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HYDRAULIC SEPARATION
PHP SEPARATORS AND CANISTERS

Hydronic heating offers several benefits over other heating mediums, one of which is the ability to easily zone various areas of a building. Previously, with high-temperature and high-mass boilers, zoning has been done simply by branching off the boiler supply and return mains with tees to service the various zones.

With the advent of new controls and condensing boilers, flow through the boiler can be impacted significantly by the piping strategy used for the various zones. The result has been the adoption of primary/secondary piping which creates independent loops to serve the boiler and the heating zones.

Closely-Spaced Tees

P/S piping allows the boiler to maintain required flow rates while allowing the zones to operate independently with no effect on boiler flow rate. P/S piping is accomplished using closely-spaced tees to separate the primary and secondary loop flows.

Closely-spaced tees should have their supply and return connections no greater than 4 pipe diameters apart. This produces very little pressure drop between tees and prevents unwanted flow to idle zones. The flow pattern between the tees depends on flow rates in the primary and secondary loops. See Figure 1.

When the primary flow is greater than the secondary flow, as shown in the top illustration, supply water will be introduced to the zone at the delivery temperature from the heat source. Return water to the heat source will be at a mixed temperature produced by the zone return mixing with the supply temperature.

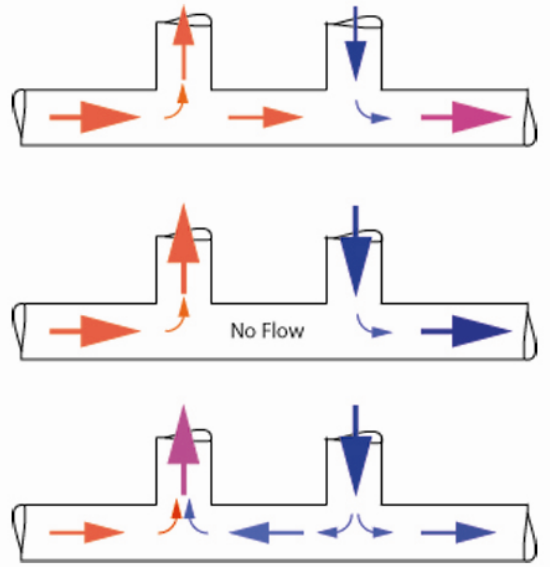

Figure 1

When primary and secondary flow rates are equal, all supply water temperature is directed to the zone and all zone return water is directed back to

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the heat source. There is no flow between the two tees.

As shown by the lower illustration in Figure 1, when the secondary flow rate is greater than the primary flow rate, the zone return water will mix with the supply water to produce a mixed temperature which is sent to the zone. The heat source will see the return temperature from the zone.

P/S Series and Parallel Installations
Traditional P/S piping may be installed as series or parallel secondary zones.

Series zones are piped along the secondary loop using several closely-spaced tees as shown in Figure 2. In this application, supply and return connections are placed next to each other along the loop.

The result is that subsequent zones downstream of the first zone will experience decreasing supply water temperatures because each previous zone's return water is reintroduced into the supply water resulting in a lower mixed temperature to the following zones.

This may be desirable if zones require different supply temperatures due to heat load or floor covering requirements.

Proper planning is required so that zones are installed in order of decreasing water temperature requirements.

However, the zone delivery temperature may change if previous zones are not active. This may pose problems if a zone's delivery temperature must not exceed a specified high limit.

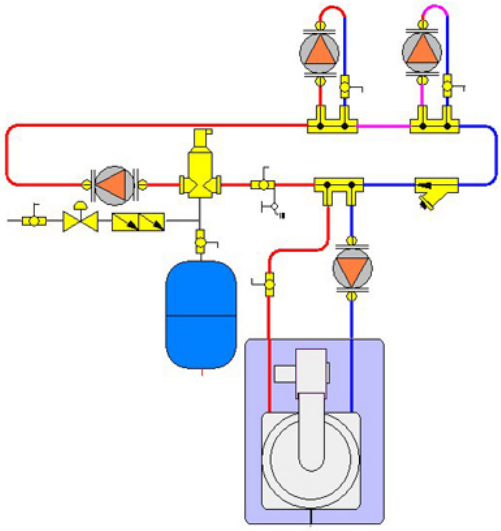

Figure 2

Parallel zones are piped so that the primary loop is divided into several "cross-over branches" which then serve the secondary zones via closely-spaced tees. See Figure 3.

