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REFRIGERATION SYSTEM VIRTUAL IN-PLANT TRAINING

SESSION 3 – NOV 3, 2020

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2 Truths and a Lie

Take the Poll

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Session 3: Condensers

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Today's Agenda – Session 3

- Compressor review
- Compressor group quiz

- Condensers basics
- Condenser energy saving opportunities
- Condensers check sheet

- **Opportunity Development:** Agropur, Campbells, Flower Foods, General Mills, Sugar Creek
- **Q & A:** Tyson

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What Drives Compressor Power?

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Reduce Lift = Reduce Compressor Work

- **Raise Suction:** More Capacity (TR)
- **Lower Discharge:** Less Power (BHP)

Compressor Work = BHP/TR

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Rules of Thumb

2% compressor savings per °F of increase in **suction** temperature

1.5% compressor savings per °F of decrease in **condensing** temperature

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What's the Ideal?

- Minimal Lift: (Maximum Suction, Minimal Discharge)
- Slide Valve Properly Functioning
- Minimal Inefficient Unloading
- Correct Volume Ratio
- Controls Telling the Truth

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1. What compressor settings, adjustments, or calibrations could save energy?
2. What is the approximate percent power a screw compressor uses when fully unloaded on slide valve?
3. Find the suction pressure (psig) an evaporator sized with a 12°F temperature difference (TD) is rated for, given a freezer temperature of -10°F.
4. Use the Excel Efficiency Tool to find the optimal Vi for 8 psig suction and 110 psig discharge.
5. Explain what compressor "Vi" represents.
6. Ideally, how many VFD-driven compressors do we need per suction?
7. Explain what is meant by "compressor lift" and what is has to do with energy efficiency?

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Head Pressure and Condensers

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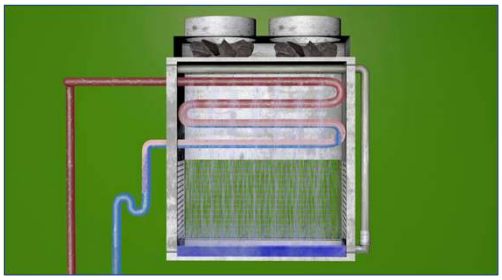
Induced Draft Condenser Cut Away



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Evaporative Condensers

Why use evaporative condensers?

- Evaporative condensers drive towards wet bulb temperature
- Wet bulb temperature is lower (or occasionally the same) than dry bulb
- Lower lift = lower compressor power

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Pros and Cons of Condenser Types

Basic condenser styles:

- Forced draft axial
- Forced draft centrifugal
- Induced draft axial
- Hybrid
- Water saving

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Identify the Condenser Type

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Identify the Condenser Type

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Identify the Condenser Type

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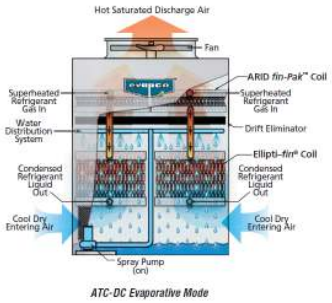
Identify the Condenser Type



ATC-DC Evaporative Mode

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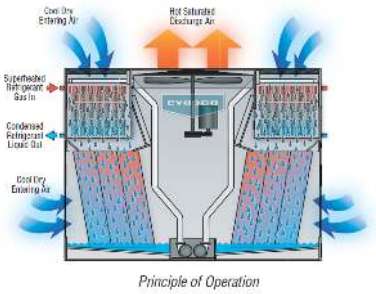
Identify the Condenser Type



Principle of Operation

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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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Assess Condenser Approach

- How close does saturated condensing temperature get to the ambient wet bulb?
- More than 15-20 °F?
- Might be some capacity issues

Hot Weather, high load Test

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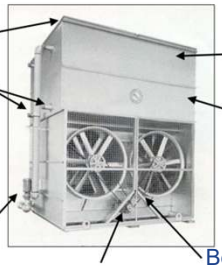
Condenser Components



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Condenser Maintenance

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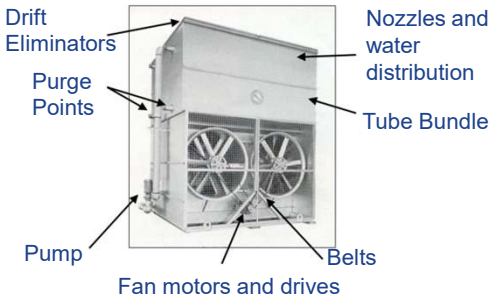
Problems Affecting Energy



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Ideal Peak Condenser Performance

- Appropriate Water Spray Distribution
- Clean Tubes
- Full Air Flow
- No Non-Condensables

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Optimize Water Delivery—Pumps and Nozzles

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What do Your Nozzles Look Like?

