Overview of Chilled Water Systems

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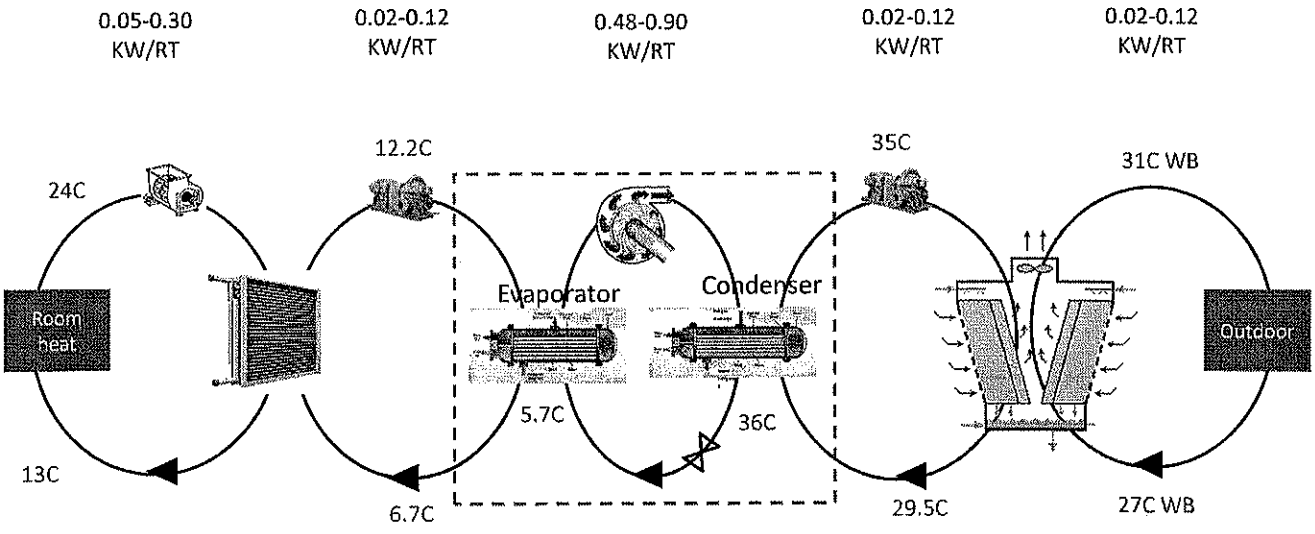
Agenda

1. Air cooled and water cooled CHW systems
2. Constant primary CHW system
3. Constant primary, variable secondary CHW system
4. Variable primary CHW system
5. Series counter flow CHW system