The advantage of parallel P/S piping is that each zone will receive the same supply water temperature from the primary loop.

Parallel P/S piping requires more components and piping to set up properly. Additional circuit setters must be added to properly adjust the zone flow requirements. These additional components and piping add cost to the system.

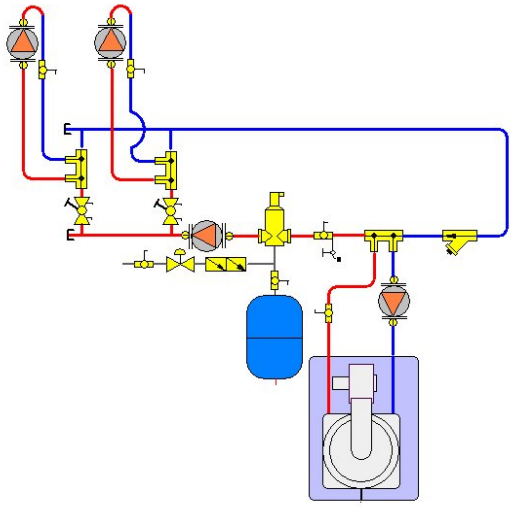

Figure 3

Another requirement of P/S piping, for either series or parallel systems, is a primary loop circulator. In addition to the heat source pump, a primary loop pump must be added to provide flow around the primary loop. This also adds additional cost to the installed system and additional operating cost over the life of the system.

Hydraulic Separators
Hydraulic separators provide the same benefits of P/S piping but with additional benefits. A hydraulic separator installs between the primary and secondary loops and eliminates the need for an additional pump to circulate fluid through the primary loop.

Hydraulic separators offer more compact system piping since the need to provide a separate primary loop is eliminated. The heat source connects to one side of the hydraulic separator while the heat distribution loop connects to the other side. See Figure 4.

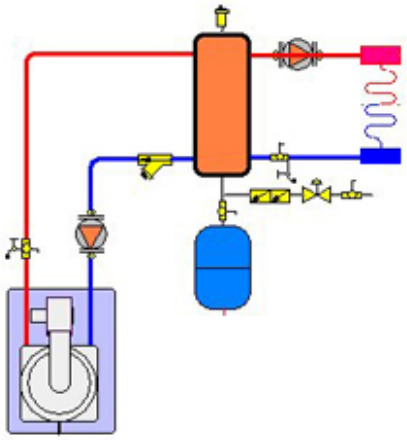

Figure 4

PHP Hydraulic Separators
The **Mini-Sep™** is an economical, small hydraulic separator that includes an air vent and pressure-reducing fill valve.

The Mini-Sep™ provides a fast primary-secondary piping solution. With reversible primary ports, the Mini-Sep may be connected from either side to the primary and secondary loops.

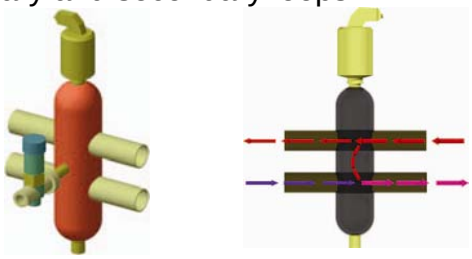

Figure 5 – Mini-Sep™ (patents pending)

This provides a compact basic hydraulic separation solution for any boiler as shown in Figure 6.

Figure 6 – shown with Mini-Sep Plus™ (patents pending)

The Low-Loss Header (**LLH™**) provides a basic system hydraulic separator that accepts field-installed zone pumps. See Figure 7.

The LLH™ includes an air vent, pressure-reducing fill valve, temperature and pressure gauge, system pump and a drain valve.

It is a fast primary/secondary piping solution and the primary side may be connected to either side of the header simply by removing the caps on one side and installing them on the other.

The LLH™ is best used with side-piped wall-hung boilers with a single delivery water temperature to all zones.

