

Applications Corner

Large Tonnage Solutions Marketing



This August 2010 LTS Update Newsletter's edition of Applications Corner was written by Chris Paraskevakos, Applications Engineering Manager.

Definition and Discussion of SCF (Series Counter flow)

In the Application Engineering group we are frequently asked to evaluate if SCF will improve the chiller plant efficiency. Simply put, SCF is a chiller piping configuration in which two chillers, usually identical, are arranged in series with the chilled water and cooling water flowing in opposite directions through the chillers. One such example arrangement is shown in Figure 1.

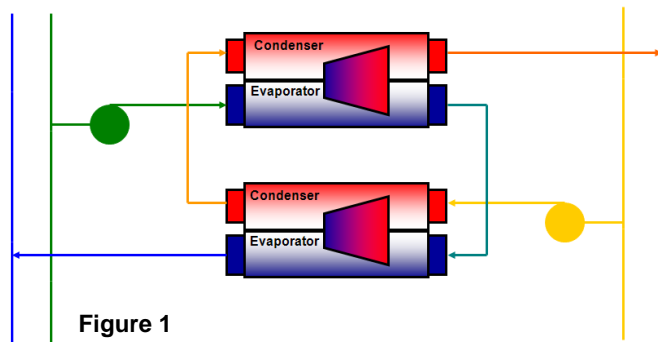


Figure 1

This series counter flow configuration results in one chiller seeing the warmest condenser water and the returning (warmest) chilled water. This chilled is referred to as the "lead" or "high-side" machine. Alternatively, the other chiller sees the coldest condenser water and the leaving (coldest) chilled water. This chiller is referred to as the "lag" or "low-side" machine. The result is that both chillers see a slightly lower "head" or "lift" compared to chillers piped in a parallel flow configuration. In line with our Johnson Controls York chiller philosophy, lower lift is always more efficient and results in lower energy consumption.

To further illustrate the energy saving principal of a series counter flow arrangement it is best to use an example and compare SCF versus a typical parallel arrangement. Assume an application with the following conditions:

- 2000 Tons (7,000kW) total capacity required
- Chilled water: 56°F (13.3°C) entering, 40°F (4.4°C) leaving , 3000 gpm (189 l/s) total flow
- Cooling water : 85°F (29.4°C) entering, 3.0 gpm/TR (3.2 l/min per kW)
- Standard ARI fouling factors
- 30' (10m) maximum pressure drops
- Customer requires 2 chillers for this duty

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For straightforward parallel piped chillers consider the standard arrangement in Figure 2 and the resulting Pressure-Enthalpy (P-H) diagram shown in Figure 3. Both chillers have identical (theoretical) conditions and performance.

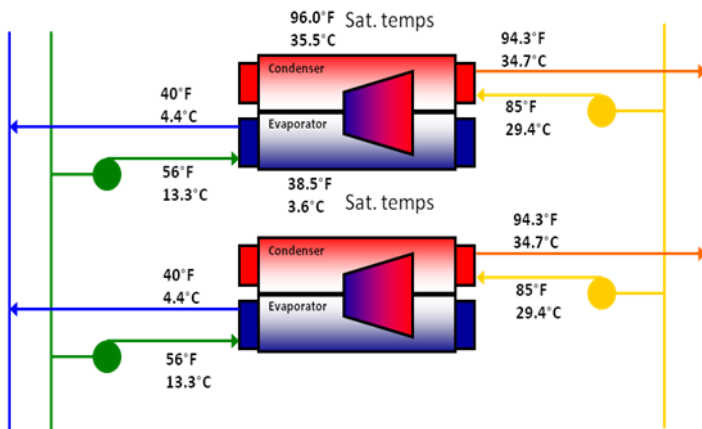


Figure 2

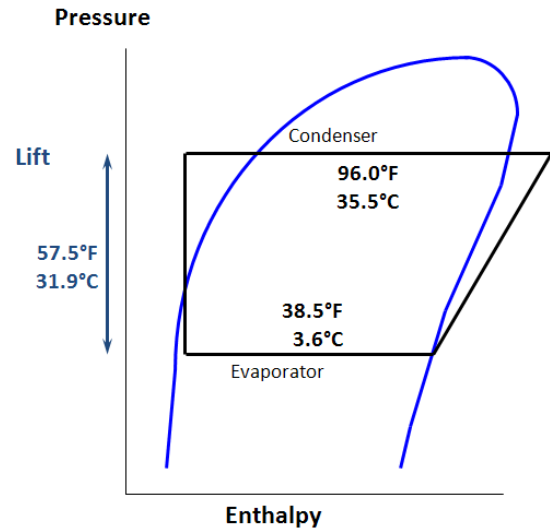


Figure 3- Installing chillers in parallel (single lift operation) requires each to produce the total system lift.

Now compare this to a series counter flow piping arrangement (Figure 4) and P-H diagram (Figure 5) for the same application.

