



Better Plants
U.S. DEPARTMENT OF ENERGY

**REFRIGERATION SYSTEM
VIRTUAL IN-PLANT TRAINING**

SESSION 7 – NOV 17, 2020



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Meet Your Trainers



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Week 4 – By The Numbers!

Completed roughly 2,700 hrs of training!

Average of 216 unique users per session!

6 companies represented from over 100 plant locations!

Thank you!



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MK12

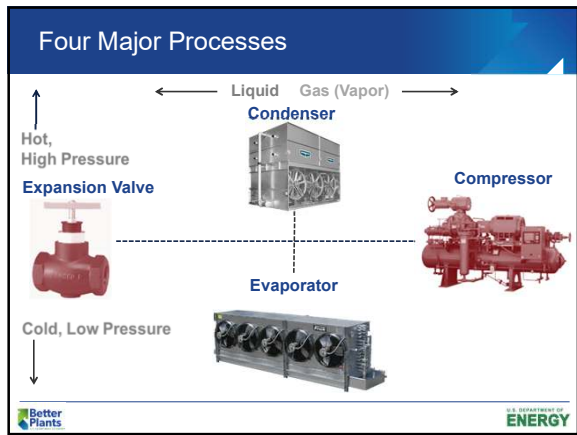
Today's Agenda – Session 7

Review!

- Compressor
- Condenser
- Evaporator
- Defrost

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Screw Compressors: Key Energy Issues

1. Lift (suction and discharge)
2. Capacity control
3. Volume ratio
4. Cooling
5. Economizing

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Slide 5

MK12 [@Tom Simenc] Add ~5 slides per review topic.
Michael Koch, 11/16/2020

What's the Ideal?

- Minimal Lift (max suction, min discharge)
- Slide Valve Properly Functioning
- Minimal Inefficient Unloading
- Correct Volume Ratio
- Controls Telling the Truth



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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

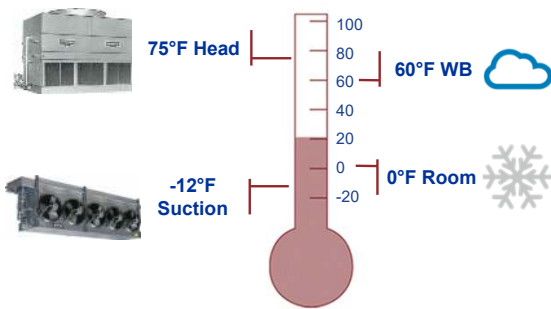
(Must work in saturated temperature, not pressure.)

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Limits of Lift



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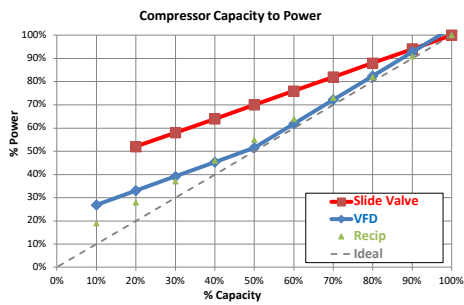
Common Barriers to Lower Condensing Pressure

- Hot gas defrost
- Heated zones
- Icing or other winter issues
- Water defrost and common sump
- Oil separator performance
- Gas-powered valves or unloaders
- Liquid injection oil cooling
- Screw compressor oil carryover
- Underfloor heating
- Control Pressure Receiver setup
- Pumper drum setup
- Direct-expansion coils
- Process or door hot gas
- Inadequate liquid pressure to serve loads
- Concerns about condenser fan and pump energy
- Misperceptions about volume ratio and efficiency
- Tradition

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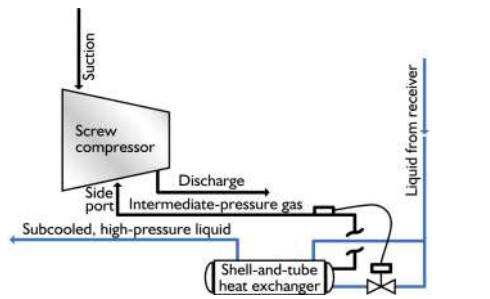
Compressor Part-Load Performance



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Economized Screw Compressors



