ENGINEERING
TOMORROW

Emerging Oil Free Technologies

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Agenda

- Chiller Overview
- Benefits of Oil Free
- Oil Free Compressors Today
- Next Generation Oil Free Compressors
- Oil Free Future

Learning Objectives

- Obtain an overview of new compressor technologies using magnetic, ceramic, and gas (foil) bearings, which can operate without oil.
- Introduce advances in compression technology, which enable oil-free systems for more demanding air-cooled applications.
- Explore the current and expanding opportunity for oil-free technologies in air conditioning systems.

Background

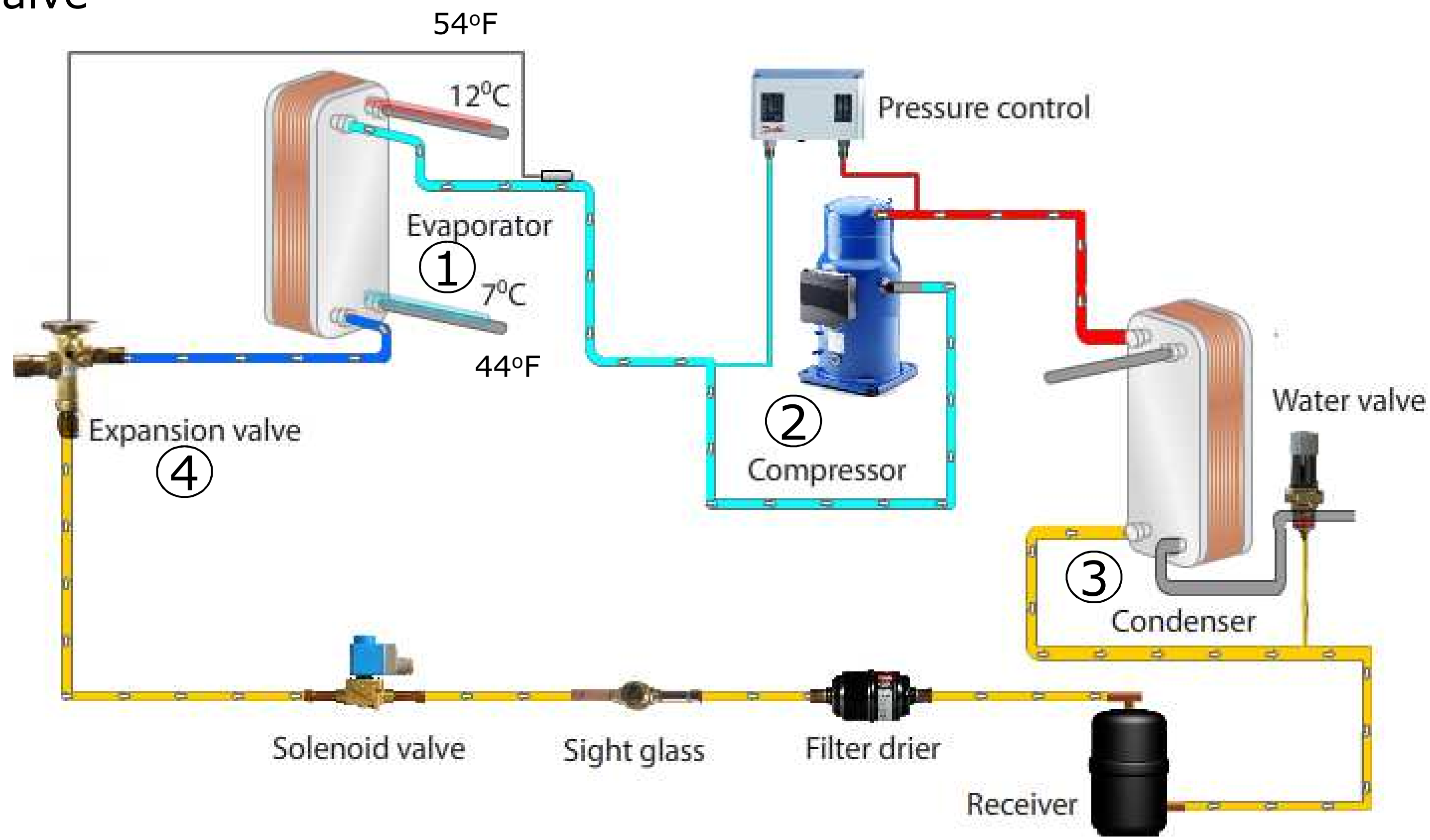
What is a Chiller?

- A chiller is a machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle
- The liquid is circulated through a heat exchanger to cool air, equipment or process application as required

Background

Four basic components of a vapor compression chiller

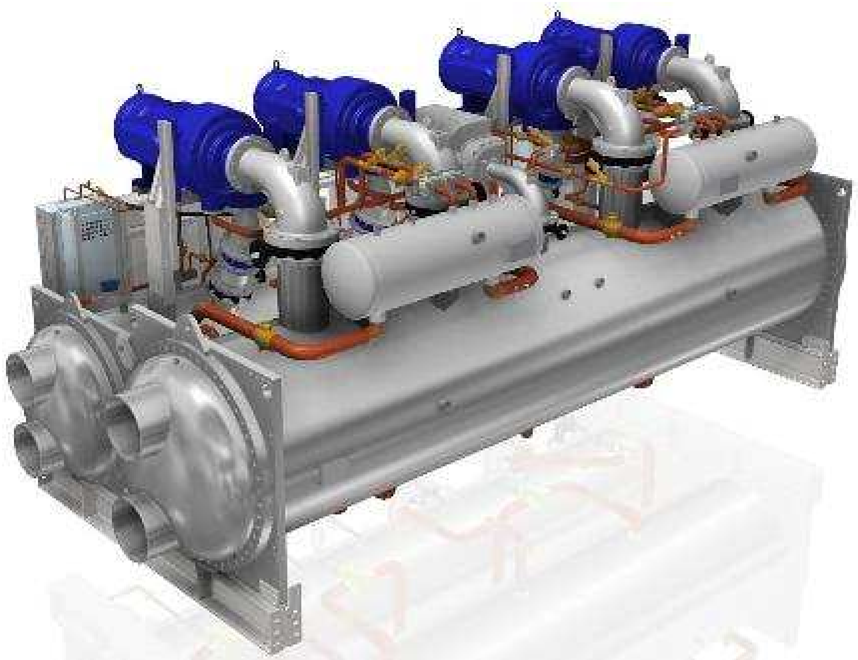
- Evaporator
- Compressor
- Condenser
- Expansion Valve



Two Major Types of Chillers

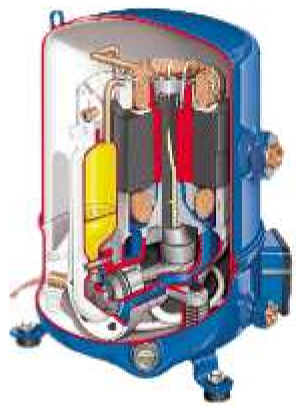
Heat from application load is rejected into the atmosphere in 2 ways:

- Air Cooled
- Water Cooled – Cooling Tower



Compressor Types Used in HVAC

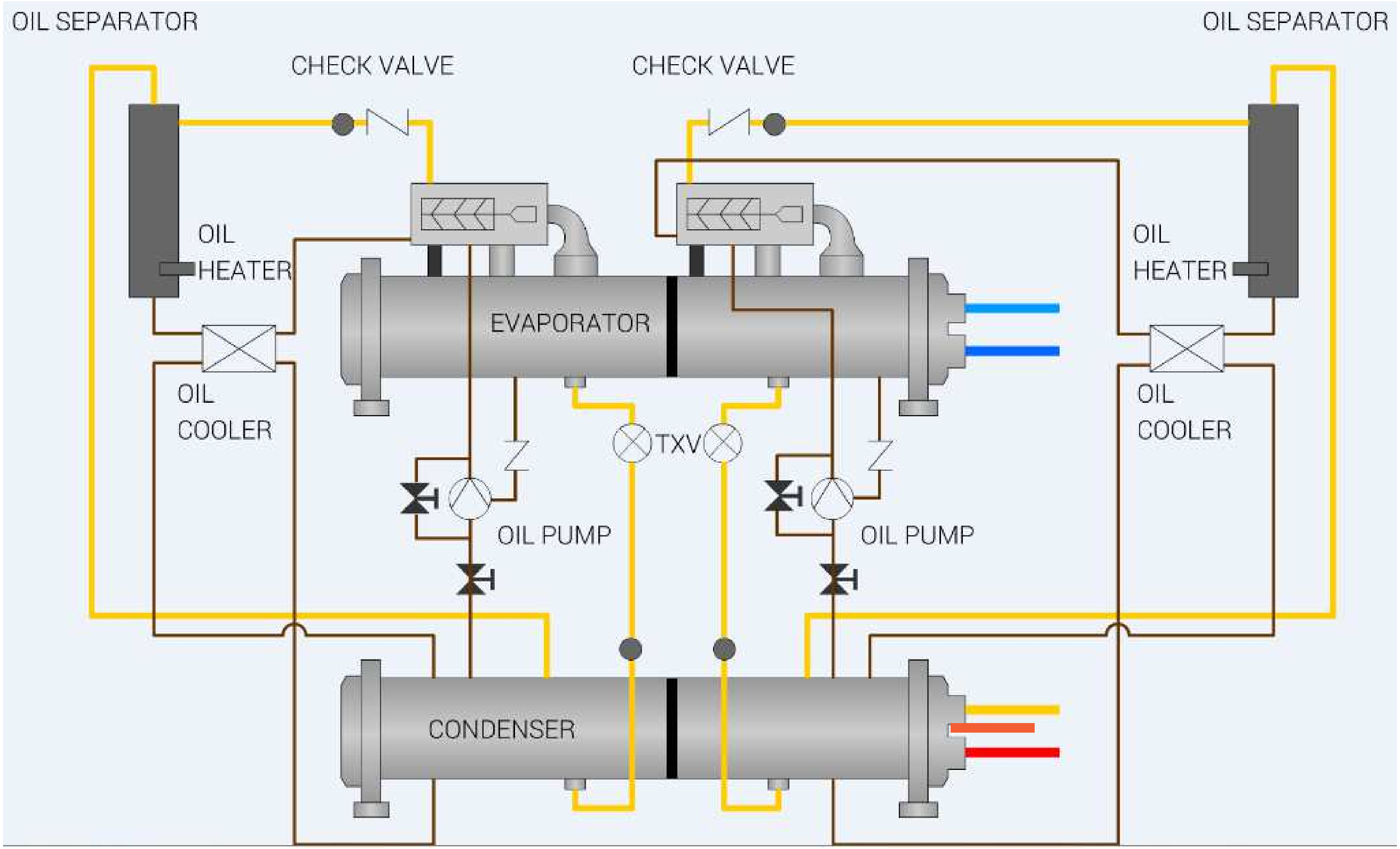
Capacity

Reciprocating	Scroll	Screw	Centrifugal
			

Oil – A Critical Component

- Lubricate bearings
- Form seal during compression
- Open drive compressor shaft seal
- Lubricate gears
- Lubricate ancillary system components