The Low-Loss Header Plus (**LLH-Plus™**) is a more complete system solution which includes an expansion tank and end-suction zone pumps with spring-check valves. See Figure 8.

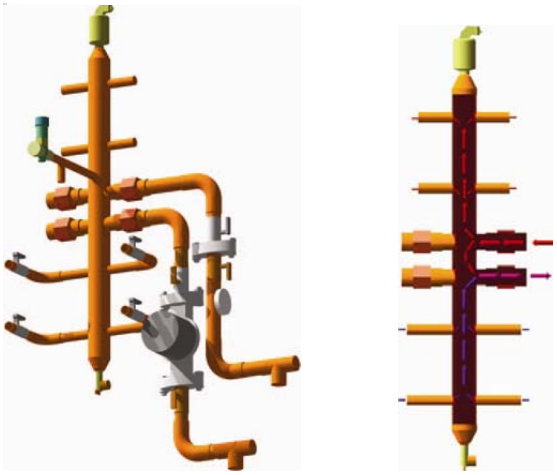

Figure 7 – LLH™(patents pending)

Figure 8 – LLH-Plus™ (patents pending)

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PHP Hydraulic Canisters
The hydraulic canisters provide a more complete and compact system component by providing an internal hydraulic separator and supply/return headers.

The **Sep-Can™** is a basic hydraulic separator for vertical or horizontal installation.

It can accept field-install zone and system pumps.

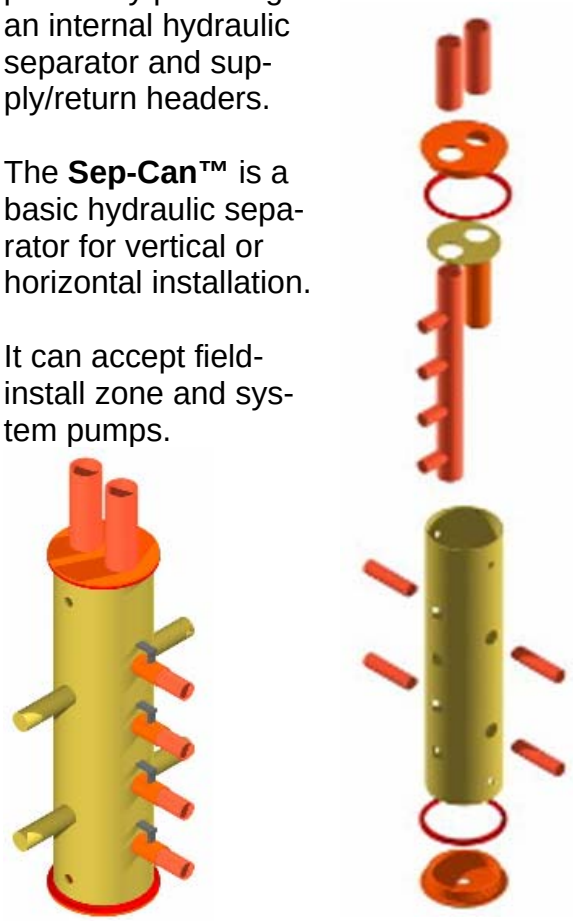

Figure 9 – Sep-Can™ (patents pending)

The **Sep-Can Plus™** is a complete package with end-suction pumps, air elimination, fill valve, primary pump, spring-check valves, and expansion tank.

It is intended or use under wall mounted boilers. See Figure 10.

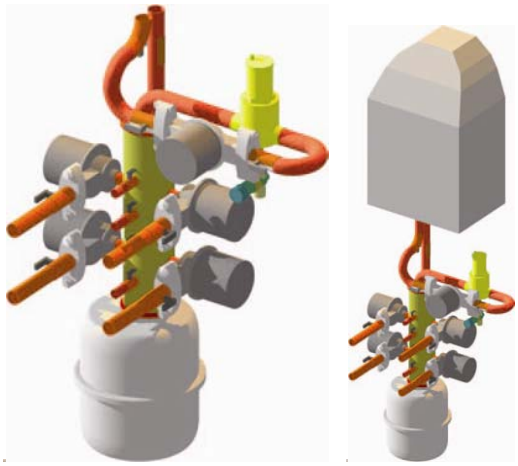

Figure 10 – Sep-Can Plus™ (patents pending)

The **Allcan™** completes the PHP hydraulic canister line. The Allcan™ is similar to the Sep-Can Plus™ but includes a built-in high-quality air eliminator.