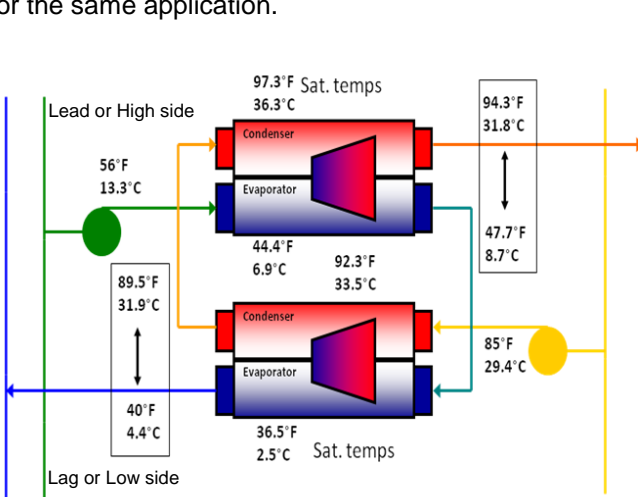


Figure 4

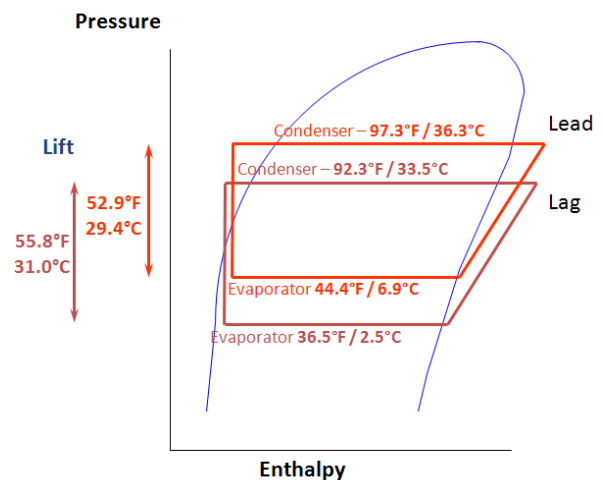


Figure 5- Installing chillers in series counterflow reduces the lift requirement for both units.

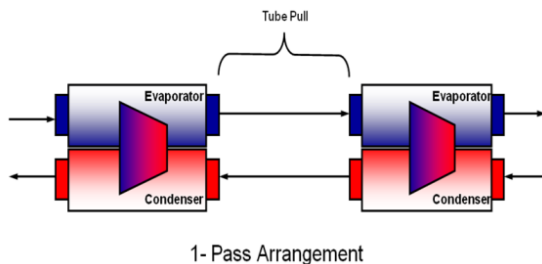
This example shows that the two chillers in parallel each had a design head of 57.5°F (31.9°C) whereas the SCF chillers had design heads of 52.9°F (29.4°C) for the high-side chiller and 55.8°F (31.0°C) for the low-side chiller. Here is a summary of the conditions and resulting energy consumption.

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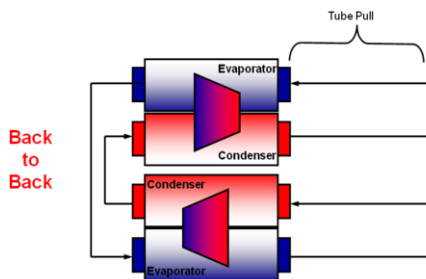
YKKVKSK1		PARALLEL	SERIES - CF
Capacity	System Tons	2000	2000
	Chiller Tons	1000 + 1000	1040 + 960
Evaporator	Passes	2	1
	GPM	1500 + 1500	3000
	Entering Temp. (°F)	56.0	56.0
	Interim Temp. (°F)	-	47.7
	Leaving Temp. (°F)	40.0	40.0
	Delta-P (ft)	12.6	13.5
Condenser	Passes	2	1
	GPM	3000 + 3000	6000
	Entering Temp. (°F)	85.0	85.0
	Interim Temp. (°F)	-	89.5
	Leaving Temp. (°F)	94.3	94.3
	Delta-P (ft)	25.6	28.4
Compressor	Input kW	1198	1144
	Full Load kW/ton	0.599	0.572
	Savings		4.5%
	NPLV kW/ton	0.492	0.472
	Savings		4.1%

Depending on the chiller selections in each configuration, the energy savings can typically be up to 10% for constant speed machines. We have also seen variable speed drives successfully employed in conjunction with SCF.

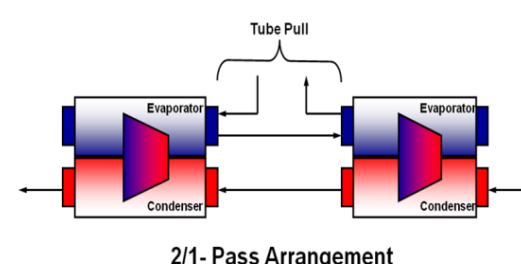
One other point for your customer to consider is the plant layout arrangement. Figure 6, 7, and 8 are a few examples of possible arrangements which are dependent on the physical floor space available, piping layouts, and maintenance clearances for tube cleaning.



1- Pass Arrangement



1- Pass Arrangement



2/1- Pass Arrangement

Figure 6

Figure 7

Figure 8

Final points for you and your customer to consider are:

1. To keep pressure drops reasonable, heat exchangers are typically selected with one pass arrangements.
2. If the chillers are kept identical, then either one can be the "lag" or "low-side" chiller.
3. Constant evaporator water flow requires a high-side reset; variable flow doesn't require a reset.

If you have a topic request for the Applications Corner found in the LTS Update Newsletter, please contact jill.h.woltkamp@jci.com.