Oil Management – A Critical System



Oil Management

Risks with oil management system

- Complexity and cost of additional components
- Maintenance

Component
Oil Sump
Oil Sump Strainers
Oil Pump
Oil Filter
Oil Heater
Oil Separator
Oil Cooler
Oil Pressure Transducer
Oil Piping and Valves
Oil Sightglass

Required Maintenance	*Frequency*
Check Oil Pressure	*Daily*
Check Oil Level	*Daily*
Inspect Oil Pump Operation	*Weekly*
Inspect Oil Sump Heaters	*Weekly*
Oil Analysis (Acidity, Moisture, Viscosity, etc.)	*Quarterly*
Oil Filter Change	*Semi-Annual*
Oil Change	*Annual*
Inspect Oil Sump Strainers	*Every 5 years*

Risks with oil management system

- Added components can increase risk for failure
- Possible alarms or faults for chillers with oil management systems:

Alarms
Low Oil Pressure
High Oil Pressure
Low Oil Temperature
High Oil Temperature
Loss of Oil Flow
Oil Pressure Transducer Failure
Oil Temperature Sensor Failure
Oil Pump Failure
Oil Pump VFD Failure
Oil Filter Clogged

Other Negative Impacts of Oil

- Performance degradation
- Environmental impact of low efficiency


Air Conditioning | Heating | Refrigeration

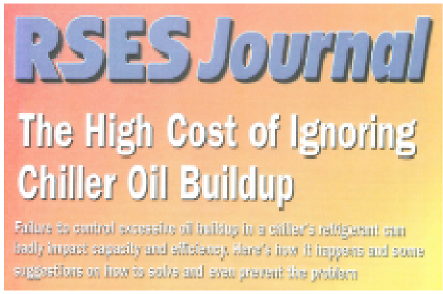
the NEWS

The High Cost of Oil Contamination

From ASHRAE Research Project 751-RP, "Experimental Determination of the Effect of Oil on Heat Transfer with Refrigerants HCFC-123 and HFC-134a",

Conclusions and Recommendations:

"The heat transfer ratio drops steadily with oil concentration and reaches a value of 0.65 [from 1.0 normalized] at an oil concentration of 10%."


RSES Journal

The High Cost of Ignoring Chiller Oil Buildup

Oil Contamination

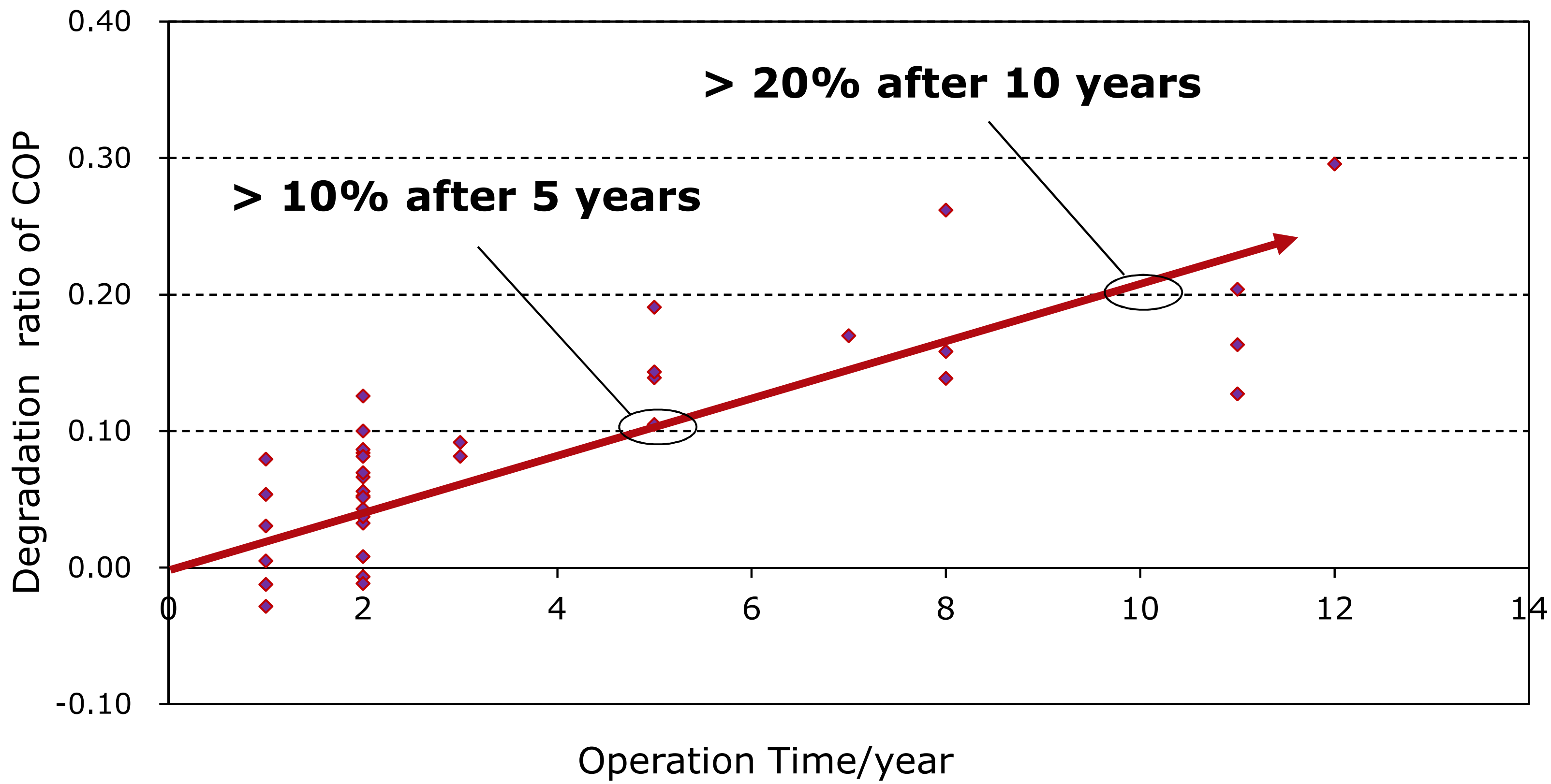
Oil In Evaporator	Performance Loss
1-2%	2-4%
3-4%	5-8%
5-6%	9-11%
7-8%	13-15%

Source: The News. 04/15/04, by Jack Sine

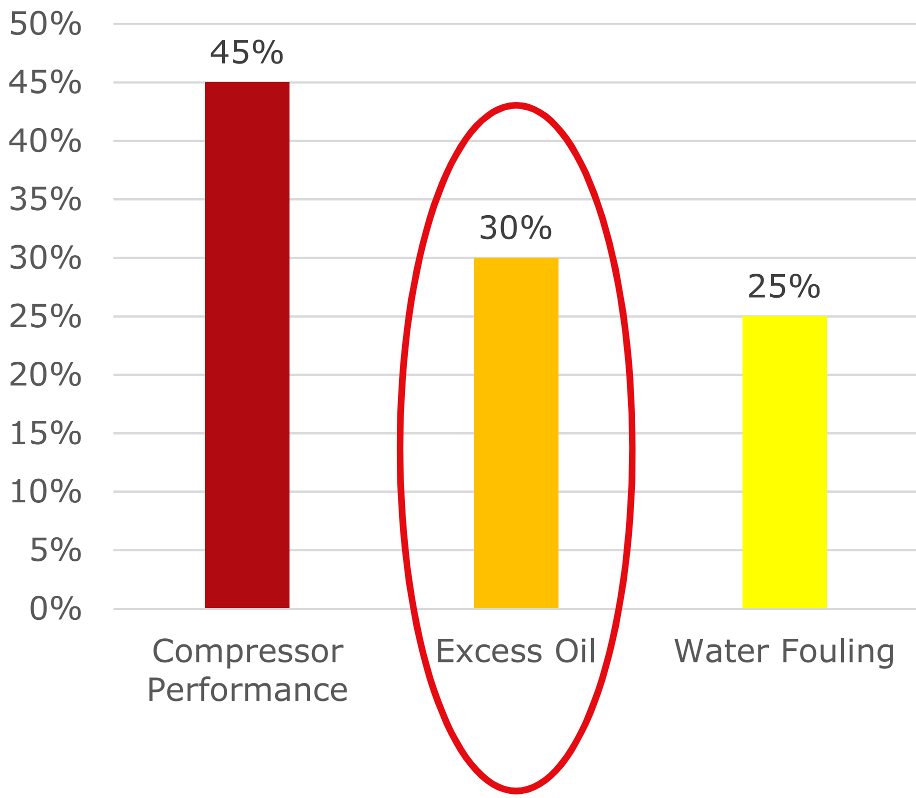
Tsinghua University Study - 2014

- A two year project with data collecting spanning over 6 years
- 24 Buildings in study
- 36 Well maintained chillers analysed
  - 26 Centrifugals
  - 10 Screw
- Project team was headed by Mr Wang Baolong

