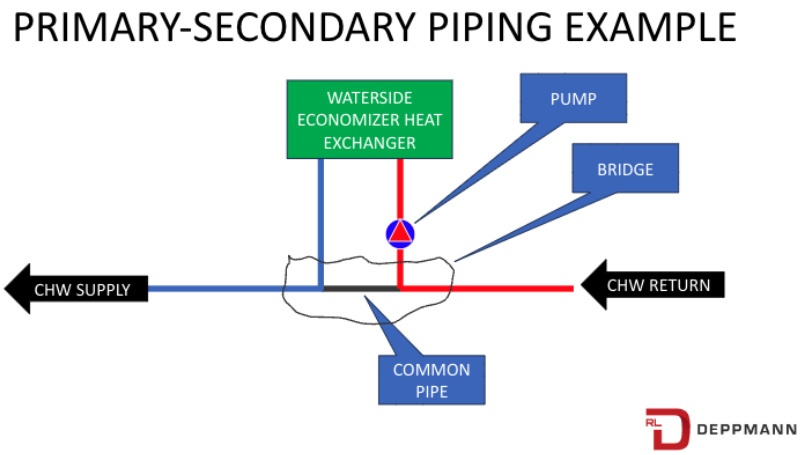
Monday, August 7, 2023

Primary-Secondary CHW Loops with Unequal Flow Rates

Monday Morning Minutes | by Norm Hall, August 7, 2023



Primary-secondary hydronic system loops have a common pipe that facilitates flow in both directions when the two loops have different flow rates. That same common pipe is used to mix the temperatures so the BTUH supplied from one system will be equal to the BTUH accepted by the other. Both requirements are key to any primary-secondary system. We can use the recent series on water side economizers as an example.

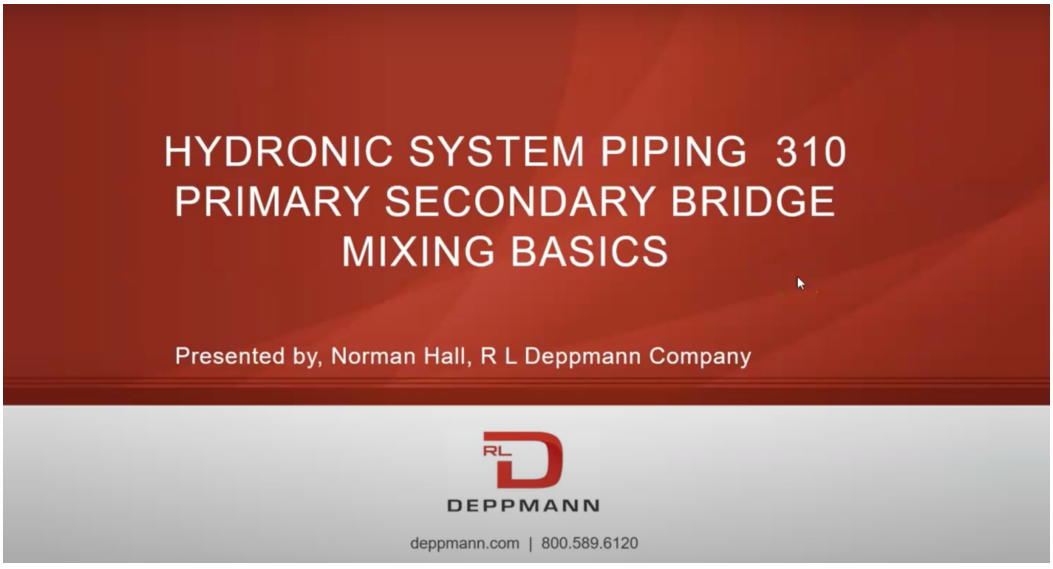
Primary-Secondary Piping Basic Rules

The primary-secondary system piping will always have a common pipe and a pump for the primary loop and a pump for the secondary loop. Look at the sketch above. The common pipe with the two tees between the primary and secondary systems is called the bridge.

There are piping configurations for the bridge to avoid unwanted circulation, but we will not address those in the article.

There are three basic “rules” for primary-secondary piping.

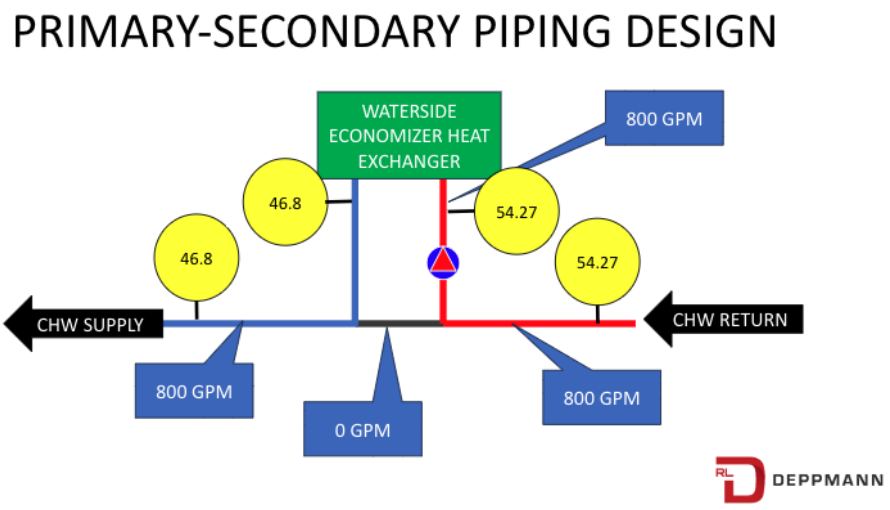
1. Keep the common piping short. The real goal here is to keep the pressure drop of the common pipe and the two tees in the bridge to a minimum. For information about that you can check out a couple of our R. L. Deppmann Monday Morning Minutes.Hydronic Primary-Secondary Piping – How Important are the Two Close Tees? and also Hydronic System Primary-Secondary Rules-Decoupling Systems.
2. Conservation of flow. The flow into a bridge tee must equal the flow out of the tee. Simple but important.
3. Conservation of energy. The total heat or BTUH in the primary system must match the total BTUH in the secondary system. A chilled water economizer system is shown above. If we remove heat from the chilled water system to cool the supply water, that same amount of heat must be transferred to the cooling tower water through the heat exchanger. Here is a short video from one of our classes.



