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REFRIGERATION SYSTEM VIRTUAL IN-PLANT TRAINING

SESSION 4 – NOV 5, 2020

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Have you been able to implement energy saving projects?

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Session 4: Condensers Continued

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Today's Agenda – Session 4

- Condenser check sheet review
- Condensers capacity control

- Condenser/compressor energy balance
- Condensers tool introduction
- **Q & A**

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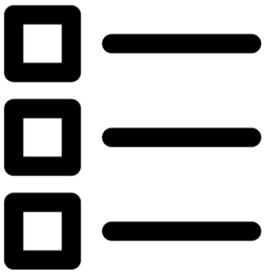
Review Condenser Check Sheets



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Condenser Efficiency Opportunity Flow

1. **Condenser Maintenance**—Ensure condensers are operating at peak performance to reduce condenser approach.
2. ***Condenser Capacity Control—Ensure condensers are operating efficiently at part-load conditions.***
3. **Condenser/Compressor Energy Balance**—Ensure condensing pressure settings are set to minimize total compressor and condenser power.

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Calibration—Do Controls Tell the Truth?

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Resolve Ambient Temp/ Humidity Measurement Issues

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Don't Place Instruments Here!

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Outside Temperature Important for Pump Control

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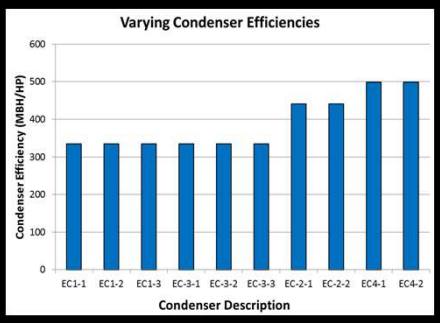
Condenser Staging



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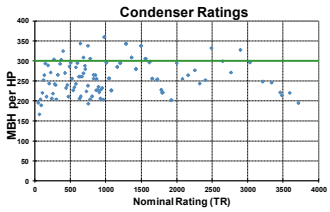
Condenser Selection

- Select efficient condensers, high MBH per hp.
- Use more surface area and less air flow (hp) to reject heat.
- Have bigger tube bundles, heavier, and more expensive.



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VFD Application

Constant Torque (Compressors)

vs.

Variable Torque (Pumps and Fans)

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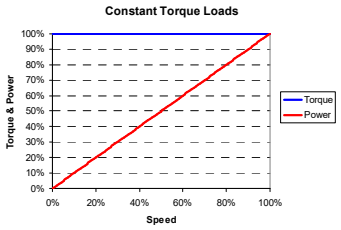
VFD: Constant Torque Loads

Compressors

- Capacity ~ speed, power ~ speed
- Example at 50% speed: capacity and power are about 50%



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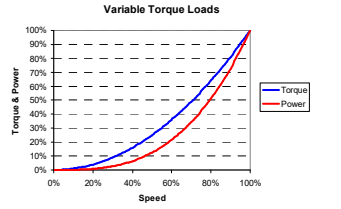
VFD: Variable Torque Loads

Fans

- Follow "affinity" or "cubic" law
- Capacity ~ speed, power ~ speed^3
- Example at 50% speed: capacity is 50%, power is 12.5%



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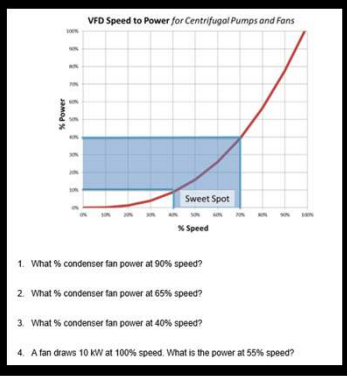
Condenser Fan VFDs



1. What % condenser fan power at 90% speed?
2. What % condenser fan power at 65% speed?
3. What % condenser fan power at 40% speed?
4. A fan draws 10 kW at 100% speed. What is the power at 55% speed?