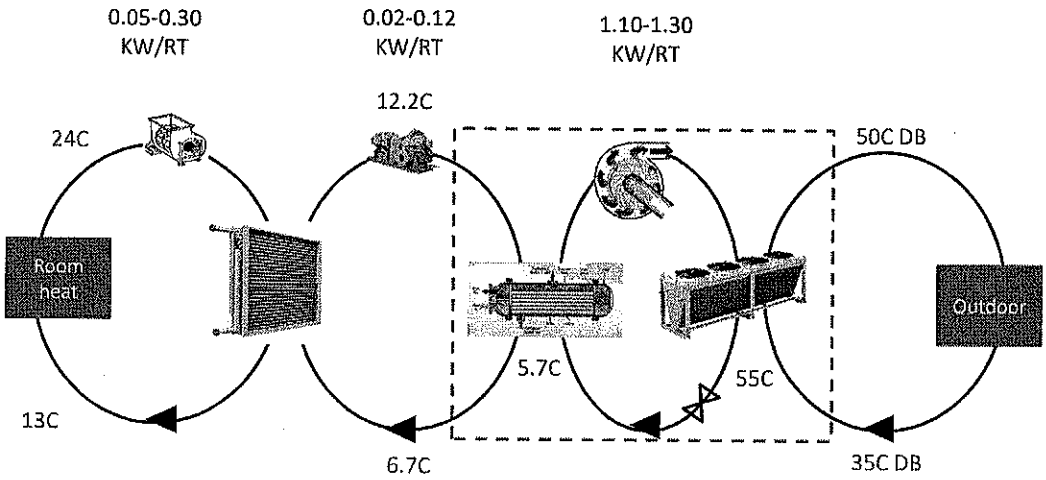
Air cooled and water cooled CHW systems

Water cooled CHW system



Airside CHW Chiller CW CT Air

Air cooled CHW system



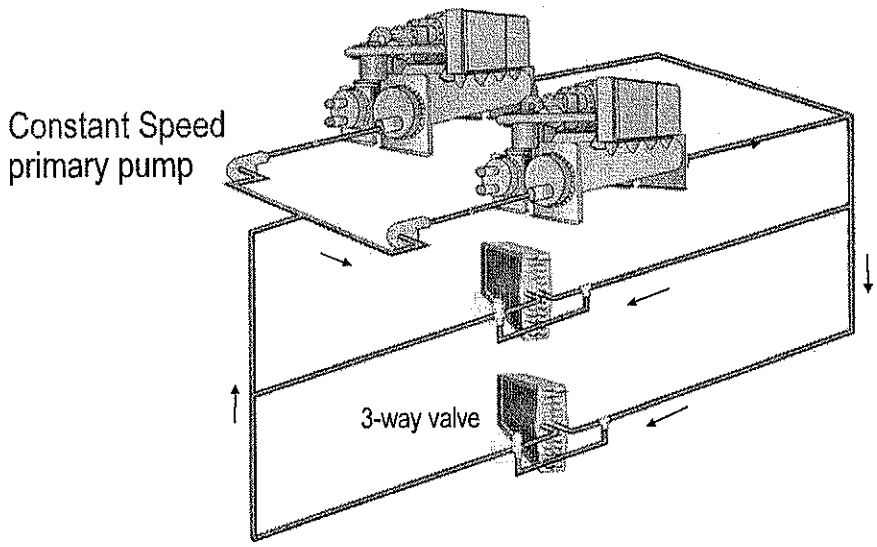
To achieve better efficiency, reduce friction.

Water cooled vs Air cooled CHW system

	Water cooled CHW system	Air cooled CHW system
Energy efficiency	High eff (0.60 to 0.75 KW/RT)	Low eff (1.10 to 1.30 KW/RT)
Space requirement	More	Less
First cost	More	Less
Maintenance cost	More	Less
Life span	Approx 15 years	Approx 10 years

Constant Primary Flow System

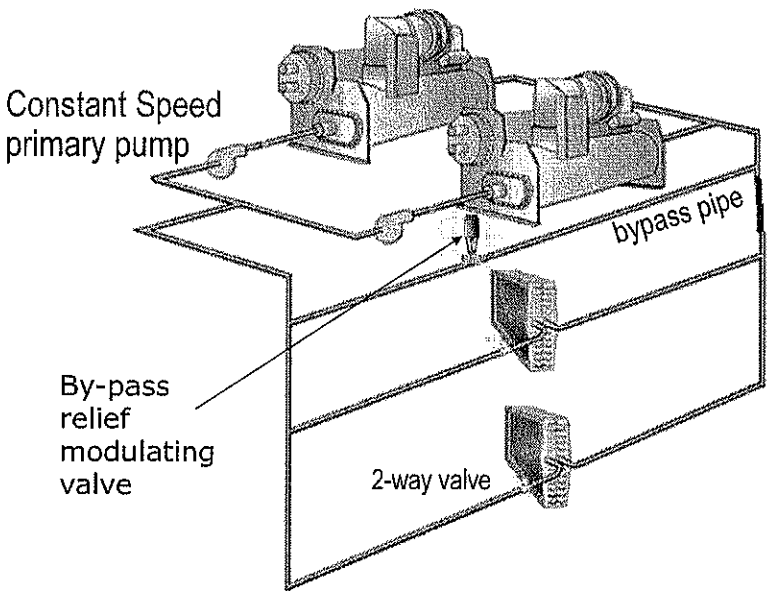
Primary constant flow system
3-way valves



