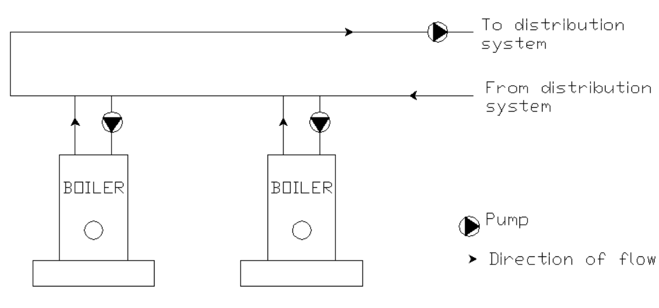


Figure 1 Simple Boiler Piping System

For a system with baseboard convectors, to get return water above 130°F, the water will have to be sent out at least 20°F higher, or 150°F at a minimum. More commonly, 160°F would be a minimum setting. In mild weather, this will over-heat the building.

This problem lead to the development of a variation that would allow for lower send-out temperatures (*Figure 2*).

This is the piping system that is most widely used today. It uses a motorized 3-way valve to mix some of the cool return water with the hotter supply water from the boilers. For example, if water temperature from the boilers is 160°F and the return water is 140°F, then the two can be mixed for a supply temperature to the radiators of around 150°F. If you think about it carefully, you can see that this cannot really work. One of the problems is that the flow back to the boiler is diminished when water is diverted, because the water is bypassing the boilers. This might be OK for a big fire-tube boiler that holds hundreds of gallons of water. A modern high-efficiency boiler, however, only holds a few gallons. Reduce the flow to the boiler and the heat exchanger will melt in a heartbeat. Even if the failure is not immediate, hot spots will develop on the heat exchanger that will cause scaling and eventual failure. Besides this, it does not address the problem of low return temperatures. It will not save energy in spring and fall, which is half our heating season, because the boiler controls will increase the supply temperature to the radiators to avoid low return temperatures. Saving energy requires a system that can send out low temperature water to the radiators in the distribution system in milder weather.

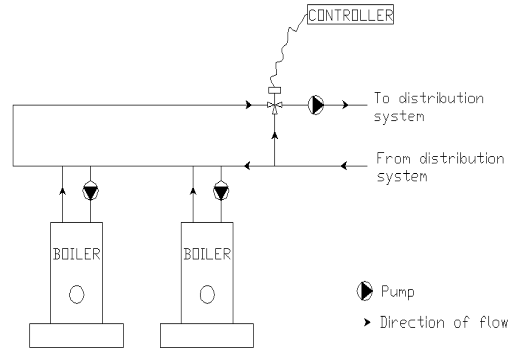


Figure 2 Conventional Piping with 3-way valve

High efficiency (non-condensing) boilers require two things. They need a constant flow of water through them and they need return water temperature that is, in most cases, no lower than 130°F. The simplified layout of a PST system is pictured below (*Figure 3*).

This system has a boiler loop that always maintains a high temperature and a constant flow, so that the boilers stay happy. The distribution system (going to the rads or fan coils) is a closed loop. The injection loop pumps hot water from the hot boiler loop into the distribution loop as it is needed. The hot water is metered into the distribution loop with a variable speed pump or a motorized 4-way valve. This allows very fine and immediate control of the supply temperatures. When combined with DDC controls, we can control the supply temperatures to the distribution system to within one degree. Conventional systems try to control the temperature by cycling the boilers on and off. This is like trying to drive through town with a stuck gas pedal by turning your car on and off. Rapid cycling is hard on the equipment and results in poor energy efficiency as you can imagine.

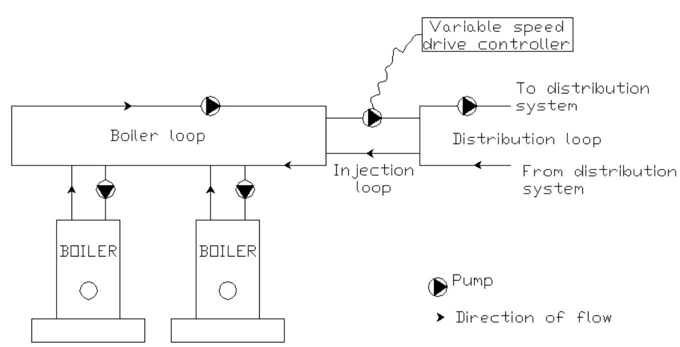
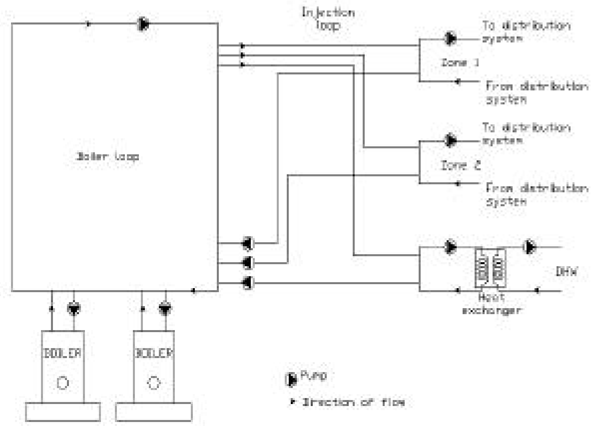


Figure 3 PST System

In the PST system, the distribution loop can be any temperature. In fact, different zones can be different temperatures. Because of this, we can use the same boiler plant to heat zones with different requirements, and produce hot water for domestic hot water use, as shown in *Figure 4*.

Figure 4
Multi-Zone PST System



To summarize:

1. The PST system ensures long boiler life by keeping the return water temperature high, providing constant flow and preventing the boilers from cycling.
2. The PST system can safely provide lower send-out temperatures than other systems, preventing overheating, saving energy and increasing resident comfort.
3. The PST system provides accurate control of send-out temperatures, eliminating temperature swings and improving energy efficiency.
4. The PST system can be used for multiple zones that require different temperatures and can be used to heat domestic hot water, thus saving money by eliminating separate boilers.

The Fine Print

The preceding diagrams are very much simplified. The actual design of such a system requires diligent engineering . . . much more so than an old-style boiler plant. The amount of water in the boiler loop is critical to the system working smoothly. The pumps must be accurately sized. The pressure drops through each piece of equipment must be calculated. And so on. In other words *'We are professionals . . . do not try and do this at home!'* The success of this design depends on sound engineering and experience with this type of system.

Weinstein Taylor and Associates is a mechanical engineering firm specializing in hydronic heating and air conditioning. We were the first firm to apply this technology to multiple-unit buildings in the late 1980s.

Weinstein Taylor and Associates
100 Broadview Avenue, Suite 415, Toronto Ontario M4M 3H3
Phone: (416) 463-6662 Fax (416) 461-8296
www.wtaeng.com info@wtaeng.com