Solving Problems and Saving Energy in Chilled Water Systems

Important considerations for owners and consulting engineers

Minnesota Health Care Engineers Association 2024 Fall Conference

- Overflowing coils is responsible for low chilled water temperature differential *(Low Delta T)*
  - ✓ Inadequate control valves
  - ✓ Inaccurate instrumentation
  - ✓ Chilled water coil inlet and outlets reversed
- Chiller system inefficiencies and reduced capacity *(Due to Low Delta T)*
- Frozen cooling coils
- Lack of redundancy in supply and return fans
- Cooling tower basin sediment buildup
- Excessive fouling of chiller condenser water tubes
- Control of Legionella
- Corrosion of chilled water piping due to sediment, water quality, and microbial activity

Times have changed…. Global Warming, etc.

Older systems were designed for low risk using proven simple designs. (Don't blame designers)

Today systems are more complicated and require more extensive and precision high performance engineering design.

High performance design does not mean higher first cost!!!

The majority of the time high performance <u>reduces</u> first cost by reducing the amount and the amount and/or size of equipment by precision engineering design.

High performance design reduces risk because system operation is greatly improved.

Typical Conditions

8 Row Coil

Face Velocity

Entering Water

Entering Air

Leaving Air

Air Pressure Drop

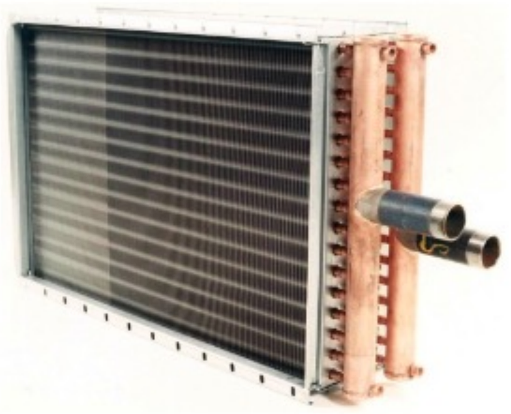
Water Pressure Drop

Fouling Factor

30 Δ°F Chilled Water

Coil performance validated every four years by AHRI

Model Number	DW0B55104G0FB140HABA0AB*******
System type	Chilled Water W
Rows	8
Tube matl/wall thickness	.020 (0.508 mm) copper
Nominal fin spacing	140 fins per foot
Fin material	Aluminum
Fin type	Prima-flo H (Hi efficient) .01"
Actual coil face area	40.08
Nominal coil height	55" (1397 mm)
Finned length	104" (2642 mm)
Casing option	Galvanized
Turbulators	Yes
Rigging weight	1385.1 lb
Installed weight	1743.4 lb
Tube matl/wall thickness	.020 (0.508 mm) copper



Capacity	
Total capacity	761.20 MBh
Sensible Capacity	545.85 MBh
Air	
Elevation	700.00 ft
Actual airflow	20000 cfm
Entering dry bulb	80.00 F
Entering wet bulb	67.00 F
Leaving dry bulb	54.70 F
Leaving wet bulb	54.60 F
APD	1.032 in H2O
Face velocity	499 ft/min

Fluid	
Standard fluid flow rate	50.46 gpm
Entering fluid temp	40.00 F
Leaving water temperature	70.09 F
Fluid PD	6.38 ft H2O
Fluid velocity	1.51 ft/sec
Fluid type	Water
Fouling factor	0.00050 hr-sq ft-deg F/Btu
Volume	42.88 gal
Reynolds number	5942.92 Each
AHRI 410 Classification	
AHRI 410 classification	NOT certified by AHRI
Data generation date	8/31/2021
Trane Select Assist update number	2500

Coil and Control Valve Selection for Proper Chiller System Loading

- Coils have been historically selected for much high chilled water flows than needed. Coils should be selected for lowest flow with acceptable (low) air and water pressure drops and ≈30 Δ°F.
- Coils typically operate at two to three times the required flow because of control valve and other instrumentation limitations..
- Metering control valves are required for precision control in chilled water coils. Standard pressure dependent or valve/flowmeter control methods cannot control flow within the tolerance required wasting energy and increasing the potential for coil freezing.
- Chillers can be fully loaded and chilled system can be operated at optimal efficiency chilled water coil flow is precisely controlled