Primary constant flow system
3-way valves

- This system is the typical chw design 20yrs ago. While chw plants are rarely designed this way, many such system are still in operation today.
- This system satisfy a important requirement that chiller manufacturers demand in the past. That is the chw flow through the chiller must be constant whenever it is on operation.
- The pumps are fixed speed and all of them are run whenever any chiller is in operation.
- If a room becomes too cold, the t-stat in the room will command the 3-way valve to by-pass the chw from the coil, thereby reducing its cooling capacity.
- The drawback of this system is that the pump energy is never reduced even though the system may be operating at very low load conditions.

Primary constant flow system
2-way valves



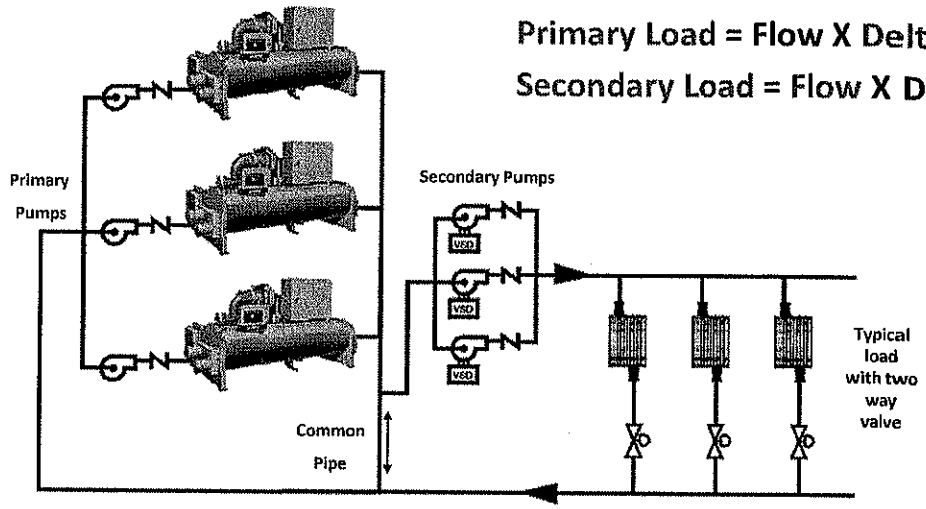
Primary constant flow system
2-way valves

- Later on, a more sophisticated chw system evolved. Note that this system still uses constant speed pumps.
- There are 2 key difference between this and the previous system.
- 1st, 2-way valves are used at the Cooling coils. If a room is too cold, the room T-sat will command the 2-wat valve to close a little to reduce the chw flow into the coil thereby reducing its cooling capacity.
- 2nd difference is the presence of a by-pass pipe and a modulating valve on it. The purpose of the by-pass pipe is to by-pass unwanted chw from the coil back to the chiller. This helps to maintain constant flow through the chiller to satisfy the chiller's constant flow requirement.

- This is system saves some valve and piping cost but does little to save any energy.

Constant Primary, Variable Secondary Flow System

Constant primary, variable secondary flow system



Primary loop flow rate = Sec loop flow rate

Constant primary, variable secondary flow system

- An even more sophisticated system evolved to save pumping energy. Designers split the chw loop into two parts. The production or primary loop where chw flow needs to be constant and the distribution loop or secondary loop where the flow can be varied to save energy. A by-pass pipe w/o any fittings on it is used to separate or de-couple the primary loop from the secondary loop.

- The key difference is that the secondary pumps have VSDs. They only pump enough chw to meet the cc demand. Any excess chw is by-passed via the by-pass pipe. This system satisfy the need for constant flow through the chillers and yet can conserve significant pumping energy at part load.

- However, it incurs additional capital costs as we need more pumps and space to locate them.