Chilled Water Primary Secondary Example

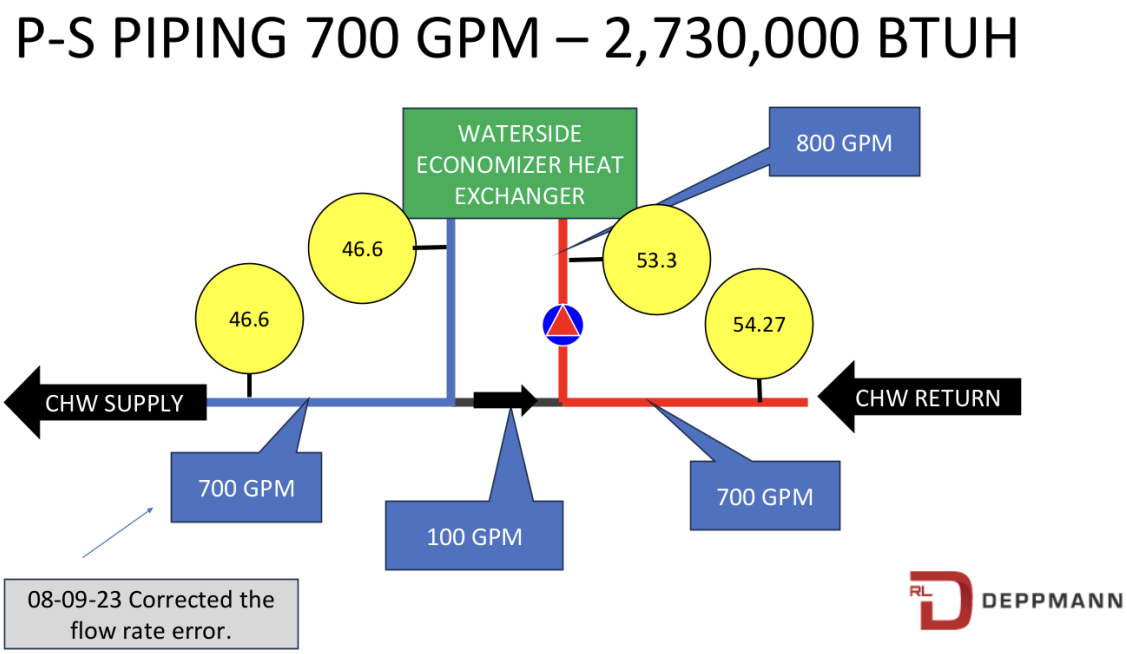
The video above showed the "rules" of primary secondary systems using a heating example. The same principles are used in chilled water systems. In our Water Side Economizer Series we used an example of a constant chilled water flow rate to the heat exchanger of 800 GPM. We will call that the primary loop in this blog. The variable flow chilled water return from the building will be called the secondary system in this blog. Never assume which is which. Always ask which system is being referred to as primary and which is secondary. People interchange the terms frequently.

Our design conditions for the heat exchanger were to cool 800 GPM of chilled water from 54.27°F to 46.8°F using 800 GPM of 43.8°F tower water. What will happen as the chilled water system flow rate drops?



As the chilled water flow rate from the system drops down, there will be mixing at the bridge from the heat exchanger outlet back to the inlet tee. This will lower the entering water temperature to the heat exchanger. The BTUH will be less and the mixed CHW supply

temperature to the heat exchanger will drop. Look at the numbers when we have 700 GPM of chilled water return.



The heat exchanger has a fixed amount of surface. As the chilled water flow rate drops, the number of BTUs drops also. As the flow rate continues to drop, there will be a greater quantity of heat exchanger outlet water mixing with the return water. For a given tower water supply temperature, the BTUH capability of the exchanger will also drop.

You may think, of course the load drops. The two-way valves are closing at the coils because they require less BTUH. That is what is dropping the flow rate. If the load increases, the two-way valves will open and the BTUH from the heat exchanger will also rise until the design capacity of the water side economizer is met.

This may seem like too much information, but you can see how the primary secondary bridge works in this application.

What happens when the tower water supply temperature rises? What is going on with the coils? Next week we will look at the coils in winter mode and how they react to warmer supply temperatures.