Tsinghua University Study Confirms Chiller Efficiency Loss Over Time



Sources of Performance Degradation

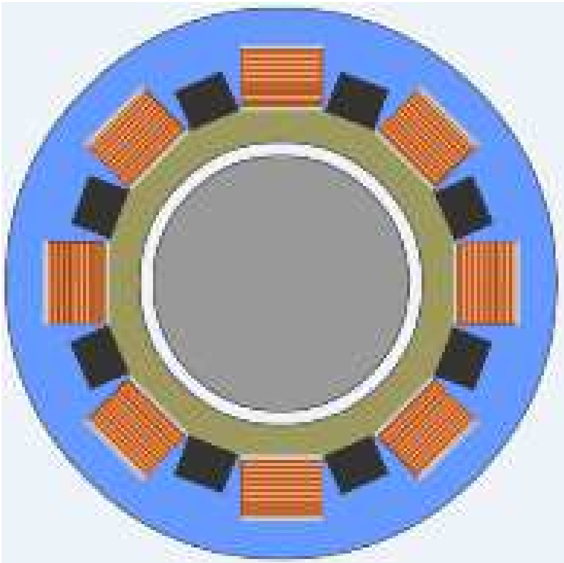


- Excess oil accounted for 30% of the performance degradation

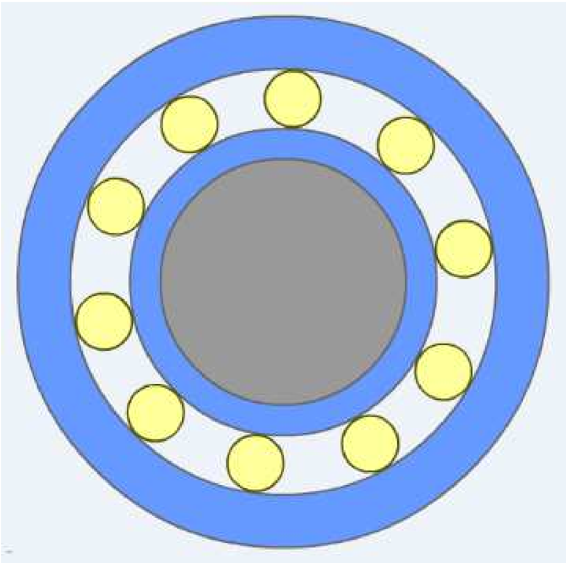
There is an Alternative!!

