Presentation Details

- Tuesday, 01.31.17, 11:15 AM - 11:35 AM
  - Location: Theater A
  - Exhibitor: Yaskawa America, Inc.
  - Title: Applying VFDs to Chillers
  - Speaker: Larry Gardner, Product Manager, Yaskawa America, Inc.
- Description: This presentation includes a description of variable frequency drives, their purpose, and basics of operation. Learn how chillers with VFDs will dramatically reduce energy costs, extend equipment life and maximize customer comfort.

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Booth # C1140

Applying VFDs to Chillers

Larry Gardner

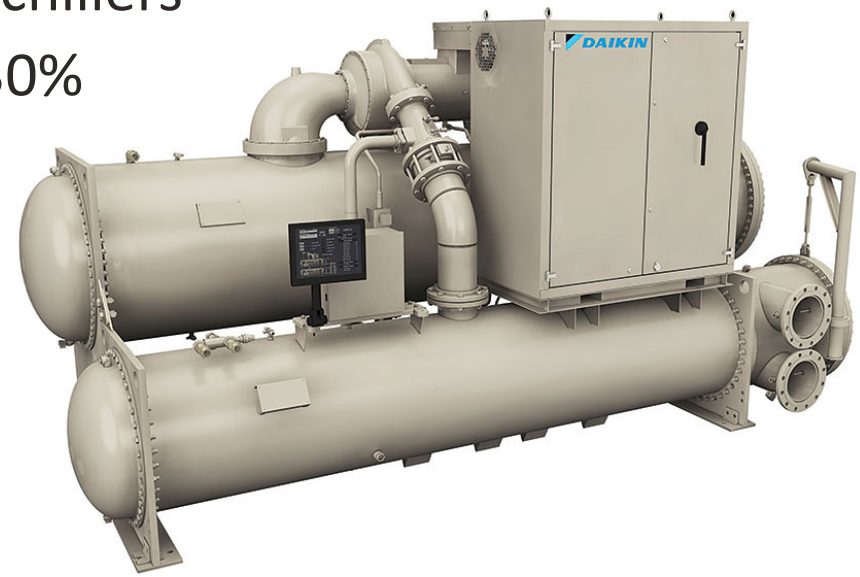
Product Manager

January 31, 2017

Yaskawa America, Inc.

Learning Objectives

- Understand variable frequency drives (VFDs)
- Describe VFD applications to chillers
- Cut electrical energy use by 30%