Constant primary, variable secondary flow system

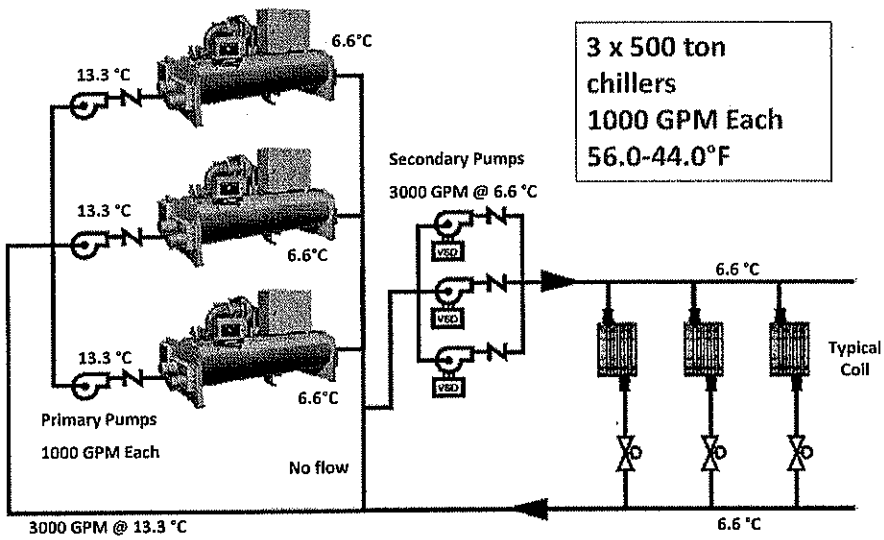
Advantages

- Easier to control (vs Variable Primary Flow (VPF) system)
- Can base load chillers (eg Heat recovery chiller or Absorption chiller)
- Can have secondary pumps of different head.

Disadvantages

- Need more space for secondary pumps
- Highest Installed Cost (Sec Pumps, Piping, electricals, etc.)
- Higher pressure losses due to more fittings (vs VPF)
- Less energy efficient because of constant primary flow (vs VPF)
- Less energy efficient because of lower Delta T (vs VPF)

Constant primary, variable secondary flow system



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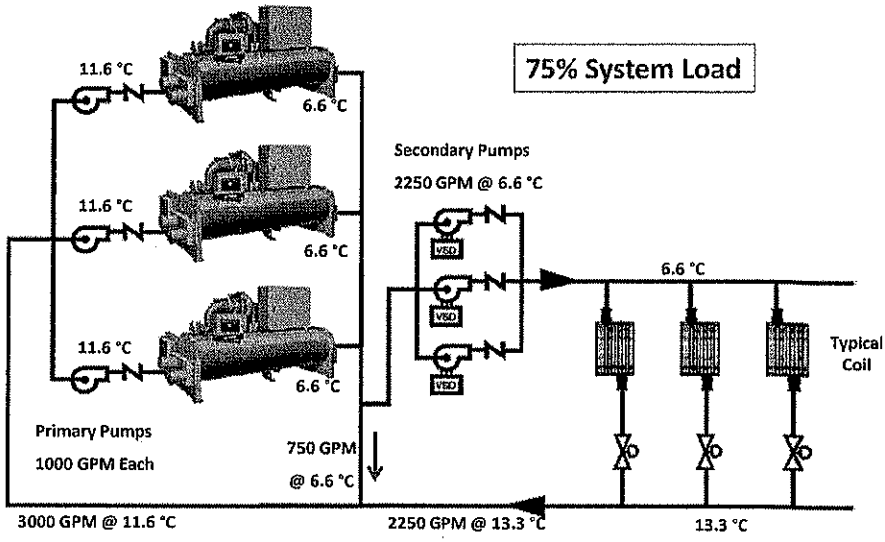