Older design 180° nozzle

Newer “clog free” nozzles

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Plugged Nozzles

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Pumping System Issues



Link to DOE pumping system sourcebook:

https://energy.gov/sites/prod/files/2014/05/f16/pump.pdf

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Throttled Pumps

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Restricted Water Flow



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Plenty of Pressure Here!

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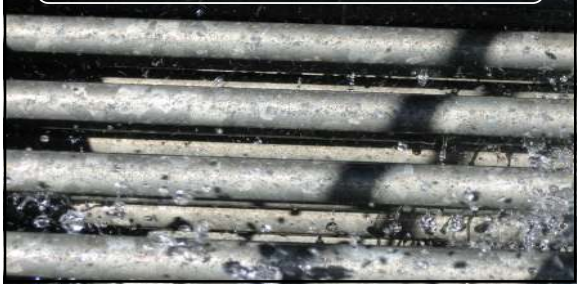
Revisit Water Treatment

Water treatment is often difficult, frustrating, misunderstood, ignored, or perceived as expensive!



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Water Treatment Issues

Scale

Microbial

Corrosion

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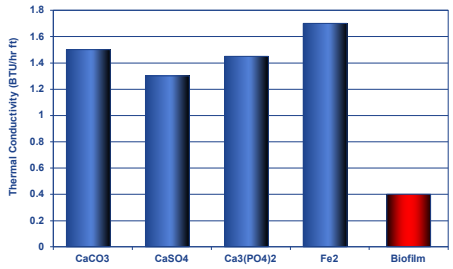
Relative Impact of Deposits on Heat Transfer



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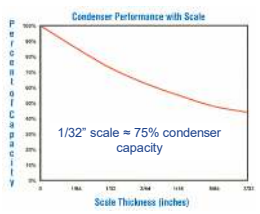
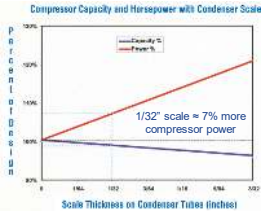
Impact on Performance





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Water Treatment Terms

- Make Up
- Blow Down ("Bleed")
- Cycles of Concentration

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Water Flow

You get what you *inspect*—not what you *expect*!



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Water Treatment – What Can You Do?

1. Regularly inspect condensers.
   - Ensure internal checks are being completed even if water treatment is addressed by 3rd party.
   - Don't let it get away from you.
2. Address issues with water treatment service provider.
3. Keep on it!
   - Condenser replacement projects are expensive.
   - Poorly performing condensers are expensive.

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Remove Non-Condensables/Troubleshoot Purger

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Checking for Non-Condensables

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Purgers—What Can Go Wrong?

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Loose Belt

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Clogged Drift Eliminators

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What is performing well?
What could use improvement?

Take the Polls

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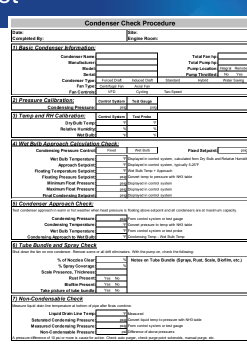
Condenser Check Sheet

Fill this out for all condensers at your site.

Email to Steve for review on Thursday, Nov 5th.



Condenser Check Procedure

Date:
Completed By:
Site:
Engine Room:

1) Basic Condenser Information:

Condenser Name:
Manufacturer:
Model:
Serial:
Condenser Type: Forced Draft / Induced Draft / Standard / Hybrid / Water Saving
Fan Type: Centrifugal Fan / Axial Fan
Fan Controls: VFD / Cycling / Two Speed
Total Fan hp:
Total Pump hp:
Pump Location: Integral / Remote
Pump Throttled: No / Yes

2) Pressure Calibration:

	Control System	Test Gauge
Condensing Pressure:	psig	psig

3) Temp and RH Calibration:

	Control System	Test Probe
Dry Bulb Temp:	°F	°F
Relative Humidity:	%	%
Wet Bulb:	°F	°F

4) Wet Bulb Approach Calculation Check:

Condensing Pressure Control: Fixed / Wet Bulb
Fixed Setpoint: psig

Wet Bulb Temperature:	°F	Displayed in control system, calculated from Dry Bulb and Relative Humidity
Approach Setpoint:	°F	Displayed in control system, typically 5-25°F
Floating Temperature Setpoint:	°F	Wet Bulb Temp + Approach
Floating Pressure Setpoint:	psig	Convert temp to pressure with NH3 table
Minimum Float Pressure:	psig	Displayed in control system
Maximum Float Pressure:	psig	Displayed in control system
Final Condensing Setpoint:	psig	Displayed in control system

5) Condenser Approach Check:

Test condenser approach in warm or hot weather when head pressure is floating above setpoint and all condensers are at maximum capacity.