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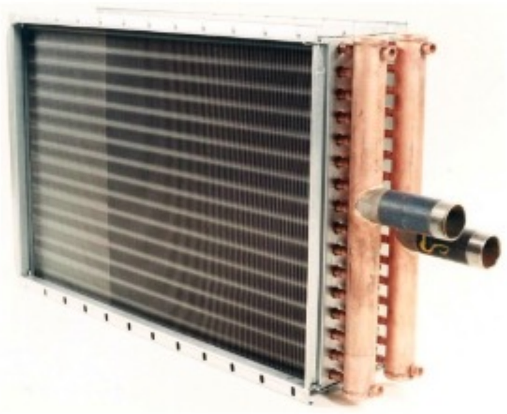

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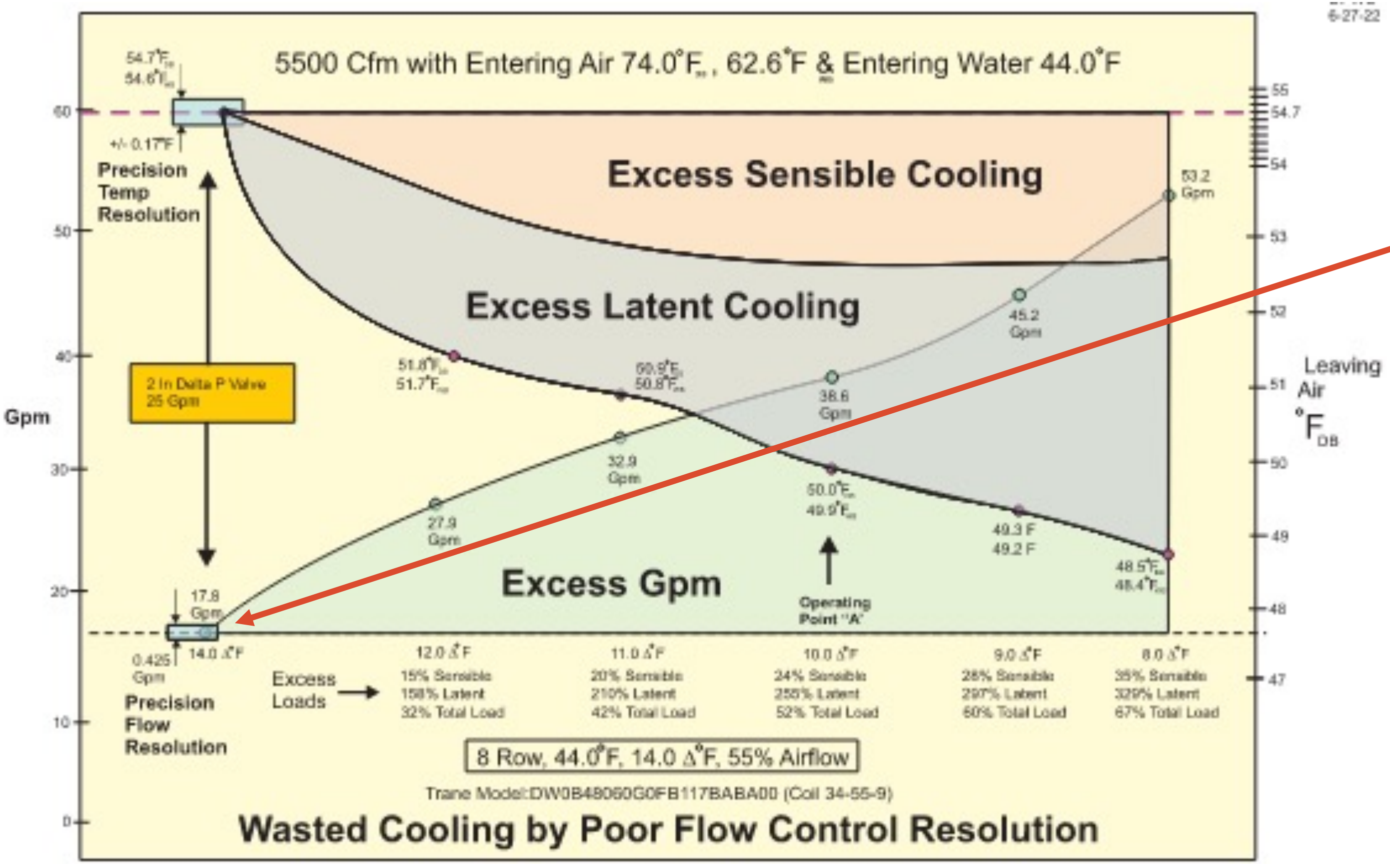