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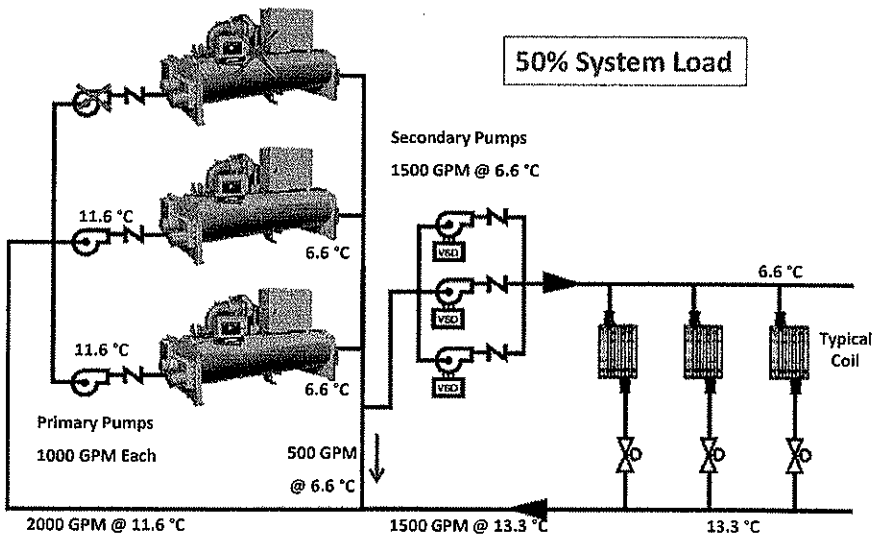

Variable Primary Flow (VPF) System

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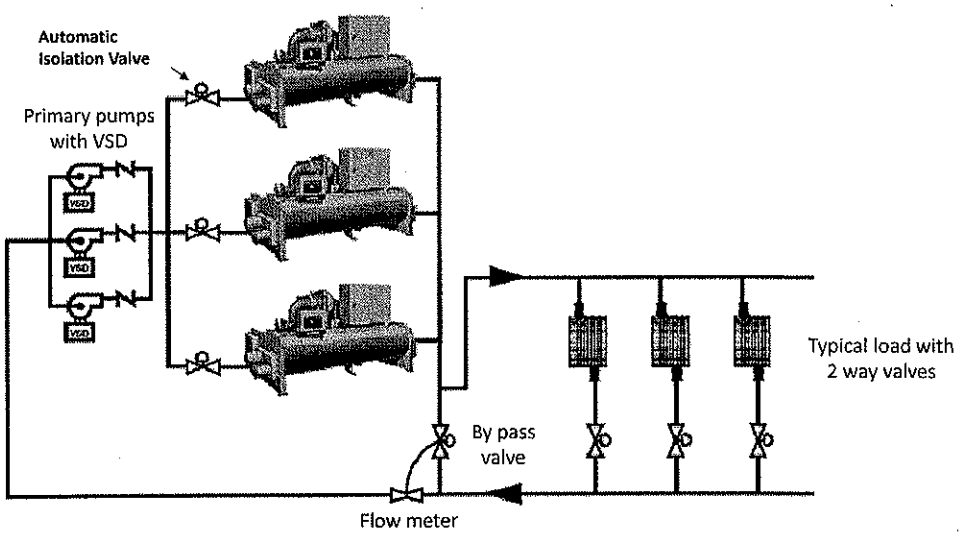