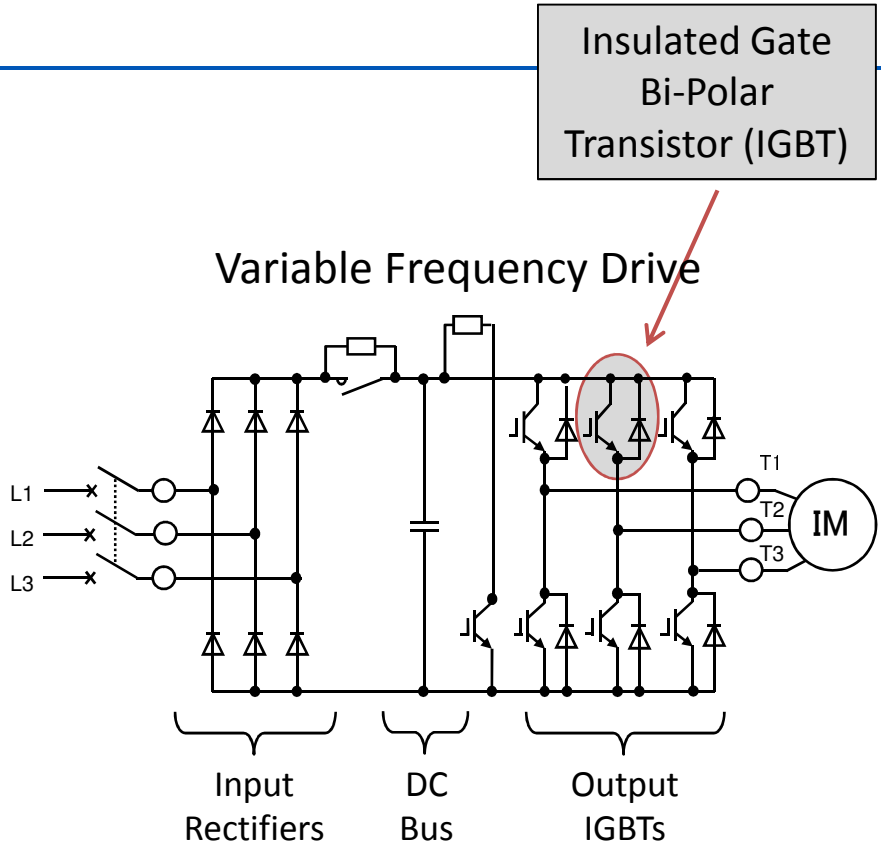


Variable Frequency Drives

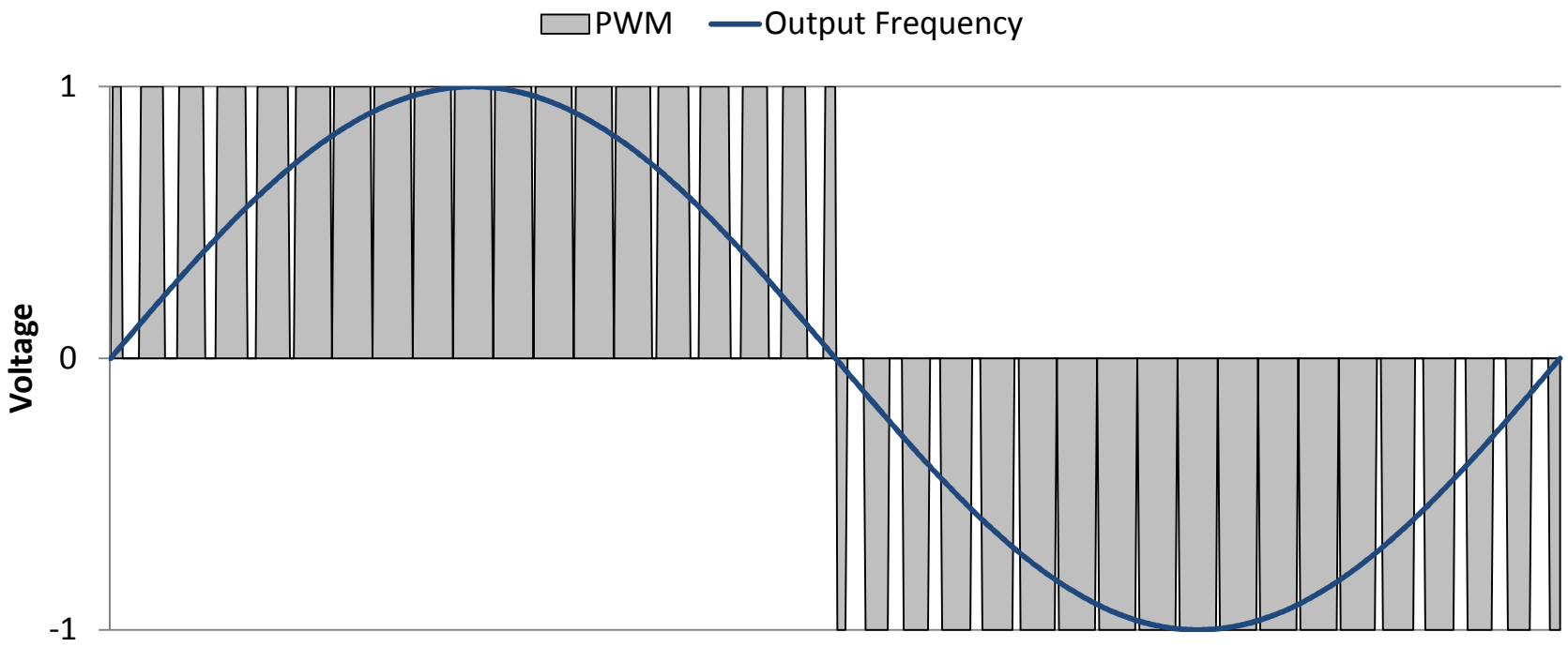
- Nomenclature
  - Variable Frequency Drive (VFD)
  - Variable Speed Drive (VSD)
  - Adjustable Speed Drive (ASD)
- Purpose
  - To vary the speed of a fixed-speed motor
    - To save energy and save money
  - And a lot more
- Method
  - Pulse width modulation to approximate a variable frequency sine wave

VFD Topology

- Rectifies incoming AC power to DC
- Stores energy in a DC capacitor bus
- Uses high-speed switches (IGBTs) to send variable frequency and voltage to the motor