Oil Free Bearing Types

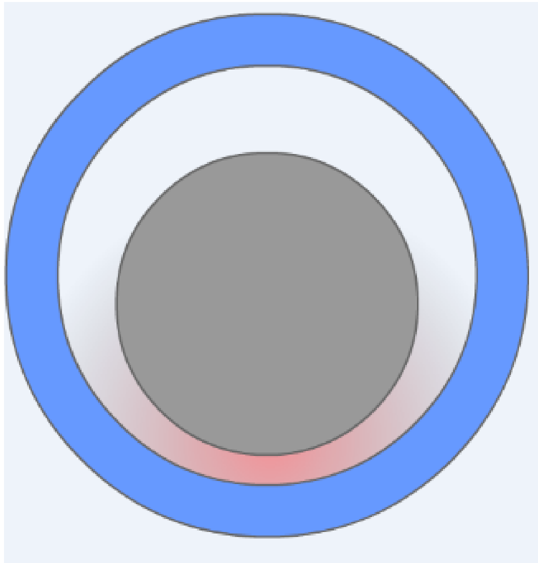
Magnetic Bearing



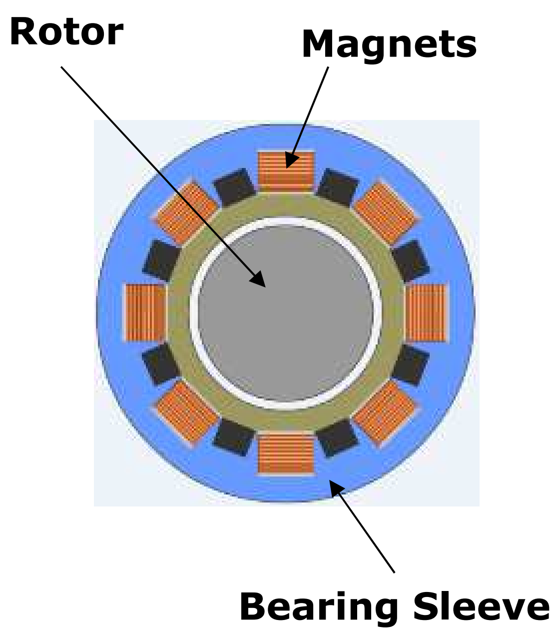
Ceramic Bearing

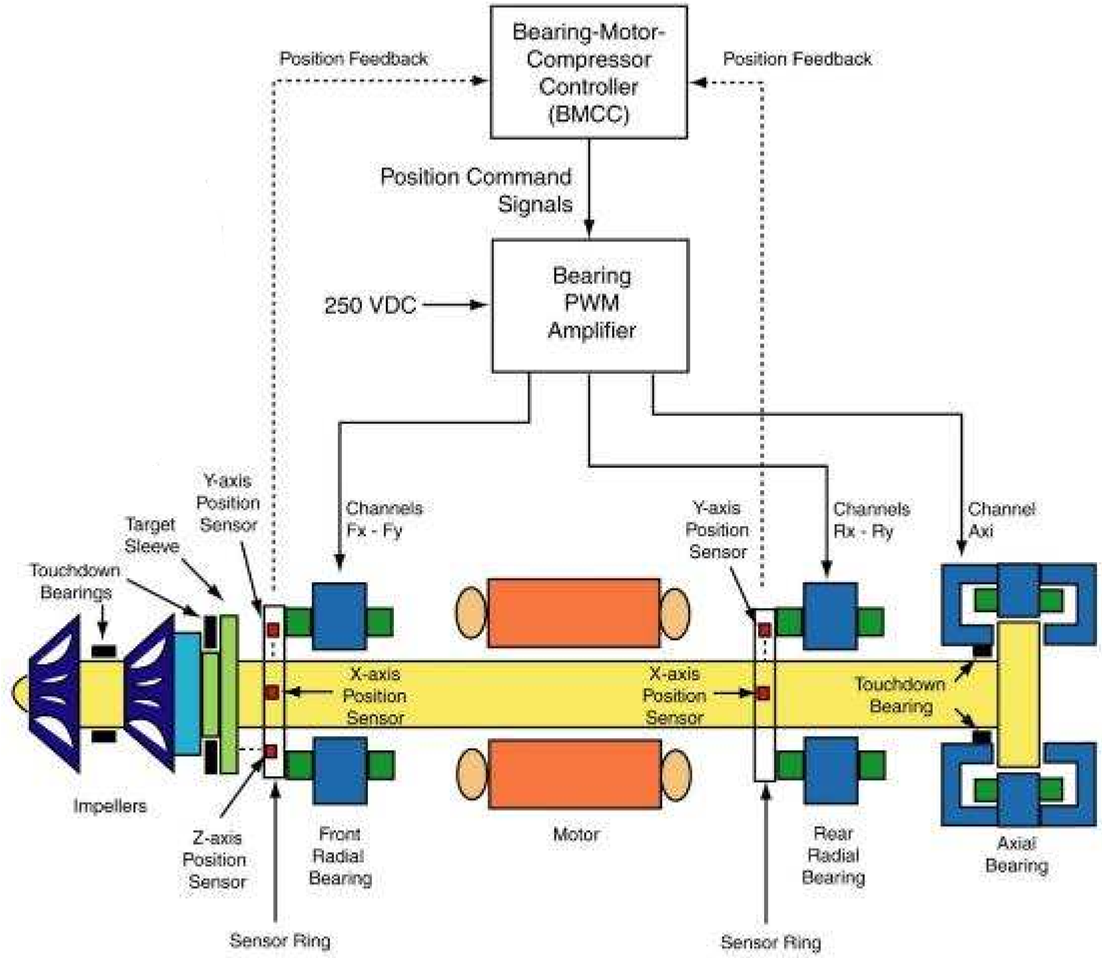


Gas Bearing

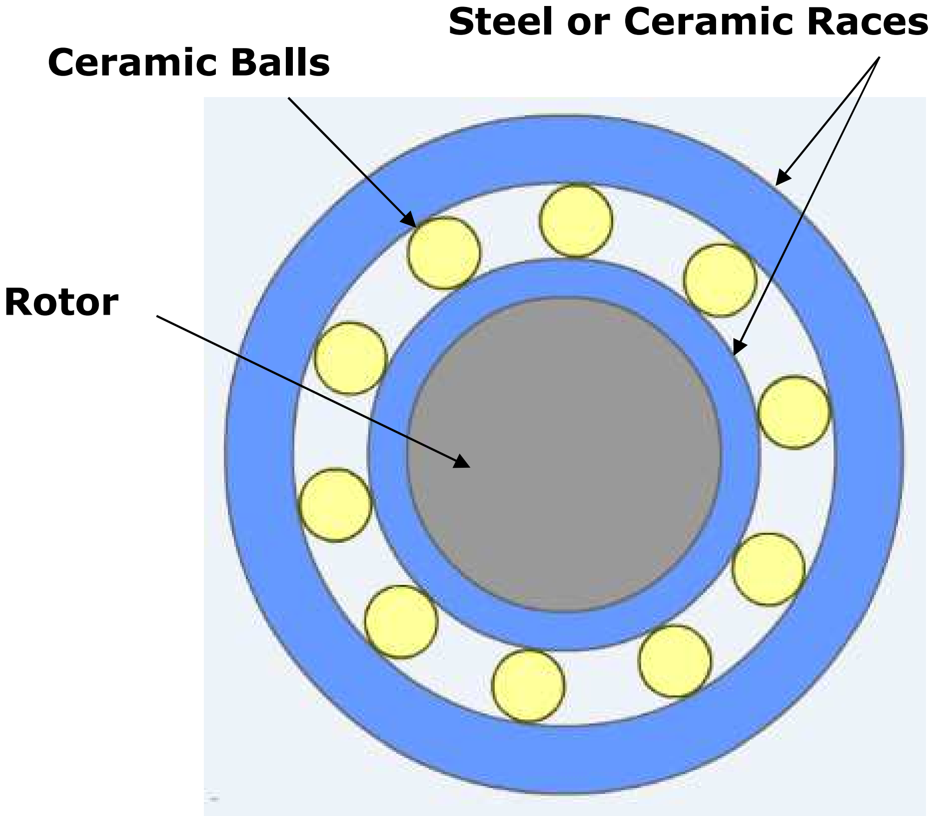


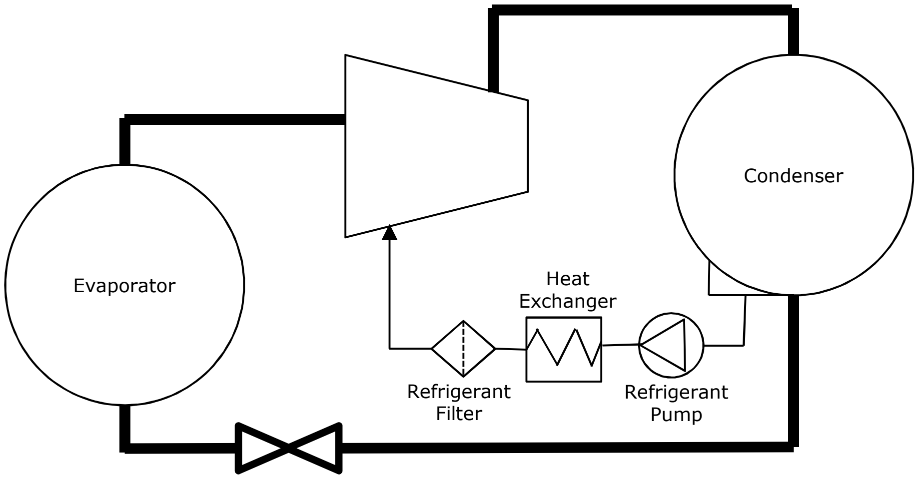
Magnetic Bearing Compressor





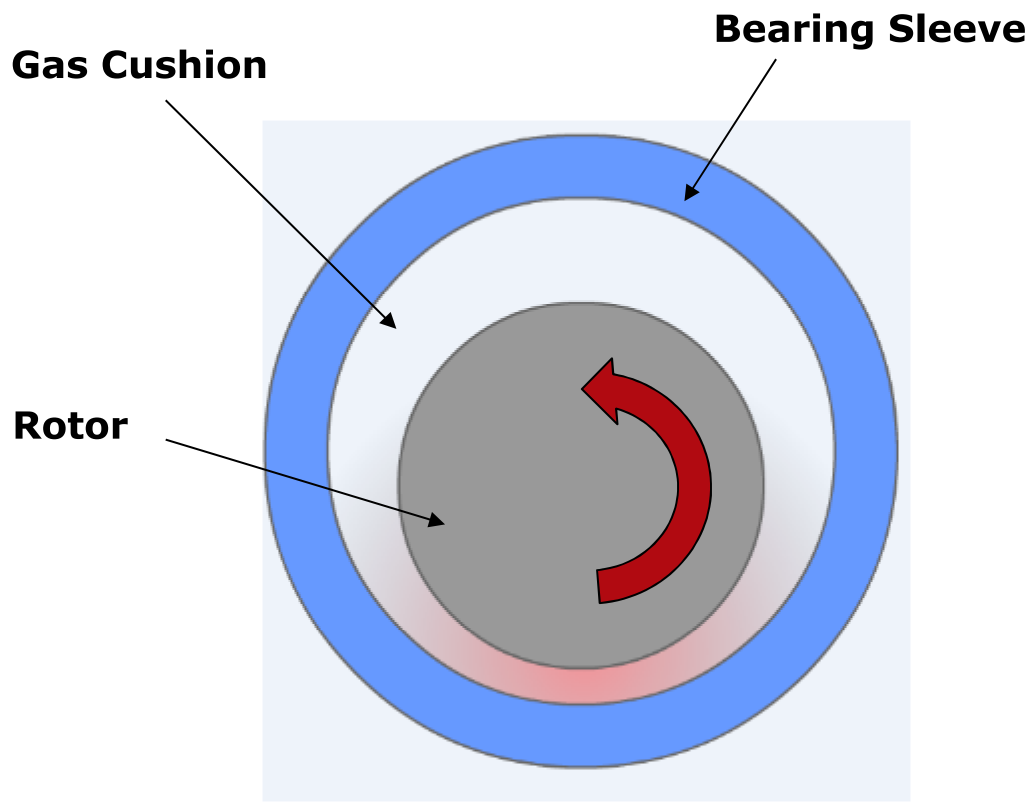
Full and Hybrid Ceramic Bearings



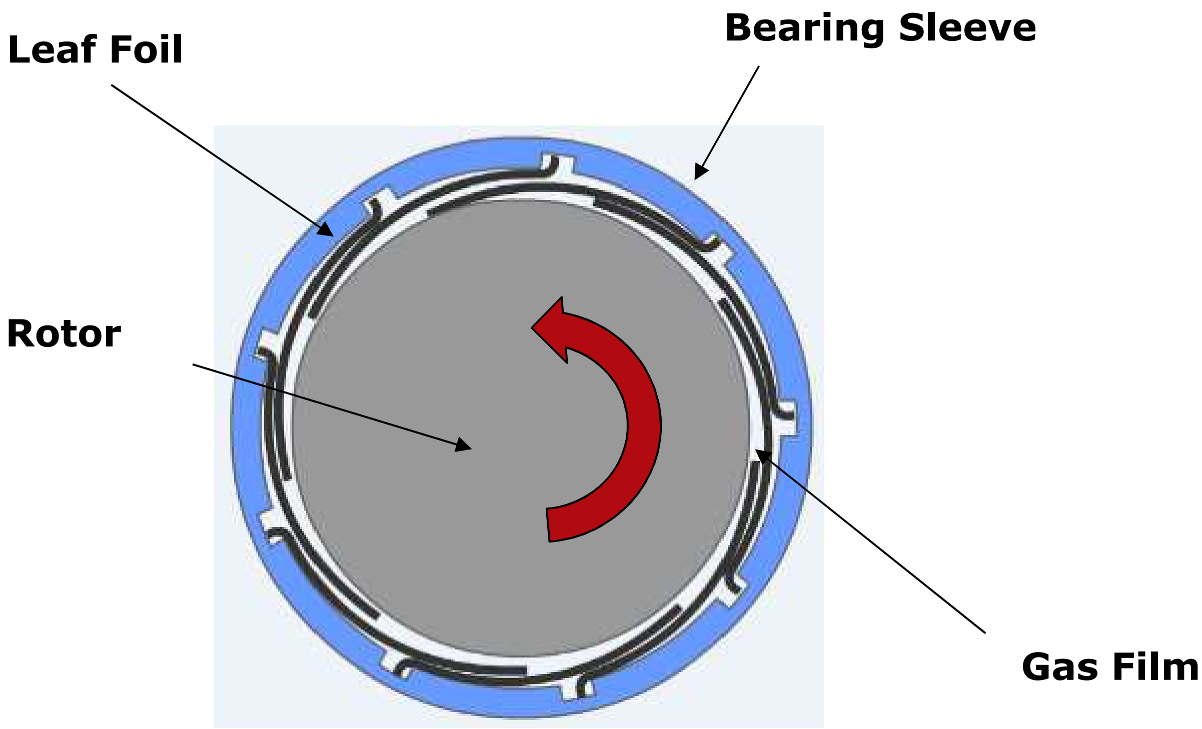


Refrigerant Lubrication Support System

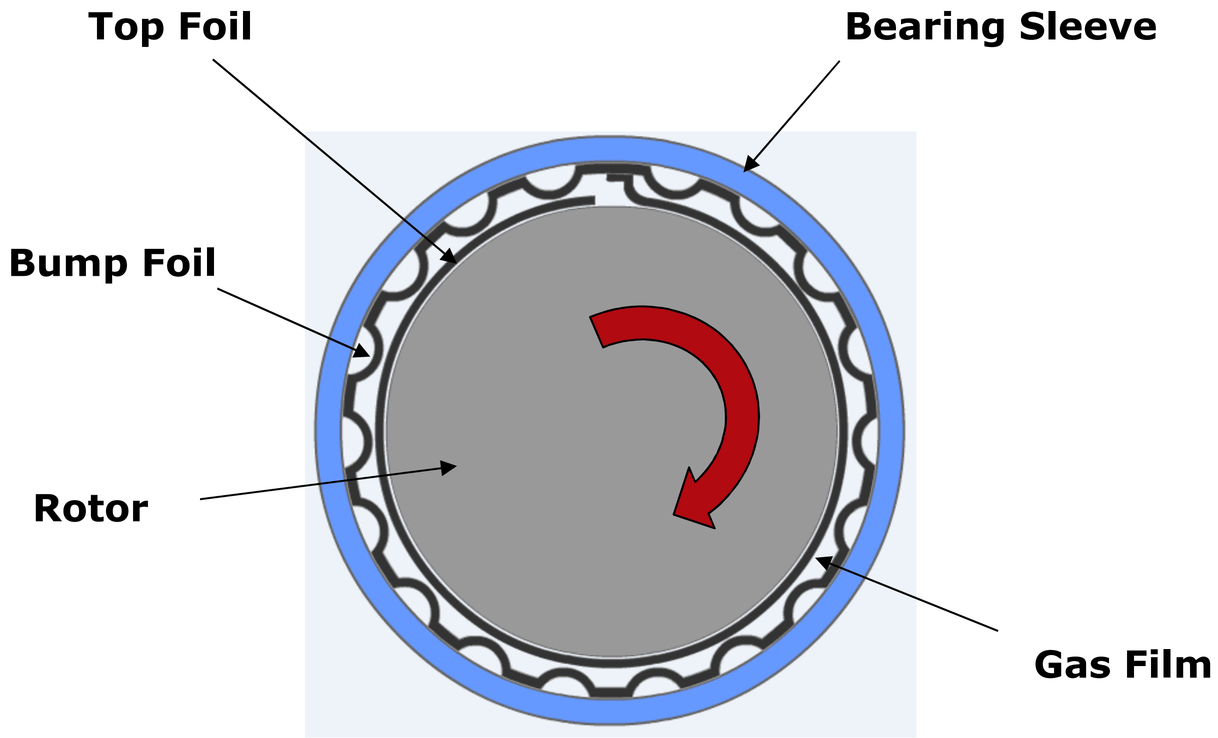
Gas Bearing (plain journal bearing illustrated)