Variable Primary Flow (VPF) System

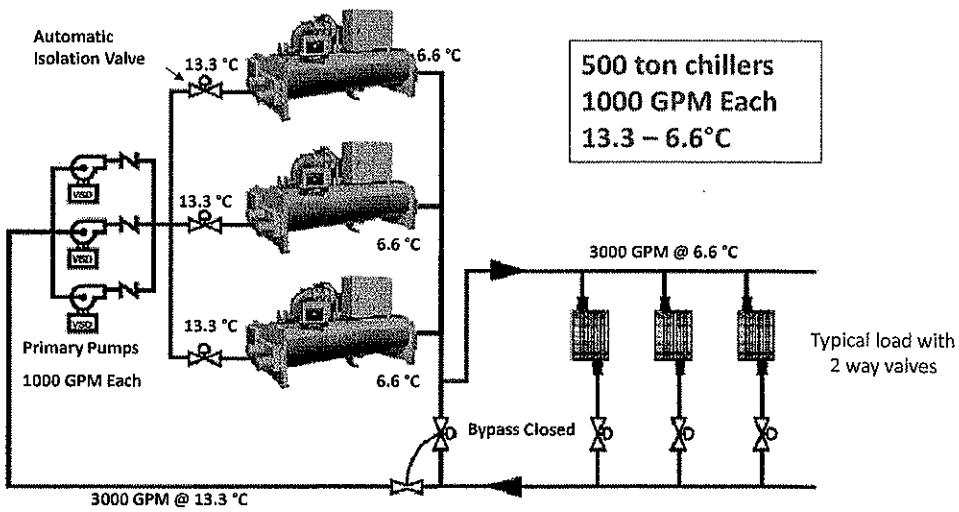
Advantages

- Lower Installed Cost (Usually by 5%)
  - No secondary Pumps or piping, valves, electrical, installation, etc.
- Less Plant Space Needed
- Better CHW Pump Energy Efficiency
  - Higher CHW DT
  - Lower Pump Design Head

Disadvantages

- Need more sophisticated controls and operators

Variable Primary Flow (VPF) System



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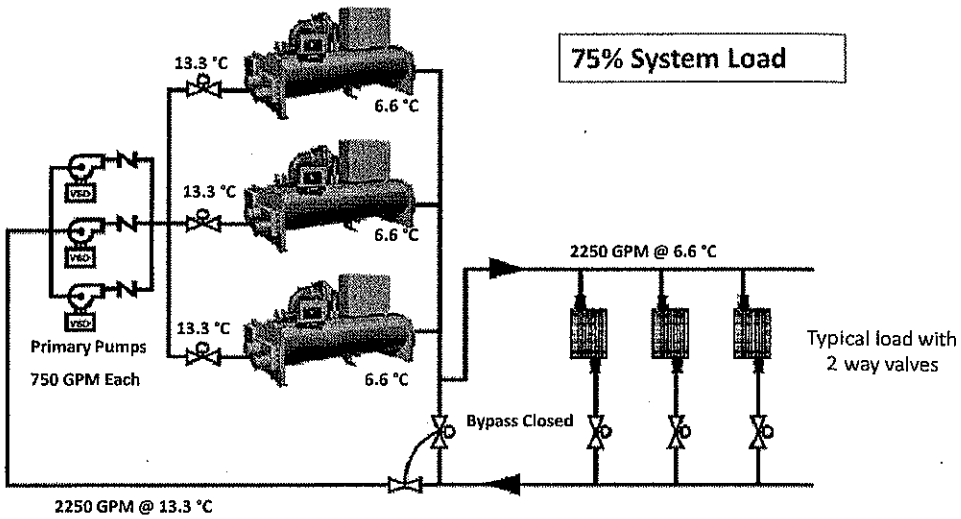

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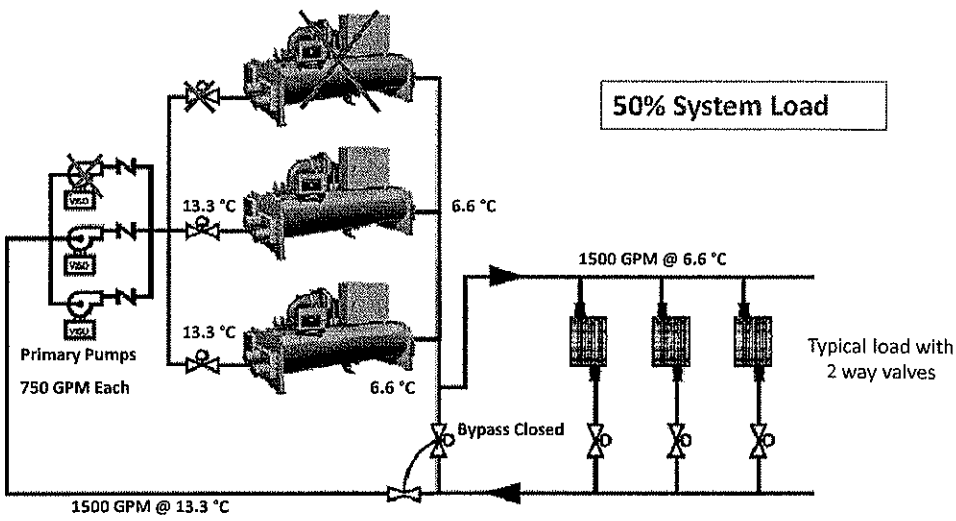

