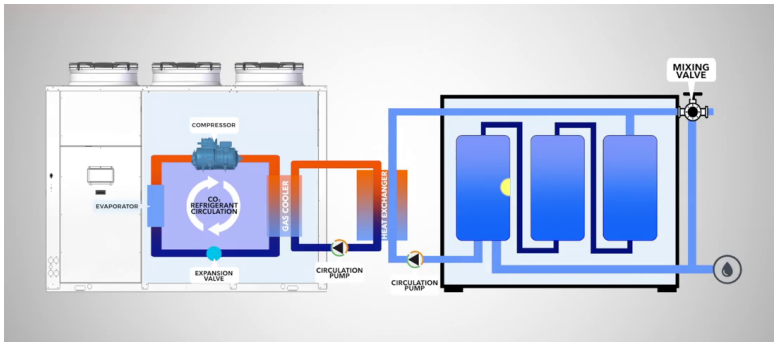
Monday, September 12, 2022

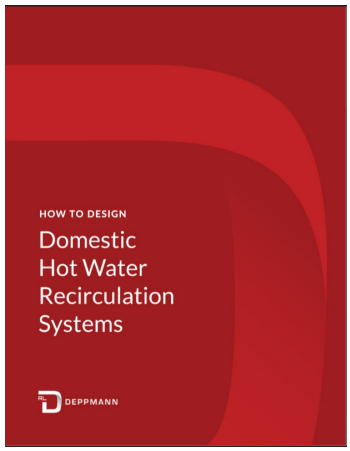
Heat Pump Water Heaters: Hot Water Recirculation (Part 6)

Monday Morning Minutes | by Norm Hall, September 12, 2022

How does the commercial heat pump water heater, using the preferred R-744 refrigerant, handle the domestic hot water recirculation load? The R-744 (CO_2) heat pump cannot handle hot return temperatures. Something different must be done for the recirc load.



Return Temperatures to the Heat Pump

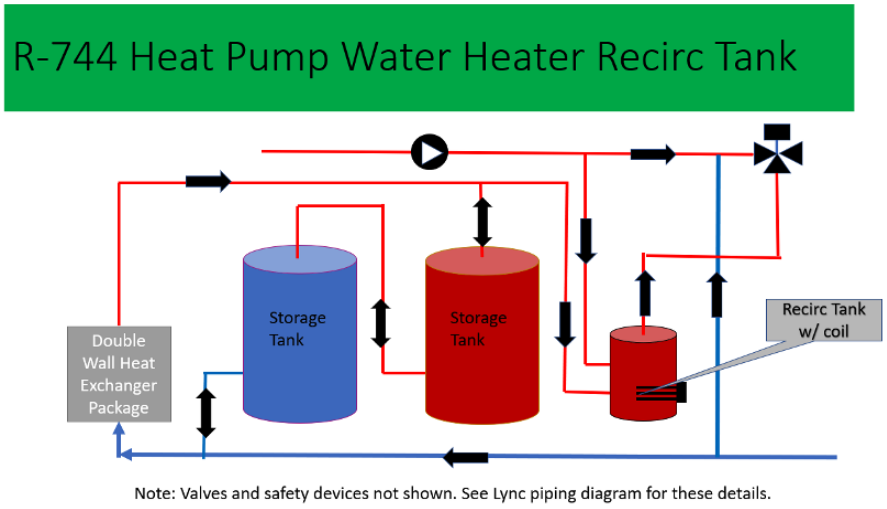


The domestic hot water return temperature in a recirculation loop should be hot. The hot water recirculation system is designed to keep the water hot near the farthest fixtures in the plumbing system. This way, the water will be hot for the user at the sink or shower in just seconds. The water returning to the water heater could be as low as 95°F in older systems and as high as 125°F in newer systems. You may download our Domestic Hot Water Recirculation Systems eBook for more information on the design of these systems.

In any of these cases, the temperature of the water returning to the heater is greater than what the R-744 heat pump can handle. How do we design the return piping and pump to avoid problems?

The Recirc Tank Solution

When there is no water draw in the system, the recirculated water will come back to the heater at too high a temperature to return directly to the heater, but too low to return to the “hot” storage tank. The solution to the return temperature issue in the recirculation system of the commercial R-744 heat pump is the recirc tank. A recirc tank, also called a trim tank or sometimes a swing tank, is a small storage tank, typically with an electric resistance coil, which is sized for the BTUH load of the recirculation system. The load was calculated to determine the flow rate of the recirculation pump. The tank is piped in series with the storage tanks and is the last tank or the one closest to the fixtures. The recirc pumped return is piped into this swing tank and the master mixer.



Note: Valves and safety devices not shown. See Lync piping diagram for these details.

We can see the general piping in the sketch above. The swing tank receives the outlet temperature of the heat pump. If the draw is greater than the heat pump flow rate, hot water also comes from the storage tank The supply hot water to the mixing valve comes

from the swing tank. The outlet and inlet openings of the tank should be sized to handle the full flow rate required to meet the load of the system.

The swing tank volume will be smaller than the storage tanks. We would recommend sizing the tank for two turns per hour based on the recirculation pump flow rate. For example, if the flow rate is 8 GPM, size the tank for 8 X 30 = 240 gallons. This should keep the start/stop cycling of the contactors at 6 times per hour based on a 10^{0}F dead band for the controls. This is not a hard and fast rule but a safe sizing method to avoid arcing of the contactors. This tank will also be part of the total storage volume.

Operation: If the domestic hot water draw is greater than the heat pump flow rate, cold water enters both the heat pump and the first storage tank lower connection. If the domestic water draw is less than the heat pump flow rate, cold water enters the heat pump from the supply and the bottom, cooler, water connection. If there is no draw, the recirculated water flows in and out of the swing tank.

Next week we look at standby capacity and ways to handle it.

Part 1: Heat Pump Water Heaters: The Road to Decarbonization

Part 2: Heat Pump Water Heaters: How They Work

Part 3: Heat Pump Water Heaters: Refrigerants and Weather

Part 4: Heat Pump Water Heaters: Temperatures & Storage

Part 5: Heat Pump Water Heaters: Parts & Pieces & Storage