Precision metering valve *with 0.425 gpm resolution will provide exacting control of coil leaving air temperature and maintain maximum possible Delta T*

W Coil, Water
8 Row; 117 Al Fins/Ft
10,000 Ft^3/Min, 500 Ft/Min
Water: 44.0˚F/58.0˚F
Water: 53.96 Gpm
Water: 0.0005 Hr-Ft^2-˚F/Btu
Water: 2.46 Δ Ft-Wc
Air: 0.725 Δ In-Wc
Enter: 80.0˚F_{DB}, 67.0˚F_{WB}
Leave: 54.7˚F_{DB}, 54.6˚F_{WB}
1000 Ft Elevation
0.020 In Copper Tube

Coil Leaving Air Dehumidification and Sensible Cooling Control

- During dehumidification the leaving air should be controlled at a dewpoint that maintains the space relative humidity setpoint.
- During sensible cooling operation (chiller on) the leaving air should be controlled at a drybulb temperature setpoint that minimizes energy consumption of the supply fan, reheat coil, and chiller system subject a lower limit imposed by duct insulation and other factors. In general, lowering the temperature setpoint to around 50 °F would be appropriate.
- Proper operation of leaving air temperature control requires that humidity and temperature instrumentation are calibrated and have the required accuracy and precision. Deficiencies in instrumentation are major factors in overflowing coils.
- High performance design determines the accuracy and precision of the temperature and humidity transducers and to know their calibration requirements.
- It is necessary to provide temperature and pressure test ports at coil inlet and outlet for calibration and testing.
- Sidestream chilled water filtration with monitor coupon racks are required for proper maintenance

Fan walls are applicable for new and retrofit air handling units eliminating single source failure.

Inlet

Discharge

Bypassed Chilled Water Piping & Reversed Coil Connections

- It is not uncommon for chilled water coil supply and return piping to be reversed, which increases the chilled water flow and prevents proper cooling at higher cooling loads.
- Sometimes the chilled water supply and return pipes are cross connected due to field errors and is not caught during startup or commissioning.

Inefficiencies & Load Shortfalls of Low Chilled Water Delta T

- Chilled water supply temperature is lowered to meet loads
- Additional chillers, chilled water pumps, condenser pumps, and cooling tower fans are operated to meet loads
- Primary/Secondary Chiller plants are unable to deliver rated cooling capacity
- Conversion of primary/secondary to variable flow primary with precision metering control valves during plant expansions will allow chilled water plants to fully load chillers

Common Problems and Solutions

- Sediment buildup in cooling towers fouls heat transfer surfaces, reduces equipment life, fuels microbial growth, and requires excessive chemical treatment.
- Basin sweeper jets and “pod” type automatic backwashing filtration of 10-15% of cooling tower flow will control sediment in cooling towers.
- Water treatment with precision, calibrated instrumentation is critically important to limit fouling of chiller condenser tubes, control legionella, and protect cooling tower and piping.
- Condenser approach temperatures (refrigerant/entering condenser water) should be recorded and condenser tubes cleaned and eddy current testing as needed..

Problem

- The 100 Ton air cooled chiller dedicated to a surgery rooftop unit was failing
- Existing water cooled 500 ton and 200 ton air cooled chillers were unable to deliver their rated capacity due to low chilled water Delta T (6 °F, Design 14 °F).
- Surgery cooling was dependent on a single chiller—No redundancy

Solution

- The 100 Ton air cooled chiller was demoed
- Precision metering control valves were installed on all chilled water coils
- Precision RTD temperature transducers and temperature/pressure ports installed on all chilled water coils
- **Result:** 250 tons of additional capacity was reclaimed from 500 ton and 200 ton air cooled chillers with chilled water Delta T increasing close to design (13 °F). Chiller system had needed redundancy.

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