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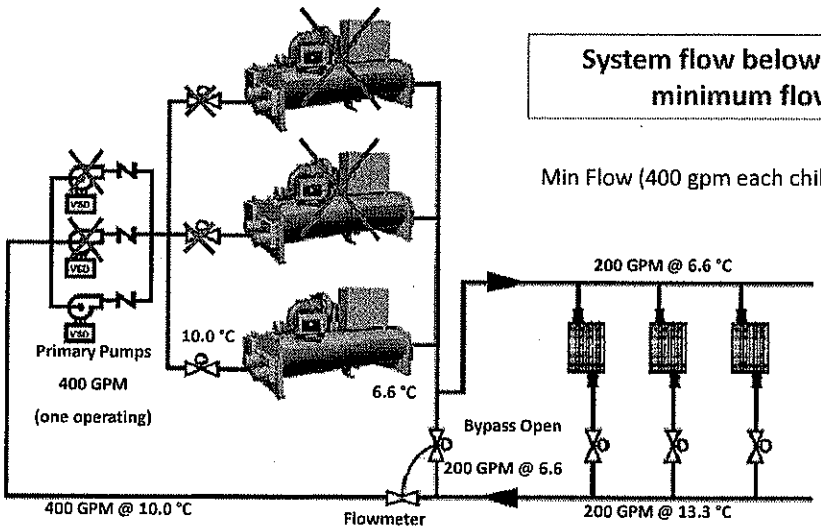
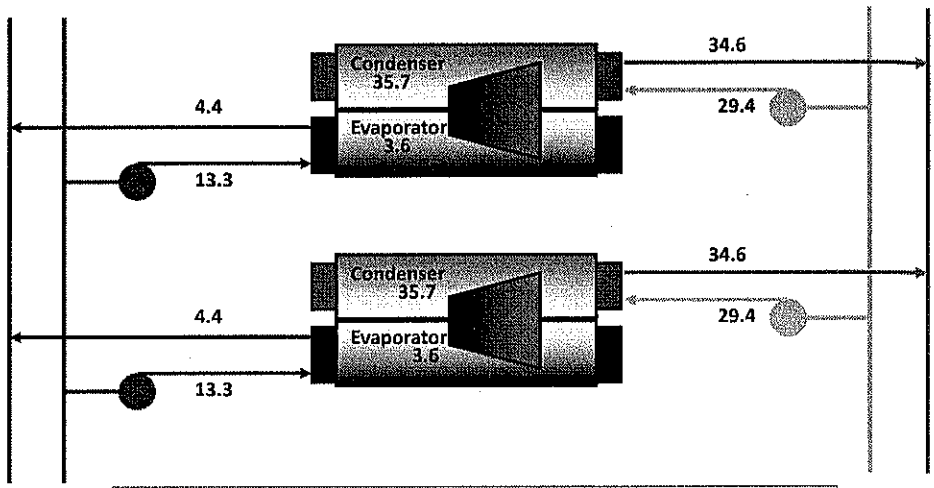