Pulse Width Modulation



VFD Challenges Solved

- Environment
  - NEMA-rated enclosures
- Reliability
  - Mean Time Between Failure (MTBF) measured in decades
- VFD effects
  - Bearing currents
  - Lead lengths
  - Harmonics

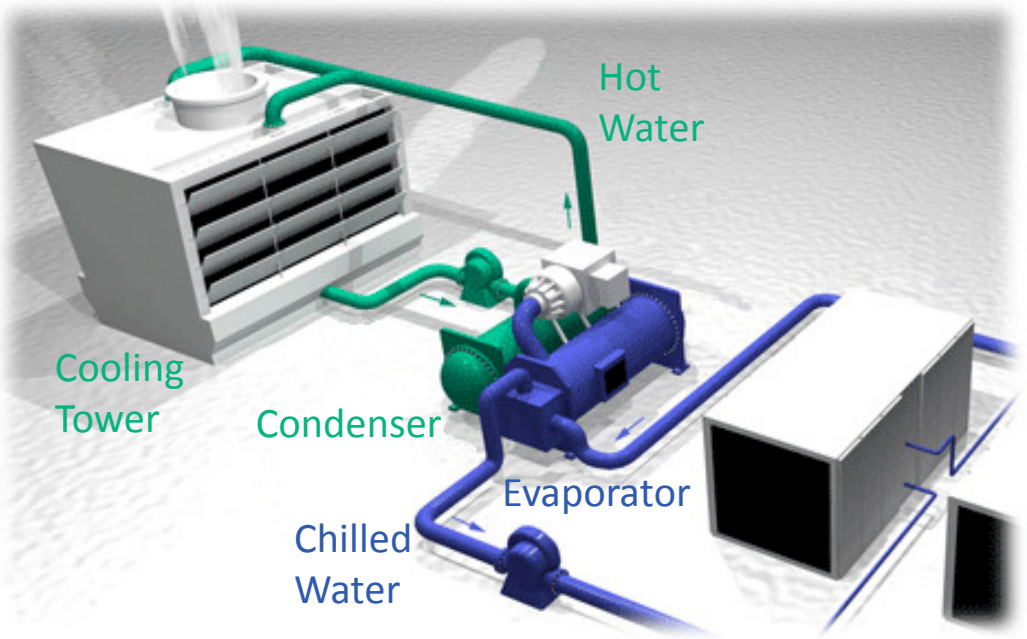
Chiller Facts

- Typically the single largest consumer of power in a building
  - 70% of chillers have centrifugal compressors
  - Compressor motors typically 150 hp to 600 hp
- Constant speed chillers are most efficient at full heat load
  - Most run at less than full load more than 90% of the time
- Applying VFD to the compressor motor = variable speed chiller
  - Variable speed chillers are most efficient at 50-70% load