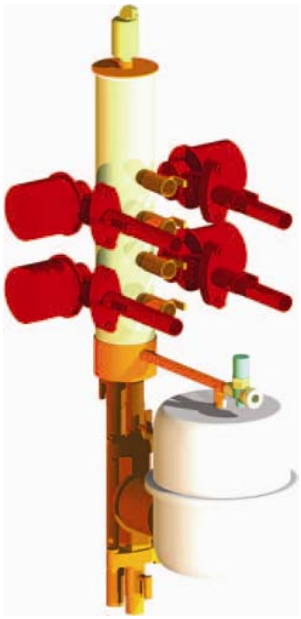

Figure 11 - Allcan™ (patents pending)

The built-in air eliminator utilizes a swirl chamber to induce a volume and

pressure change which allows air to escape via the air vent.

Water entering the swirl chamber is directed against the swirl chamber wall.

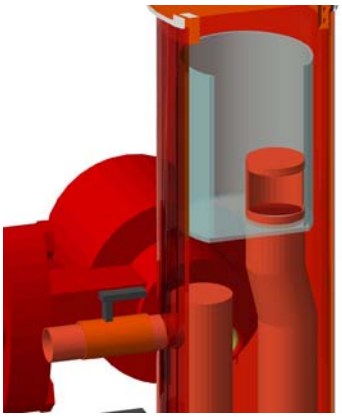

Figure 12 (patents pending)

As the water swirls upward in the chamber it is drawn down between the swirl chamber and canister walls into the supply cavity by the zone pump(s). The end-suction pumps then circulate water to the appropriate zone.

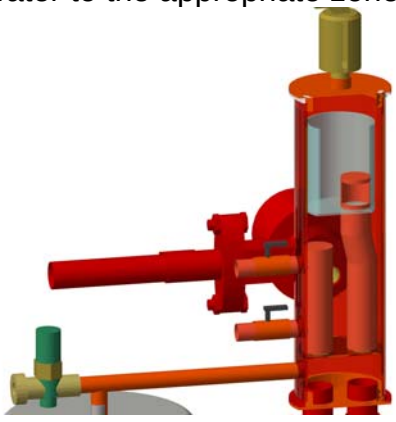

Figure 13 (patents pending)

The configuration of the Allcan™ allows the end-suction zone pumps to be swiveled to accommodate installation requirements. The two upper pumps may be swiveled to point up while the two bottom pumps may be turned down. All zones include spring-check valves to prevent flow unless the zone pump is running.

The Allcan™ is intended for use with any boiler. It may be mounted along side wall-hung boiler or easily connected to floor-mounted boilers.

The Allcan™ system pump may also be configured to operate as a variable speed injection pump by controlling its output by a variable speed controller.

Hydraulic Separation Flow Characteristics

Water flow inside the separation chamber is similar to the flow patterns of closely-spaced tees.

Primary Flow greater than Secondary Flow

When the primary flow rate is greater than the secondary flow rate, the supply temperature from the heat source will be the temperature of the water to the zone. The return water to the heat source will be a mix of the heat source water and zone return water. See Figure 14.