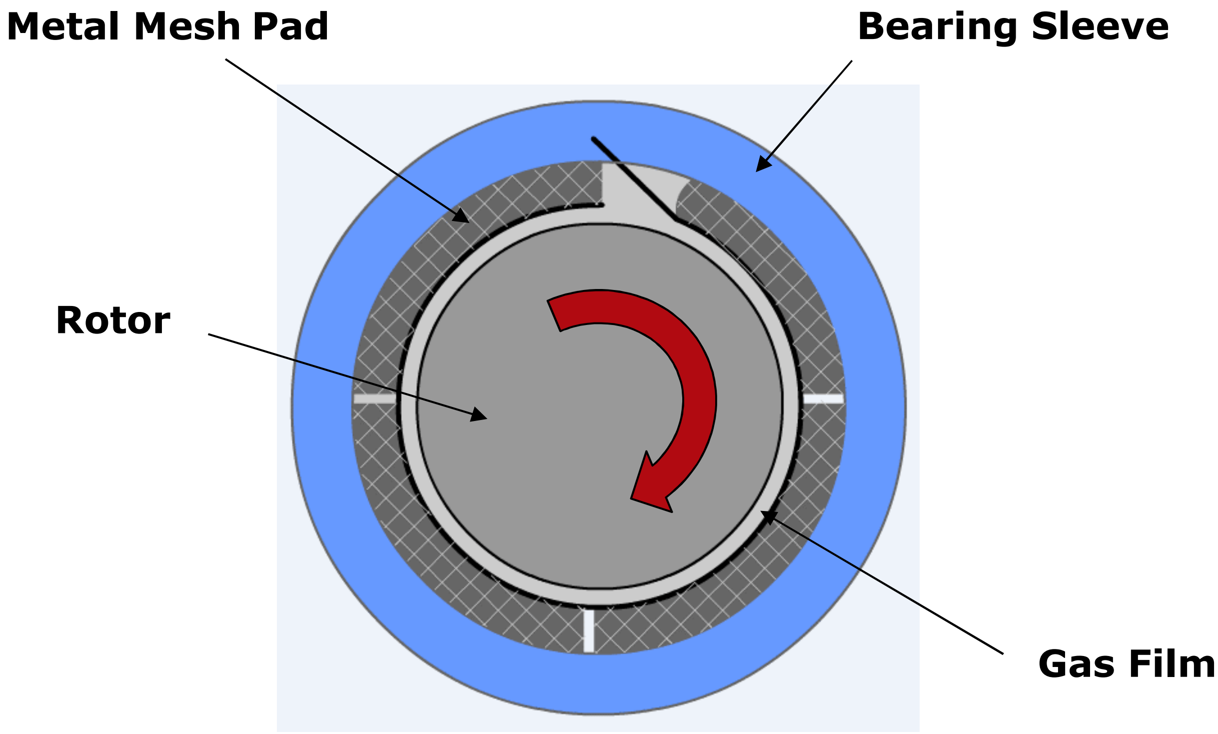
Foil or Leaf Foil



Bump Foil Bearing



Mesh Pad Bearing



Oil Free Compressor Technology Comparison

	Bearing Type		
Characteristic	Magnetic	Ceramic	Gas(foil)
High Speed Capability			
Load Capability			
Friction Losses			
Complexity			
Cost			
Reliability			
High Capacity Cooling			

Benefits of Oil Free Compressors

- Simple design
- Reduces maintenance

Component
Oil Sump
Oil Sump Strainers
Oil Pump
Oil Filter
Oil Heater
Oil Separator
Oil Cooler
Oil Pressure Transducer
Oil Piping and Valves
Oil Sightglass

Required Maintenance	Frequency
Check Oil Pressure	*Daily*
Check Oil Level	*Daily*
Inspect Oil Pump Operation	*Weekly*
Inspect Oil Sump Heaters	*Weekly*
Oil Analysis (Acidity, Moisture, Viscosity, etc.)	*Quarterly*
Oil Filter Change	*Semi-Annual*
Oil Change	*Annual*
Inspect Oil Sump Strainer	*Every 5 years*

Reduced Risk of Failure

Alarms associated with oiled management systems or no longer needed

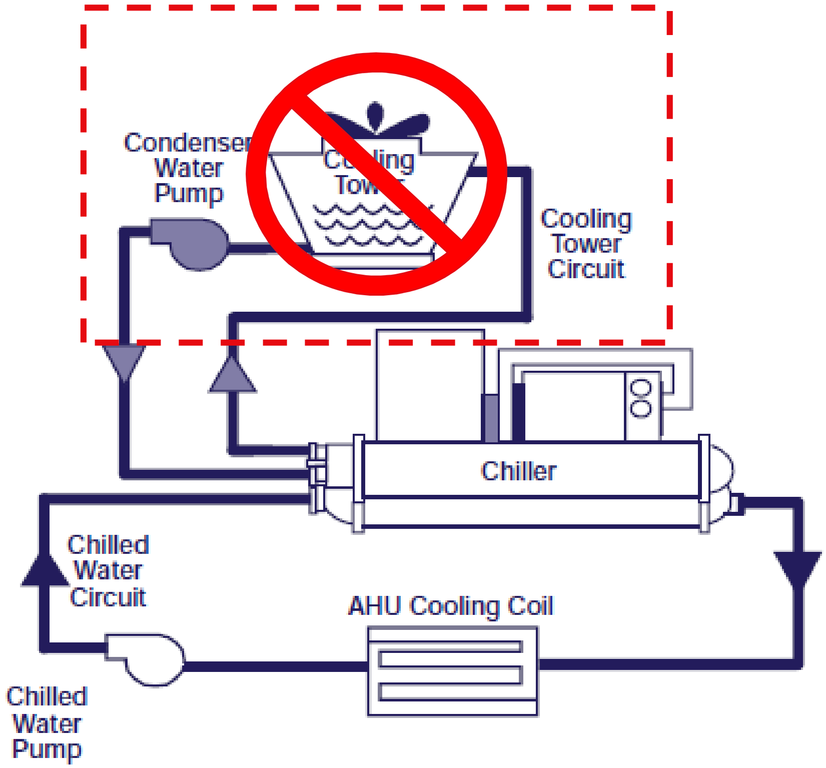
Alarms
Low Oil Pressure
High Oil Pressure
Low Oil Temperature
High Oil Temperature
Loss of Oil Flow
Oil Pressure Transducer Failure
Oil Temperature Sensor Failure
Oil Pump Failure
Oil Pump VFD Failure
Oil Filter Clogged

Applications for Oil Free Compressors

- Water cooled chillers
  - Comfort cooling
  - Process applications
- Vertical Market applications
  - Schools
  - Data centers
  - Office buildings
  - Healthcare