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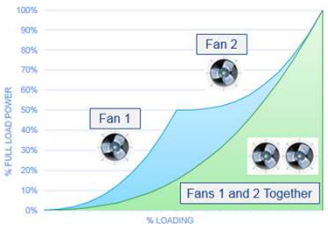
IMPORTANCE OF GROUPED FAN CONTROL

Operate a group of condensers wet, with the fans running in the highly efficient mid-range speeds. This means operating multiple VFD-driven condensers at the same speed.



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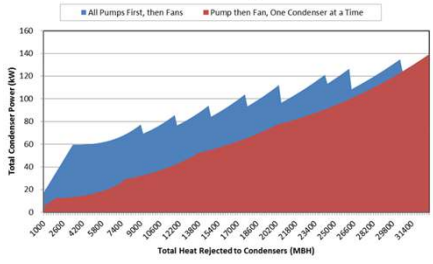
THE IMPORTANCE OF PUMP-FAN-PUMP-FAN CONDENSER SEQUENCING

Avoid operating a condenser "wet" without running the fans, because condenser efficiency in this state is poor. Condenser inefficiency can be magnified when operating multiple, large remote sump pumps without running fans. The chart below shows total condenser power for two different condenser control strategies.

Comparison of Condenser Power for Different Control Strategies



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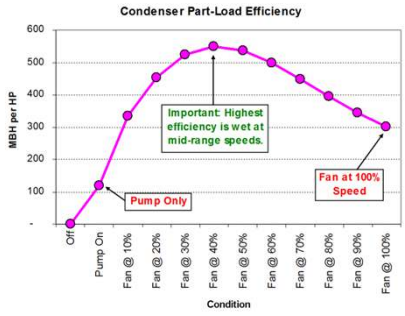
CONDENSER EFFICIENCY

The following chart shows condenser efficiency over the entire range of possible operation. Note that condenser efficiency peaks when the condenser is operating wet, with fans at mid-range speeds.



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Condenser Capacity

What % condenser capacity results from running **pumps only**—no fans?

About 10%

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Condenser Sump and Pump Location

Pump Location:

- Integral sumps (in condenser): Pump power is about 15%-20% of total condenser pump and fan power.
- Remote sumps (in compressor room): Pump power can be 35%-50% of total condenser power! *But still only give 10% capacity*

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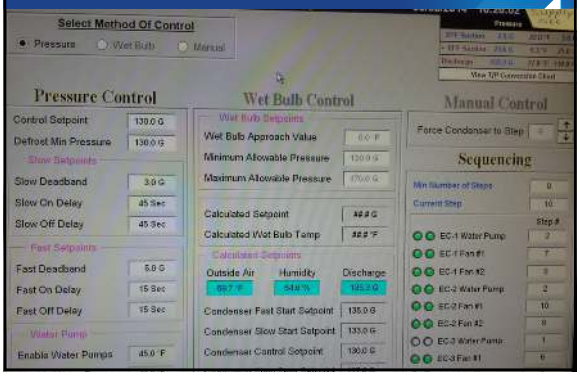
Find and Fix



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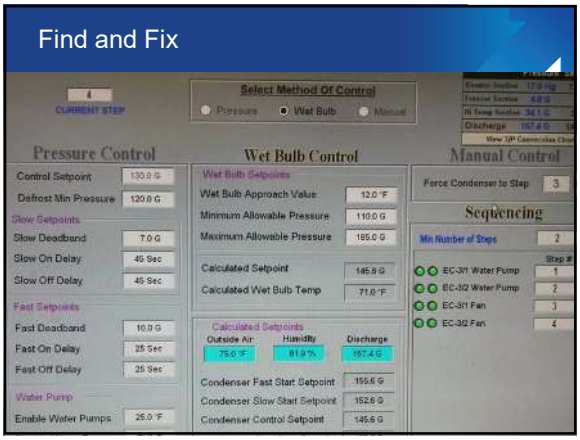
Find and Fix