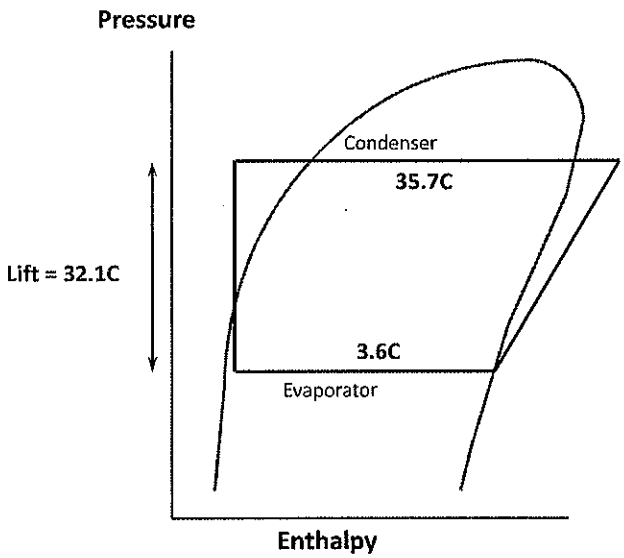
Series Counter Flow System

Series Counter Flow System



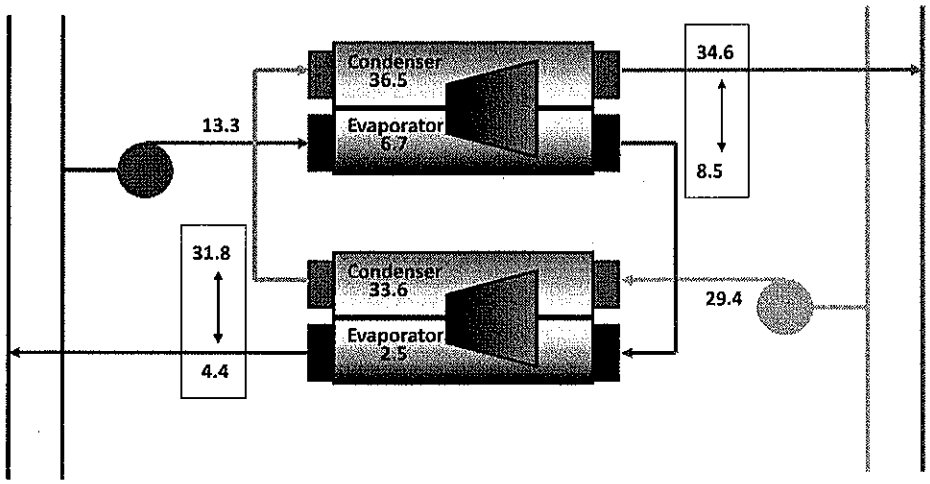
Traditional Parallel Arrangement

Series Counter Flow System



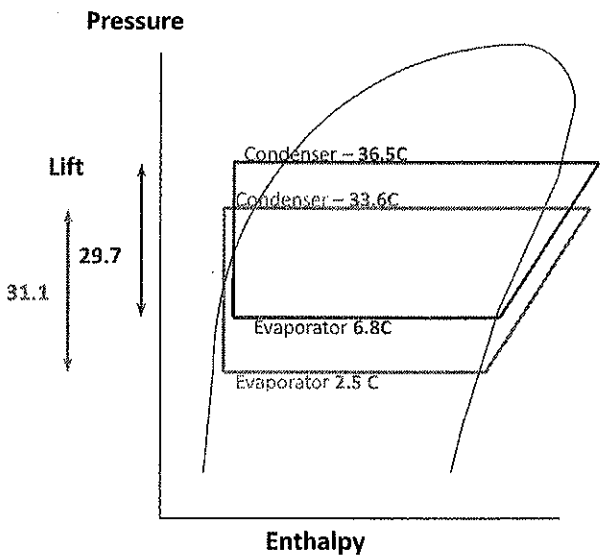
Installing chillers
in parallel
(single lift operation)
requires each unit
to produce the
total system lift

Series Counter Flow System



Series-Counter flow Arrangement

Series Counter Flow System



Installing Chillers in series-counterflow reduces the lift requirements for both units.

Series counter flow system

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Advantages

- Higher chiller efficiency due to lower compressor lift

Disadvantages

- Higher pressure drop across the series evaporators and condensers.
  - Compensate by designing higher CHW and CW DTs and variable flow
- Each capacity step is larger
  - Each capacity step is now 2 series chillers instead of 1 for parallel chillers.
  - More suited for very large loads or very constant loads.
- More complicated piping and controls

THANK YOU

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