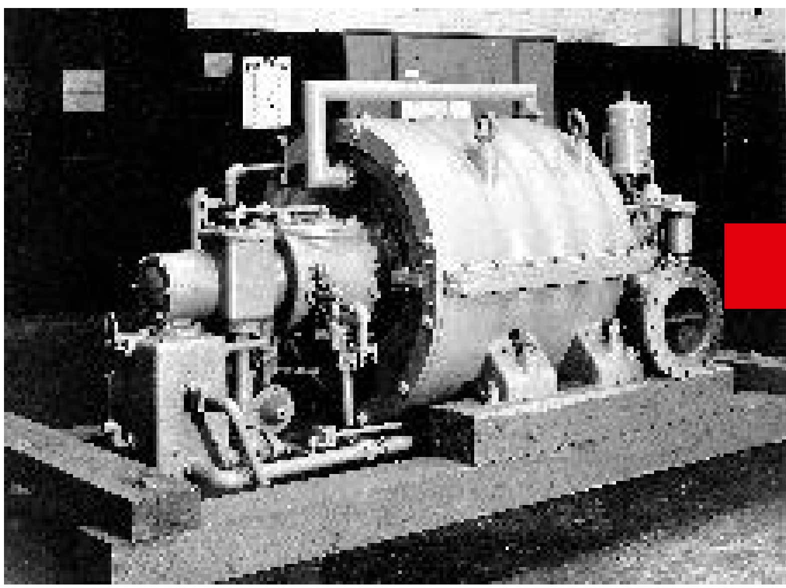
Benefits of Air Cooled Chillers

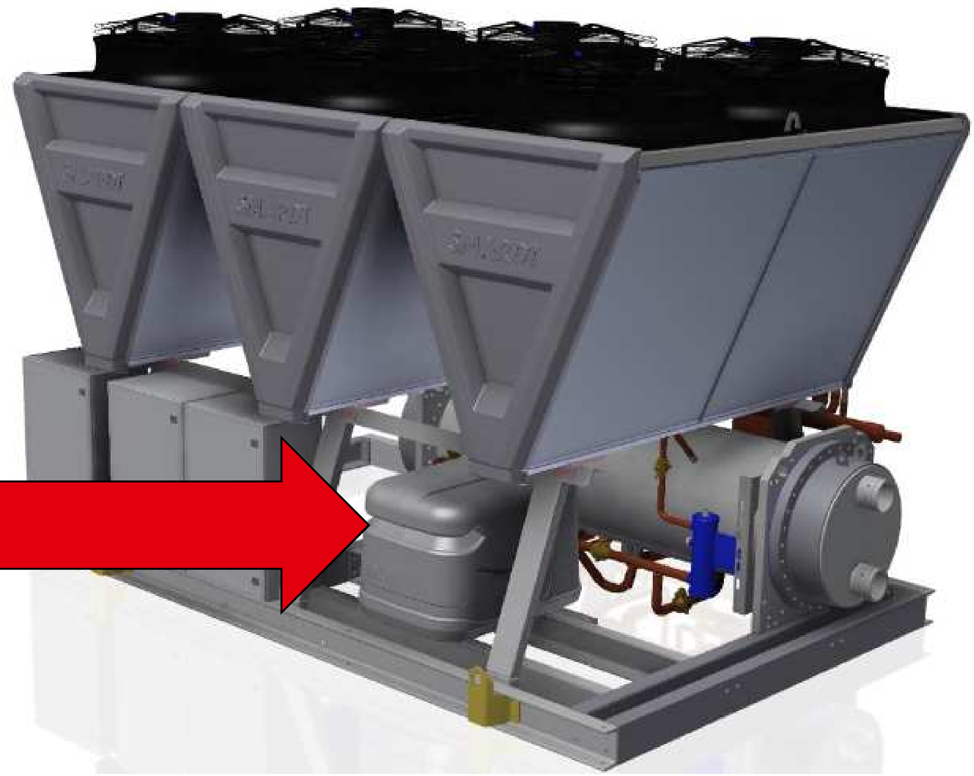
- Lower system installation cost
- Faster design cycles
- Smaller mechanical footprint
- Reduces water consumption
- Lower maintenance – no cooling tower
- Reduce risk of legionella