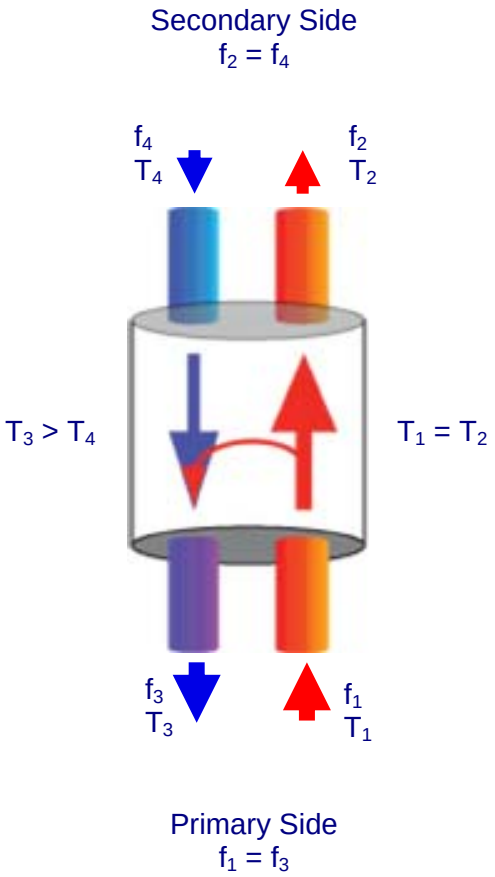

Figure 14

The water temperature returning to the heat source can be calculated using the following formula:

$$T_3 = \left(\frac{[f_1 - f_2]T_1 + [f_4]T_4}{f_1} \right)$$

Assume that the primary system flow rate is 6 GPM and is supplying 110°F water. The secondary flow rate is 4 GPM and is returning 90°F water. Using the formula the water temperature returning to the heat source is:

$$T_3 = \left(\frac{[f_1 - f_2]T_1 + [f_4]T_4}{f_1} \right)$$

$$T_3 = \left(\frac{[6-4]110 + [4]90}{6} \right)$$

$$T_3 = 96.7$$

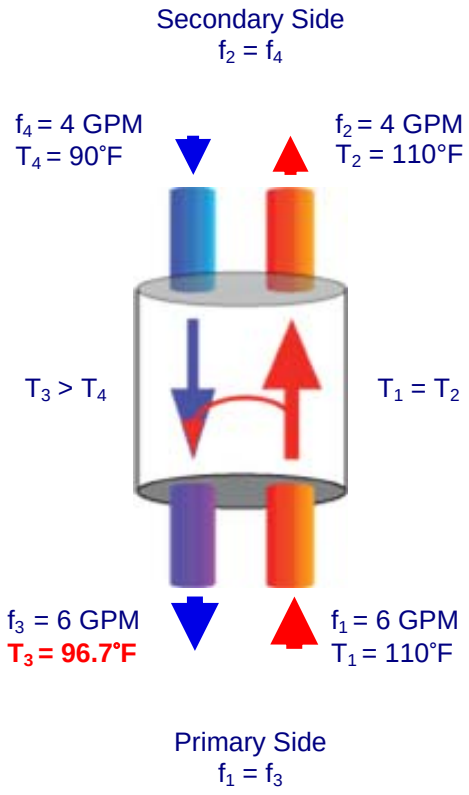

Figure 15

Primary Flow equal to Secondary Flow

When the system flow is equal to the secondary flow, all the primary water is directed to the zones and all the return water goes back to the heat source. The temperature of the zone water is the same as that supplied by the heat source and the return water tempera-

ture to the heat source equals the return water temperature from the zones.

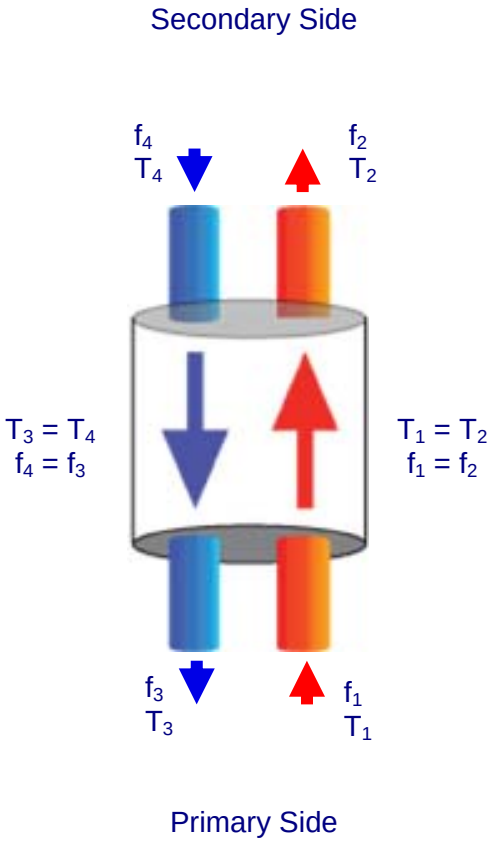

Figure 16

Primary Flow less than Secondary Flow

When the primary flow rate is less than the secondary flow rate, the supply water temperature to the zones will be a mix of the supply water from the heat source and the return water from the zones. The return water to the heat source will always be the same as the return water from the zones. See Figure 17.

