Back to Basics:

Selection of Proper Chiller Technology

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Climate | Controls | Security

LEARNING OBJECTIVES

Learning Objectives:

1. Know the key criteria required to select the best type & size of chiller for an application.
2. Understand the Bin Method.
3. Design for Delivered System Efficiency versus Equipment Submittal Efficiency.
4. Know the advantages and disadvantages of using a centrifugal chiller over a positive displacement chiller for your application.
5. Know the types of water chillers and the capacities available in each type.
6. Know the operating conditions that are likely to cause surge in a centrifugal chiller.

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SESSION OBJECTIVES

- Which chiller applications are better suited to centrifugal compression technology?
- Which chiller applications are better suited to screw compression technology?
- Application considerations
  - Surge
  - Lift
  - Noise
  - Energy
    - Ideal fan laws
    - How chillers react to changing operating conditions
    - Common causes for over estimating savings
    - How chilled water plant design impacts chiller efficiency

A CASE FOR CENTRIFUGALS

Big … Efficient … Complex

Large systems, steady conditions, linear profiles, often comfort cooling.

High leaving chilled water temperatures

Periods of reduced lift *versus design* offer variable speed savings.

A CASE FOR SCREWS

Flexible, Robust, Simple … and Efficient

Medium sized systems, steady or unsteady conditions, linear or non-linear profiles, comfort cooling as well as heating, brine, ice.

Dual Duty conditions

Periods of reduced load at any lift offer variable speed savings.

ENERGY CONSUMPTION

Centrifugals

- Governed by Ideal Fan Laws
  - Capacity ~ rpm
  - Lift ~ rpm^2
  - Power ~ rpm^3

Speed	Capacity	Lift	Power
100%	100%	Design	100%*
90%	90%	6-8 F Less	73%
80%	80%	12-16F Less	51%
70%	70%	18-24F Less	34%
65%	65%	24-32F Less	27%

Screws

- Positive Displacement … speed ~ capacity
- Variable speed screws deliver similar performance at AHRI conditions.
- Speed reduction not limited to lift reduction.
  - Simpler system
  - Opportunity for further energy savings at non-AHRI conditions

CHANGE IN OPERATING CONDITIONS

Centrifugals

- Rpm is the weathervane for efficiency.
- Operating above design lift may have exponential penalty

	Lift Rises	Lift Falls
Load Rises	Speed ↑	Speed ↑
Load Falls	Speed ↑	Speed ↓

Power ~ rpm^3

Screws

- Positive Displacement … speed ~ capacity
- Lift impacts power consumed at the speed dictated by capacity.

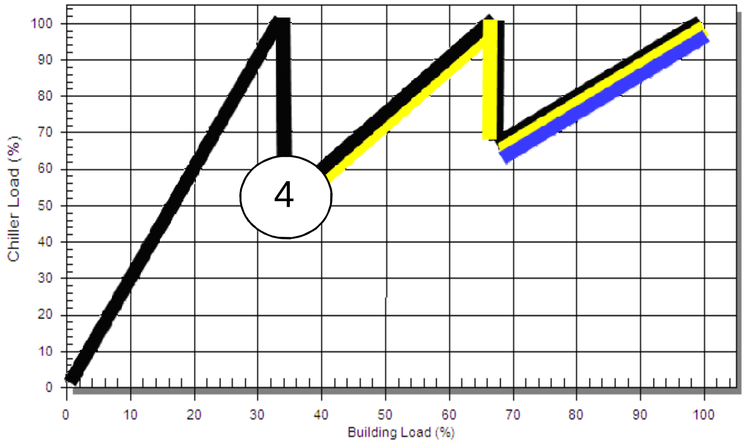
	Lift Rises	Lift Falls
Load Rises	Speed ↑	Speed ↑
Load Falls	Speed ↓	Speed ↓

IMPACT OF SYSTEM DESIGN

Chiller Staging

- 4 Steps to Optimize Chiller staging:

✓ Compare efficiency at the same temperatures.
✓ Compare the AHRI tolerance at the load points
✓ Compare the pump power consumption
✓ Consider the minimum evaporator flow rate