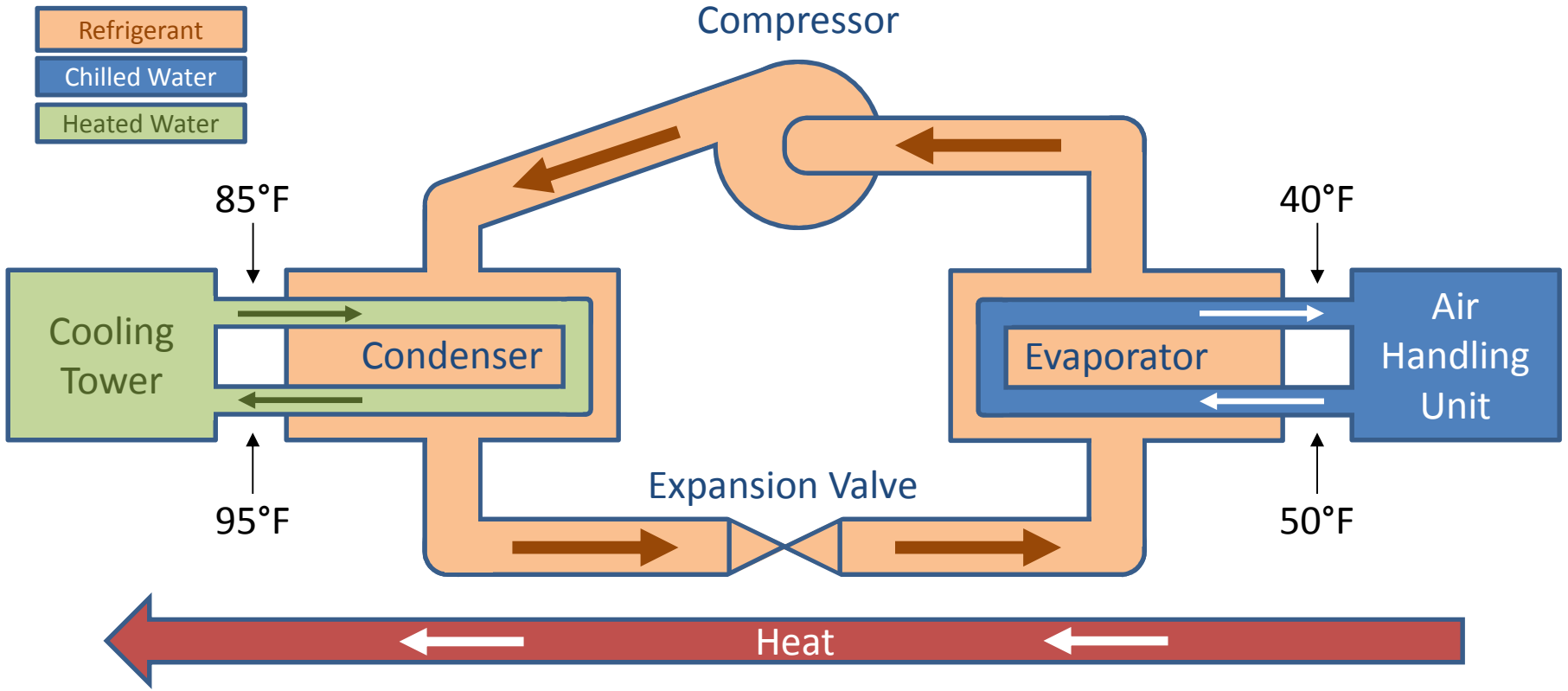
Prime candidates for energy savings.

The Chiller Plant

- Chiller
  - Compressor
  - Condenser
  - Expansion valve
  - Evaporator
- Air Handling Unit
  - Chilled water pump
- Cooling Tower
  - Condenser water pump



Chiller Operation



How VFDs on Chillers Save Money

- More efficient operation
  - 10 to 40% energy savings is typical
- Reduced wear and tear
  - Soft starts lessen electrical and mechanical strain
  - Savings on maintenance and repair costs
  - Extend chiller life
- Save even more with an all-variable speed chiller plant
  - Chiller compressor
  - Chilled water pump and AHU fans
  - Condenser water pump and cooling tower fans

Keep in Mind for Chiller VFD Retrofits

- Look for chillers 10 to 15 years old
  - ASHRAE has recommended VFDs on chillers for the last 15 years
- Be aware of manufacturers' limits
  - Minimum compressor and pump speeds
- Get professional help with controls
- Get VFD supplier advice
  - Application and installation knowledge
- Local efficiency codes may be at full load
- Power company rebates may be available

Financial Analysis Units

- Energy rates
  - 12,000 BTUs per hour = 1 refrigeration ton
  - 1 watt = 3.41 BTUs per hour
- Coefficient of Performance
  - COP = heat removal (BTU) / energy applied (BTU)
- Energy Efficiency Ratio
  - EER = net cooling capacity (BTU/hr) / applied electrical power (Watts)
- Cooling Load
  - Efficiency = applied electrical power (kW) per refrigeration ton

VFDs on Chillers – Retrofit or Replace

- Energy Cost
  - $0.09 per kWh
- Annual hours of operation
  - 2,000 hours

Simple Hypothetical Example

Chiller VFD Upgrade Comparison	15-20 Year Old Chiller	Upgraded Chiller	New Chiller
Cooling Capacity - tons	500	500	500
Cooling Capacity - BTUs per hour	6,000,000	6,000,000	6,000,000
Efficiency (EER)	9	12	15.39
Annual Energy Use (kWh)	1,333,333	1,000,000	779,727
Annual Energy Costs	$120,000	$90,000	$70,175
VFD Upgrade / New Chiller Cost per Ton	--	$50	$300
VFD Upgrade / New Chiller Cost	--	$25,000	$150,000
Annual Chiller Energy Savings	--	$30,000	$49,825
Payback in Years	--	0.8	3.0

Conclusions

- VFD retrofits for chillers save money
  - More efficient operation
  - Reduced maintenance
  - Power company rebates
- All-variable speed chiller plants are even more efficient
  - Effective control of chillers, pumps and fans will maximize efficiency
- Draw on sources of information
  - HVAC control houses
  - VFD suppliers

Sources

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