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2011 MK10

Top Compressor Action Items

1. Optimize Suction Pressure
2. Optimize Condensing Pressure
3. Use your Best Part Load Option
4. Calibrate
5. Address Improper Volume Ratio
6. Optimize Economizer Operation
7. Address Current Limiting Issues

Take the polls

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Induced Draft Condenser Cut Away

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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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Slide 14

KR2 [@Tom Simenc] [@Michael Koch] [@Steve Koski] The polls have been added to the Zoom meeting.
Kim Reed, 11/14/2020

MK10 thanks!
Michael Koch, 11/14/2020

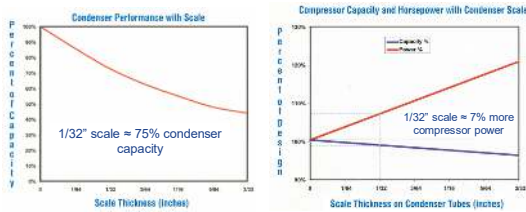
Ideal Peak Condenser Performance

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



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Impact on Performance



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Water Flow

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



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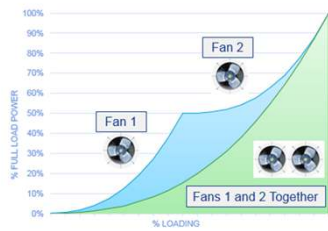
Purgers—What Can Go Wrong?



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IMPORTANCE OF GROUPED FAN CONTROL

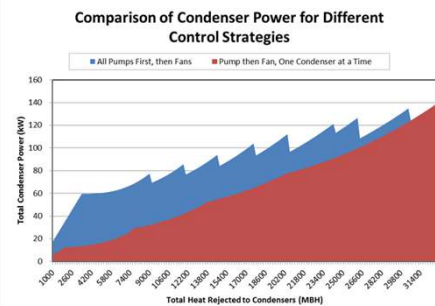
Operate a group of condensers wet, with the fans running in the highly efficient mid-range speeds. This means operating multiple VFD-driven condensers at the same speed.



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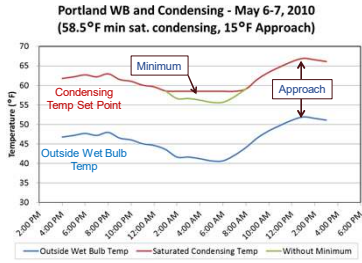
THE IMPORTANCE OF PUMP-FAN-PUMP-FAN CONDENSER SEQUENCING

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.



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What is Wet Bulb Approach?



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Top Condenser Action Items

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

Take the polls

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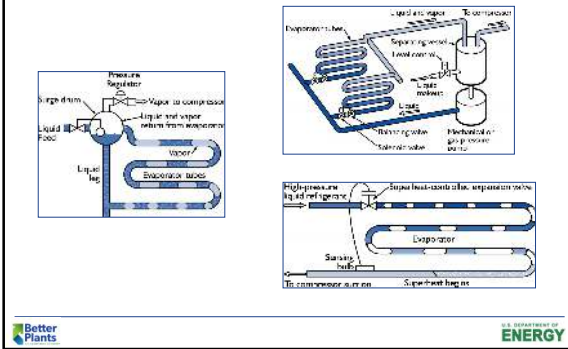
Defrost Check Sheet