System Calculation	
(1) Chiller at 100% load, 65 F Condenser Water, no AHRI tolerance	0.338 x 1.05% = 0.355
(2) Chillers at 50% load, 65 F Condenser Water, no AHRI tolerance	0.295 x 1.10% = 0.325
Capacity (tons)	300
Chiller Savings	9 kW
Condenser pump power (750 gpm x 30 ft wg)	6.8 kW
Evaporator pump power (600 gpm x 20 ft wg)*	3.6 kW
Extra pump power	10.4 kW
Net Savings (per hour)	-1.4 kW

* Constant flow application, use minimum flow rate calculation for variable flow systems.

Incorrect Component Calculation	
(1) Chiller at “full load”*	0.575
(2) Chillers at 50% load*	0.295
Delta	0.280
Capacity (tons)	300
Savings (per hour)	84 kW

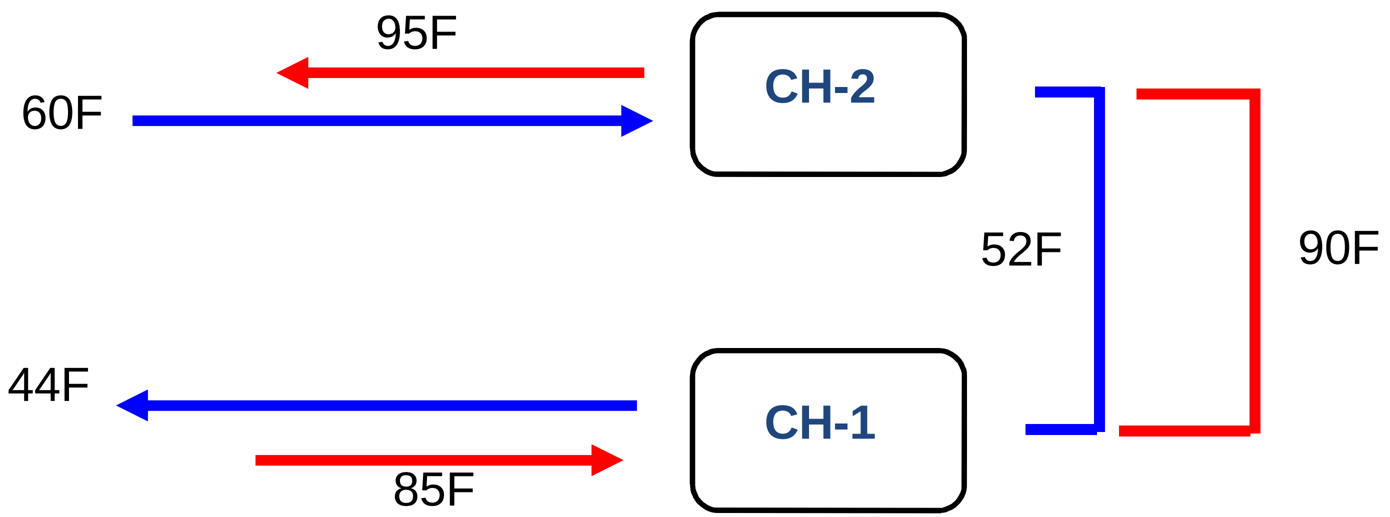
*Submittal data at 100% and 50% load is often based on two different condenser water temperatures leading to unintended calculation error.

IMPACT OF SYSTEM DESIGN

Series Counter Flow

Efficiency, Lift and sound based on *Leaving* water temperatures:

Upstream:	**51F / 95F**	**(44F Lift)**
Downstream:	**44F / 90F**	**(46F Lift)**
Parallel Plant:	**44F / 95F**	**(51F Lift)**



SUMMARY

Application Variables To Consider

- How well correlated is condenser water temperature to chiller load?
  - Convention Center versus Office Building
- How stable is the hydronic system
  - Process load versus Comfort Cooling
- What is the best way to design and stage the chilled water plant?
  - Are the controls, staff willing and capable?

Can you afford not to do a proper energy analysis?

Questions

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