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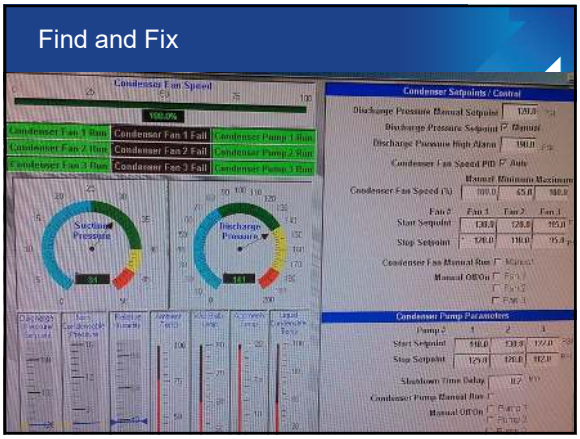
Find and Fix



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Condenser Efficiency Opportunity Flow

1. **Condenser Maintenance**—Ensure condensers are operating at peak performance to reduce condenser approach
2. **Condenser Capacity Control—**Ensure condensers are operating efficiently at part load conditions
3. ***Condenser/Compressor Energy Balance—Ensure condensing pressure settings minimize total compressor and condenser power***

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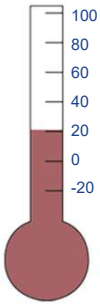
Condensing Approach to Wet Bulb

60°F Head



45°F WB

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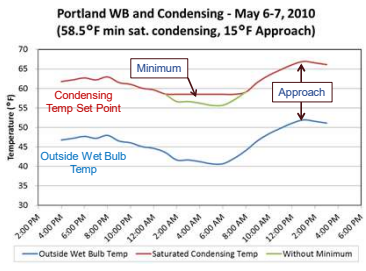
What is Wet Bulb Approach?



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Wet Bulb Approach

Why use wet bulb approach (WBA) controls?

- The goal is to reduce total compressor and condenser power.
- Fixed setpoint controls use too much condenser power at times, and not enough at other times.
- WBA control keeps condenser power in line with compressor power.
- WBA reduces condenser power during periods of reduced load.

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Wet Bulb Approach

Wet bulb approach settings:

- WBA control has the biggest benefit with VFD fans
- A common approach set point is 12°F, but varies from system to system

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Example—Wet Bulb Approach

Given: 50°F wet bulb temperature, 12°F WBA setting

Find: Condensing set point in psig

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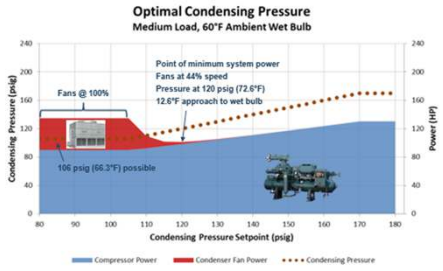
COMPRESSOR/CONDENSER ENERGY BALANCE

The following graph shows the importance of finding the condensing pressure setpoint that will best balance compressor and condenser power.



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Condenser Selection—Closer Approach to WB

- Old school = selecting condensers based on condensing 25°F above design wet bulb. I.E. 100°F (197 psig) condensing at 75°F wet bulb.
- New school = 15°F above design wet bulb. I.E. 90°F (166 psig) condensing at 75°F wet bulb.

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Survey

- How is DOE INPLT going for you so far?
- Kim will post a link to the survey in the chat window.
- Please hit the survey, then take a LOOONG break.

https://bit.ly/3oVDjxC

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BREAK

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Review—Top Condenser Action Items

- Optimize condensing pressure
- Optimize water delivery (pumps and nozzles)
- Run the most efficient condenser first
- Check part-load performance
- Revisit water treatment
- Remove non-condensables/troubleshoot purger
- Resolve ambient temp/humidity measurement issues
- Optimize operation for cold weather
- Adjust fan belt tension properly
- Correct piping issues

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Next Steps

- Continue developing your list of energy saving opportunities!

- Talk with your team about what to focus on first.
  - Any top priorities? What can you get done now?

Stick around after this to ask questions for Steve and our team!

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Open for Questions!

- Unmute yourself and ask away
- Send a chat
- Email: steve.koski@cascadeenergy.com

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