Challenges for Air Cooled Chillers

- Size



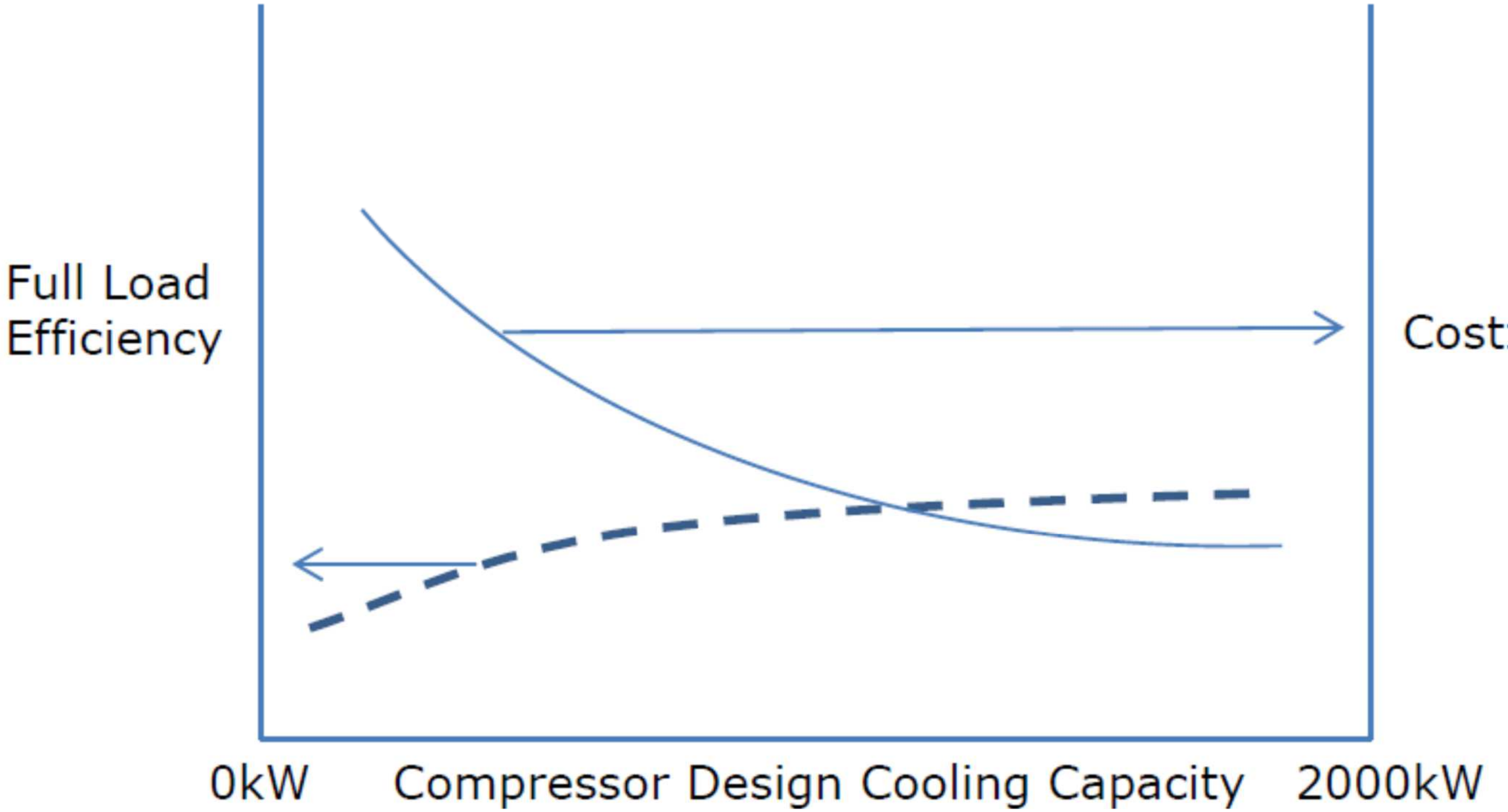


Challenges for Air Cooled Chillers

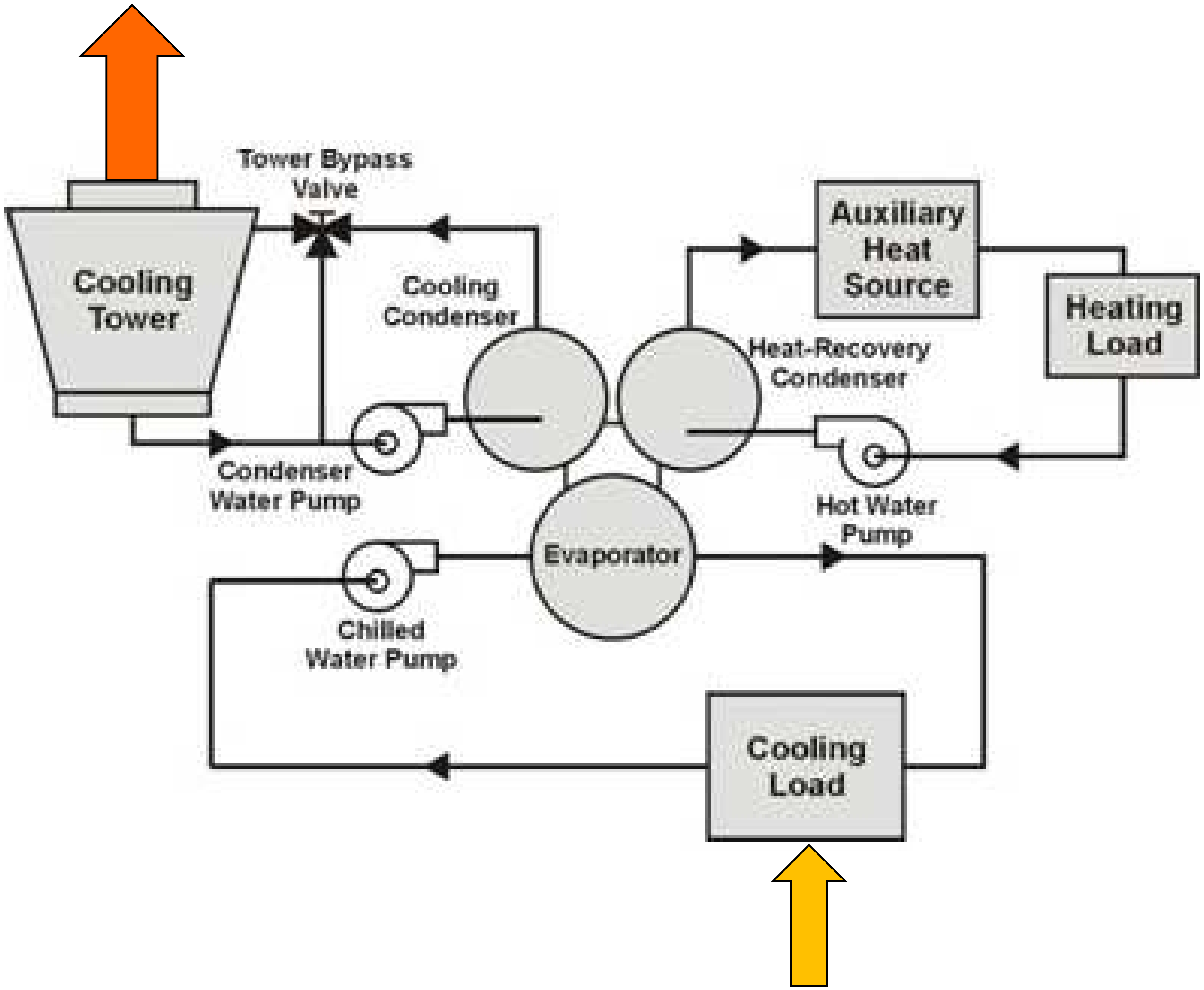
- Outdoor Application

Challenges for Air Cooled Centrifugal Chillers

- Cost/Efficiency

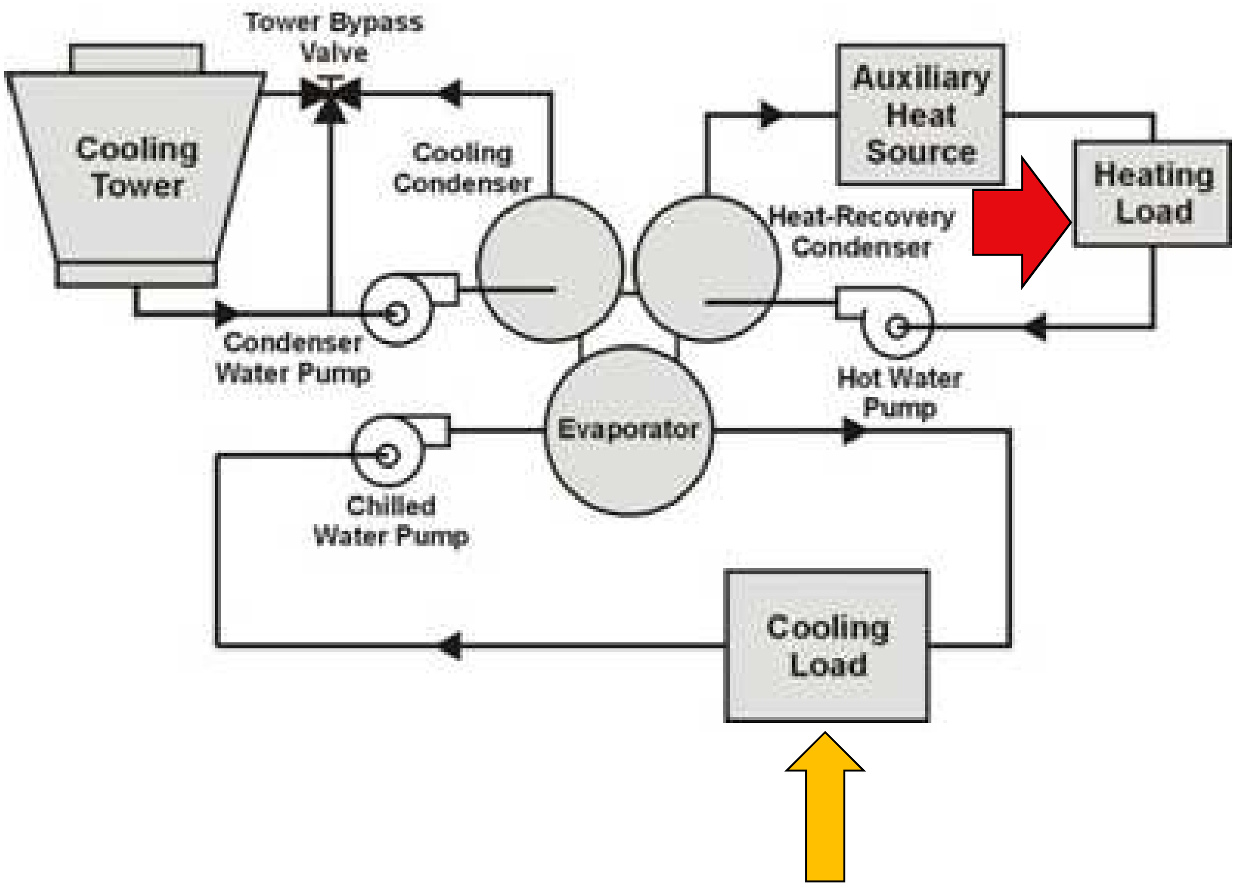


Standard Chiller – Heat Rejected to Atmosphere



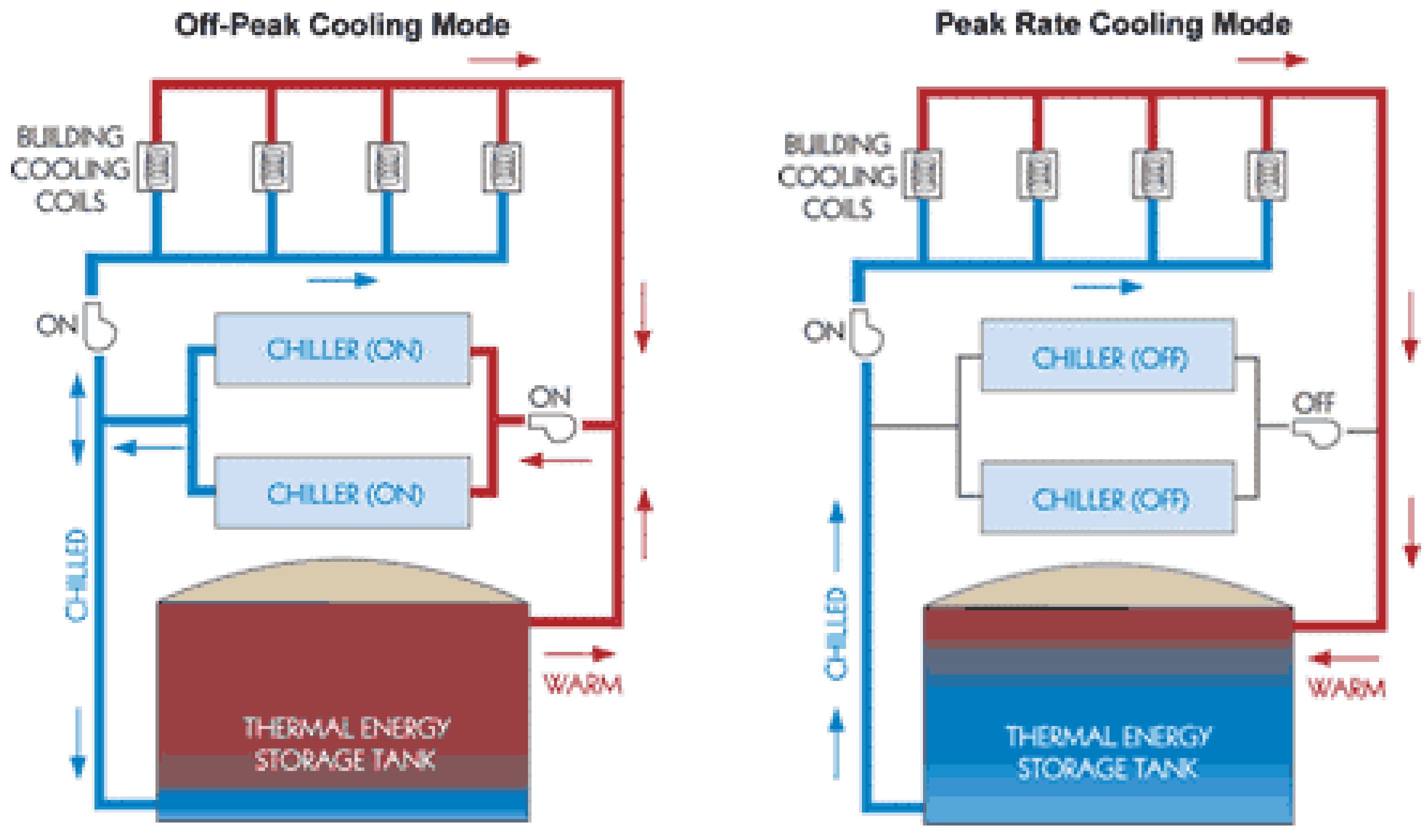
Heat Reclaim/Heat Recovery/Heat Pumps

- Heat Recovery / water-water heat pump
- Energy savings by utilizing waste heat
- Can help downsize or eliminate boiler