Defrost Check																						
Defrost By:	Time:																					
Completed By:	Equipment & Value Group ID:																					
Defrost Settings: <table border="1"> <tr> <td>Pressure Switch</td> <td>_____</td> </tr> <tr> <td>High Limit</td> <td>_____</td> </tr> <tr> <td>Low Limit</td> <td>_____</td> </tr> <tr> <td>Run Time</td> <td>_____</td> </tr> </table>		Pressure Switch	_____	High Limit	_____	Low Limit	_____	Run Time	_____													
Pressure Switch	_____																					
High Limit	_____																					
Low Limit	_____																					
Run Time	_____																					
Pre-Defrost Observations: Frost Load (See right page for history): _____ Fan Running on Start of Defrost: _____																						
Defrost Observations: <table border="1"> <thead> <tr> <th>Event</th> <th>Time</th> <th>Notes</th> </tr> </thead> <tbody> <tr> <td>Pressure Switch</td> <td></td> <td></td> </tr> <tr> <td>High Limit</td> <td></td> <td></td> </tr> <tr> <td>Low Limit</td> <td></td> <td></td> </tr> <tr> <td>Fan Running</td> <td></td> <td></td> </tr> <tr> <td>Defrost Pressure</td> <td></td> <td></td> </tr> <tr> <td>Defrost Process</td> <td></td> <td></td> </tr> </tbody> </table>		Event	Time	Notes	Pressure Switch			High Limit			Low Limit			Fan Running			Defrost Pressure			Defrost Process		
Event	Time	Notes																				
Pressure Switch																						
High Limit																						
Low Limit																						
Fan Running																						
Defrost Pressure																						
Defrost Process																						
Post-Defrost Observations: Water Regain: _____ Water Return: _____ Water Drainage: _____																						

Please email to tom.simenc@cascadeenergy.com

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Evaporator Types



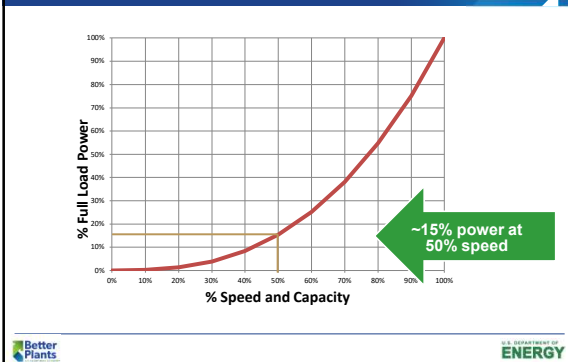
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Individual vs. Group VFD Control



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VFD Grouped Fan Control



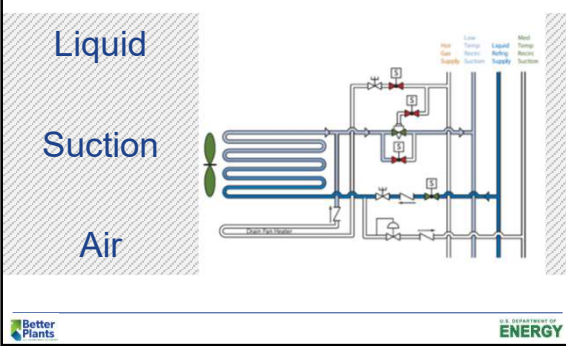
28

Impact of Poor Evaporator Performance

- Loose temperature control
- Lower suction pressure (more lift)
- More fan operation
- Increased system power

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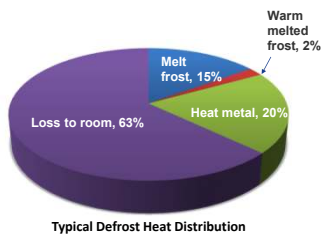
Three Keys of Evaporator Performance



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Defrost Heat

- Heat Metal
- Melt Frost
- Warm Melted Frost
- Loss to Room



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Recap

1. Keep frost out
2. Use the cheapest form of defrost
3. Start with clean coils & address problem evaporators
4. Optimize defrost frequency
5. Optimize pump down settings
6. Optimize defrost hot gas pressure
7. Optimize defrost duration

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Top Evaporator Action Items

1. Use fan cycling or VFDs
2. Minimize defrost
3. Clean evaporator coils
4. Resolve fan, motor, VFD issues
5. Use BPRs appropriately
6. Re-commission valves and regulators
7. Check water and oil contamination
8. Verify, increase temperature setpoints
9. Calibrate temperature probes

Take the polls

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Quiz!

Kahoot!
Join from your phone!

Set username as Full Name!

Prizes for Top 3!

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Slide 33

KR1 [@Michael Koch] This slide has the options numbered. Maybe we should change to bullets to be consistent?

Kim Reed, 11/14/2020

MK11 [@Kim Reed] agreed, and updated!

Michael Koch, 11/14/2020

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?
- Session 8 is focused on report outs! Come ready to hear what a few sites have identified and started working on. **AND we still need volunteers!**

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Open for Questions!

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

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