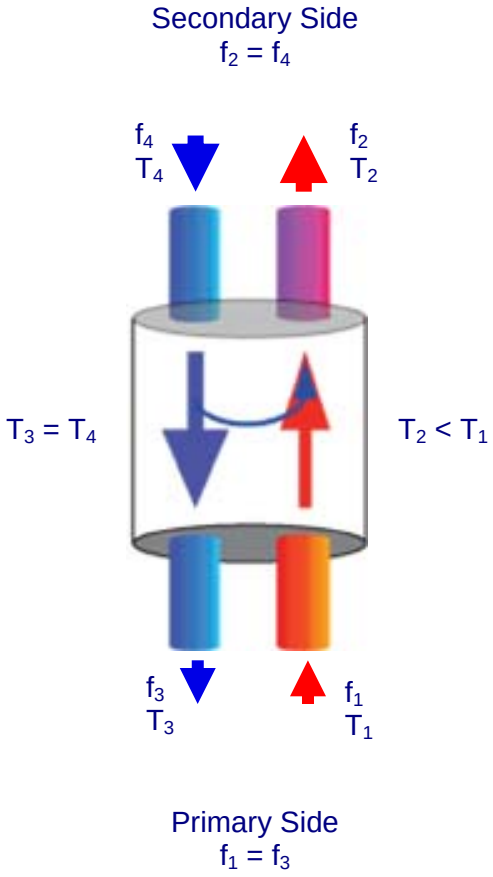

Figure 17

The water temperature delivered to the zones can be calculated using the following formula:

$$T_2 = \left(\frac{[f_4 - f_1]T_4 + [f_1]T_1}{f_4} \right)$$

Assume that the primary system flow rate is 4 GPM and is supplying 110°F water. The secondary flow rate is 6 GPM and is returning 90°F water. Using the formula the water temperature returning to the heat source is:

$$T_2 = \left(\frac{[f_4 - f_1]T_4 + [f_1]T_1}{f_4} \right)$$

$$T_2 = \left(\frac{[6-4]90 + [4]110}{6} \right)$$

$$T_2 = 103.3$$

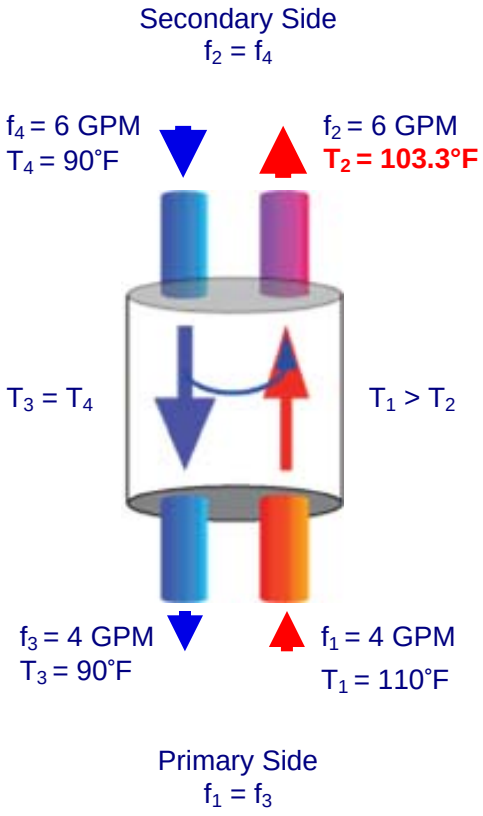

Figure 18

Summary

Hydraulic separators and canisters are an efficient, economical, and compact method of providing primary/secondary system piping for a variety of heat sources.

By maintaining proper flow rates on each side of the separator/canister, the components of a system will operate properly.

All canister products include spring-check valves to prevent unwanted heat migration into the zones when the zone pump is off.

For more information on PHP's hydraulic separators and canisters, contact PHP at 505-445-4188 or visit www.phpinc.us.