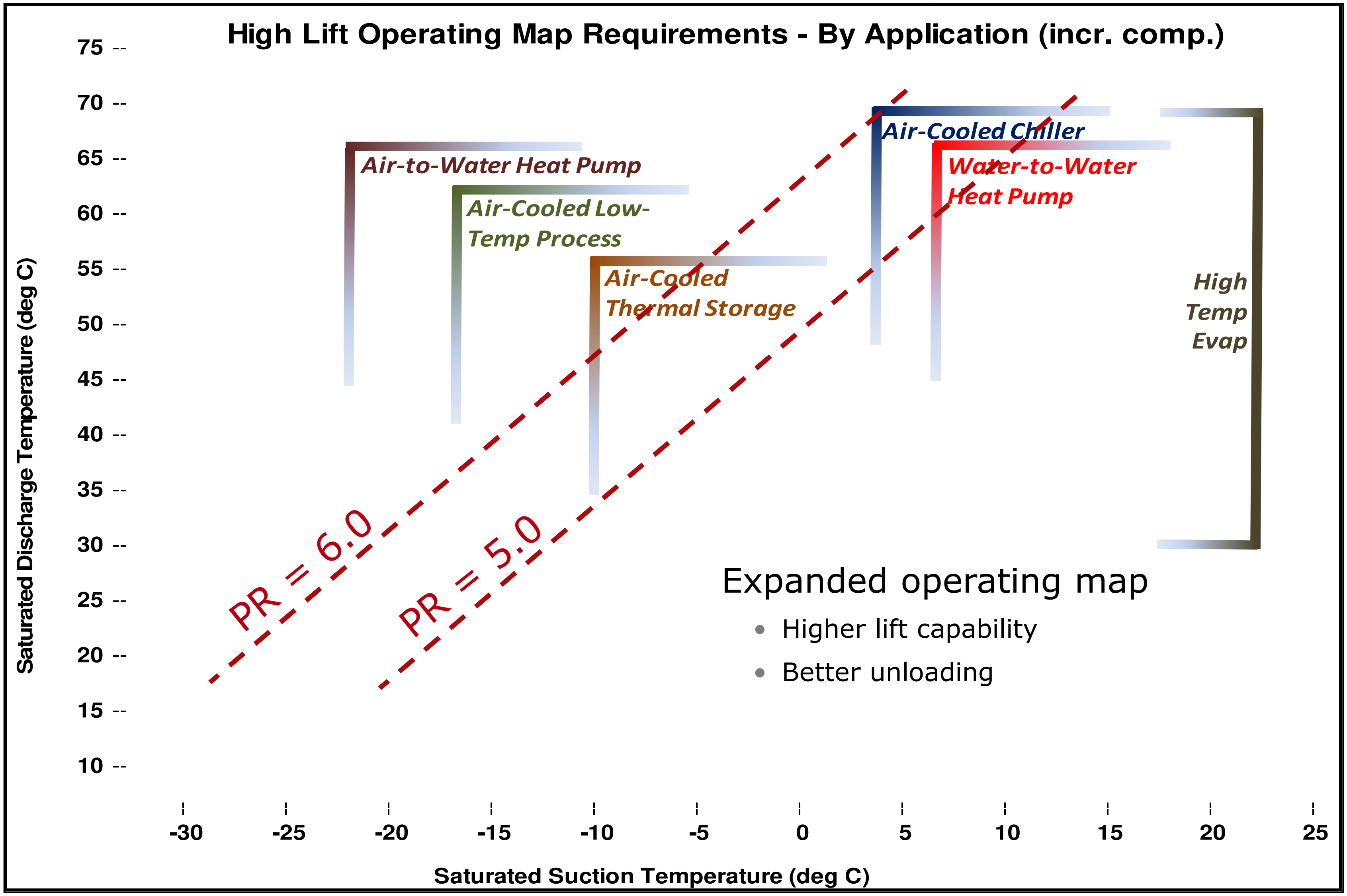


Thermal Storage

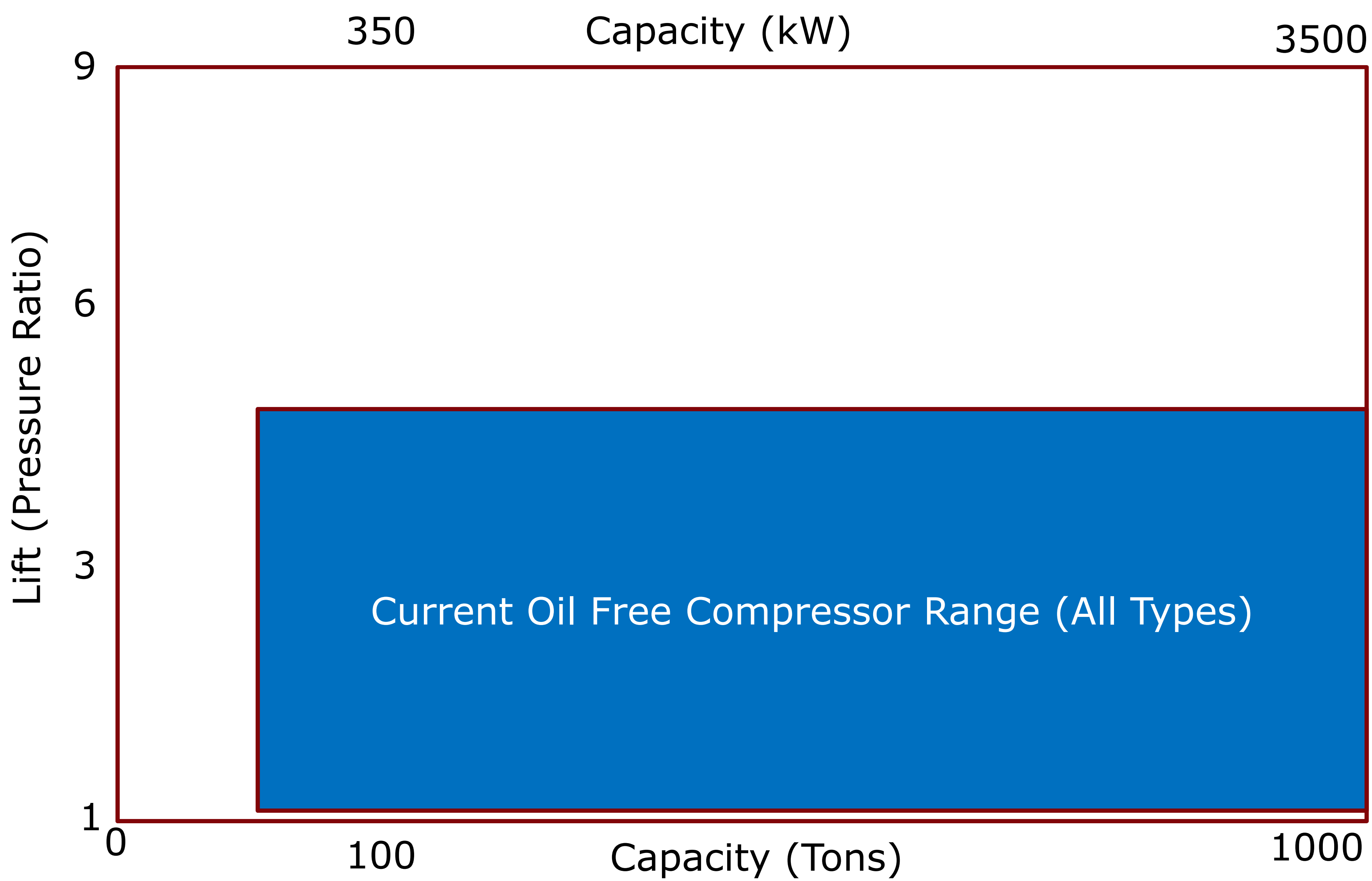
- Shifts energy consumption to less expensive off peak hours
- Lower utility rates



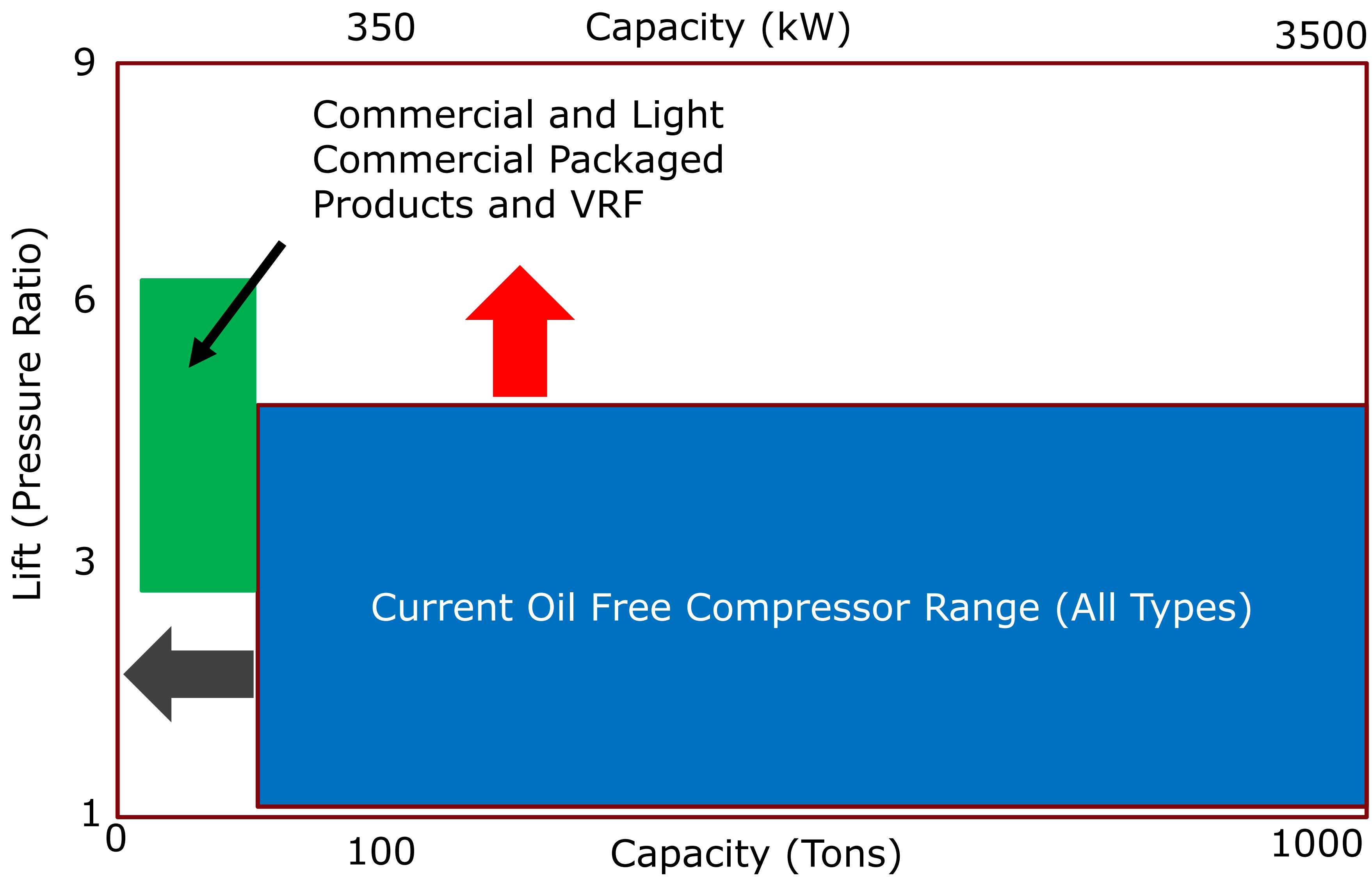
Next Generation Oil Free Compressors



Oil Free Compressor Current State



Oil Free Compressor Future



Questions?

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