Condensing Pressure:	psig	From control system or test gauge
Condensing Temperature:	°F	Convert pressure to temp with NH3 table
Wet Bulb Temperature:	°F	From control system or test probe
Condensing Approach to Wet Bulb:	°F	Condensing Temp - Wet Bulb Temp

6) Tube Bundle and Spray Check

Shut down the fan on one condenser. Remove some or all drift eliminators. With the pump on, check the following:

% of Nozzles Clear:	%
% Spray Coverage:	%
Scale Presence, Thickness:	
Rust Present:	Yes No
Biofilm Present:	Yes No
Take picture of tube bundle:	Yes No

Notes on Tube Bundle (Sprays, Rust, Scale, Biofilm, etc.)

7) Non-Condensable Check

Measure liquid drain line temperature at bottom of pipe after flows combine.

Liquid Drain Line Temp:	°F	Measured
Saturated Condensing Pressure:	psig	Convert liquid temp to pressure with NH3 table
Measured Condensing Pressure:	psig	From control system or test gauge
Non-Condensable Pressure:	psi	Difference of above pressures

A pressure difference of 10 psi or more is cause for action. Check auto purger, check purge point solenoids, manual purge, etc.

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Condenser Check Sheet

Condenser Check Procedure

Date:	**Site:**
Completed By:	**Engine Room:**

1) Basic Condenser Information:

Condenser Name:		**Total Fan hp:**	
Manufacturer:		**Total Pump hp:**	
Model:		**Pump Location:**	Integral Remote
Serial:		**Pump Throttled:**	No Yes
Condenser Type:	Forced Draft Induced Draft	Standard Hybrid	Water Saving
Fan Type:	Centrifugal Fan Axial Fan		
Fan Controls:	VFD Cycling	Two Speed	

2) Pressure Calibration:

	Control System	Test Gauge
Condensing Pressure:	psig	psig

3) Temp and RH Calibration:

	Control System	Test Probe
Dry Bulb Temp:	°F	°F
Relative Humidity:	%	%
Wet Bulb:	°F	°F

Please email to steve.koski@cascadeenergy.com

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Condenser Check Sheet

4) Wet Bulb Approach Calculation Check:

Condensing Pressure Control:	Fixed	Wet Bulb	**Fixed Setpoint:** psig
Wet Bulb Temperature:	°F		Displayed in control system, calculated from Dry Bulb and Relative Humidity
Approach Setpoint:	°F		Displayed in control system, typically 5-25°F
Floating Temperature Setpoint:	°F		Wet Bulb Temp + Approach
Floating Pressure Setpoint:	psig		Convert temp to pressure with NH3 table
Minimum Float Pressure:	psig		Displayed in control system
Maximum Float Pressure:	psig		Displayed in control system
Final Condensing Setpoint:	psig		Displayed in control system

5) Condenser Approach Check:

Test condenser approach in warm or hot weather when head pressure is floating above setpoint and all condensers are at maximum capacity.

Condensing Pressure:	psig	From control system or test gauge
Condensing Temperature:	°F	Convert pressure to temp with NH3 table
Wet Bulb Temperature:	°F	From control system or test probe
Condensing Approach to Wet Bulb:	°F	Condensing Temp - Wet Bulb Temp

Hot weather, high load Test

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Condenser Check Sheet

6) Tube Bundle and Spray Check

Shut down the fan on one condenser. Remove some or all drift eliminators. With the pump on, check the following:

% of Nozzles Clear:	%	**Notes on Tube Bundle (Sprays, Rust, Scale, Biofilm, etc.)**
% Spray Coverage:	%	
Scale Presence, Thickness:		
Rust Present:	Yes No	
Biofilm Present:	Yes No	
Take picture of tube bundle:	Yes No	

7) Non-Condensable Check

Measure liquid drain line temperature at bottom of pipe after flows combine.

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Please email to steve.koski@cascadeenergy.com

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Open Forums

- **Opportunity Development with Tom:** Agropur, Campbells, Flower Foods, General Mills, Sugar Creek
- **Q & A with Steve:** Tyson

  - (Feel free to change groups if you like)

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Open for Questions!

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

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End of Session 3

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