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Compressor and System Design Integration

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Learning Objectives

- Describe the major market and regulatory trends impacting chiller and compressor design.
- Explain how design choices for compressor, heat exchangers and other major components are inter-related.
- Define how compressor design is impacted by part load efficiency focus. Including modulation via speed and mechanical means.
- Describe the impact of new refrigerants on compressor design.

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Agenda

- System overview
- Major component discussion
- Design decisions
 - Compressor/driveline
 - Heat exchangers
 - Controls
- Summary

System Overview

- Positive displacement Compressors

38.2

2016 ASHRAE Handbook—HVAC Systems and Equipment

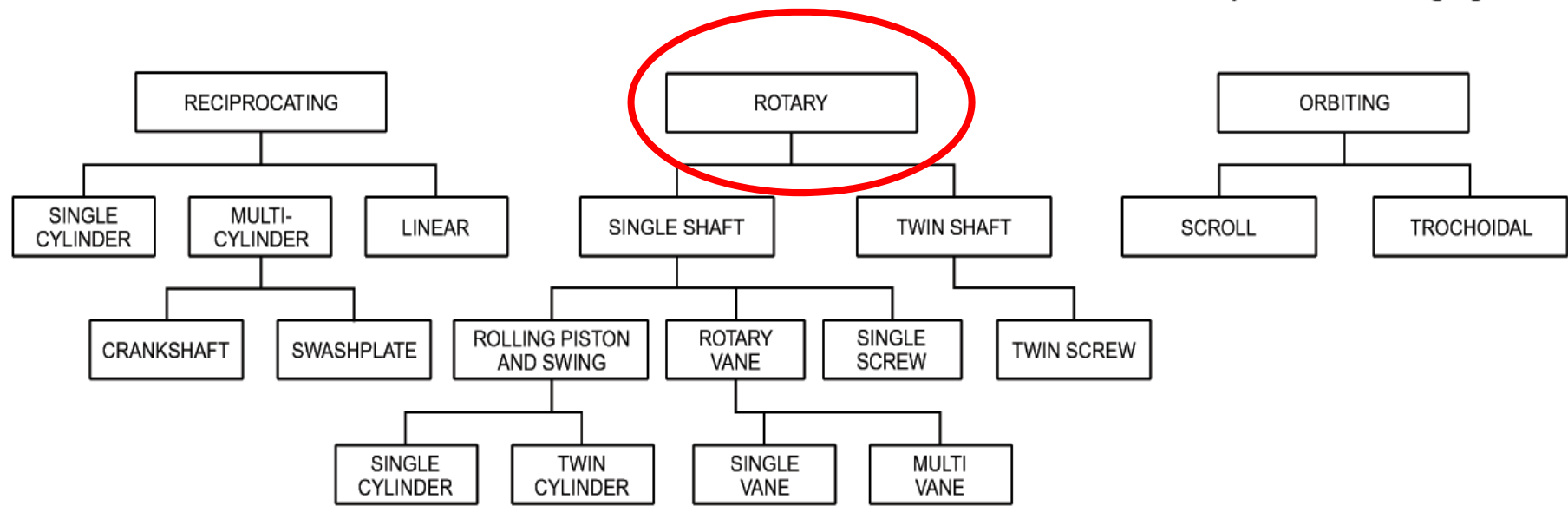


Fig. 2 Types of Positive-Displacement Compressors (Classified by Compression Mechanism Design)

System Overview

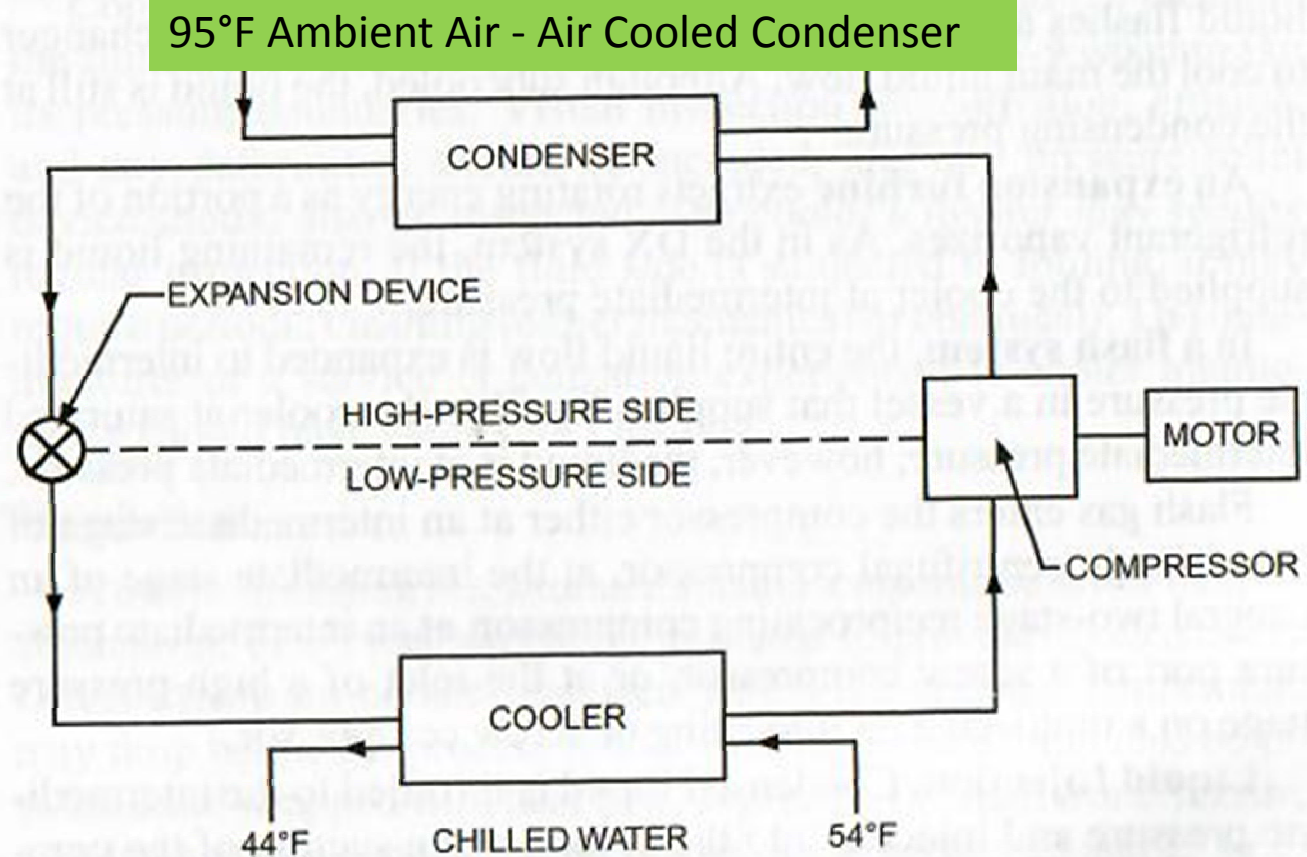


Fig. 1 Equipment Diagram for Basic Liquid Chiller

Major Component Discussion

- Screw Compressors

Single Screw

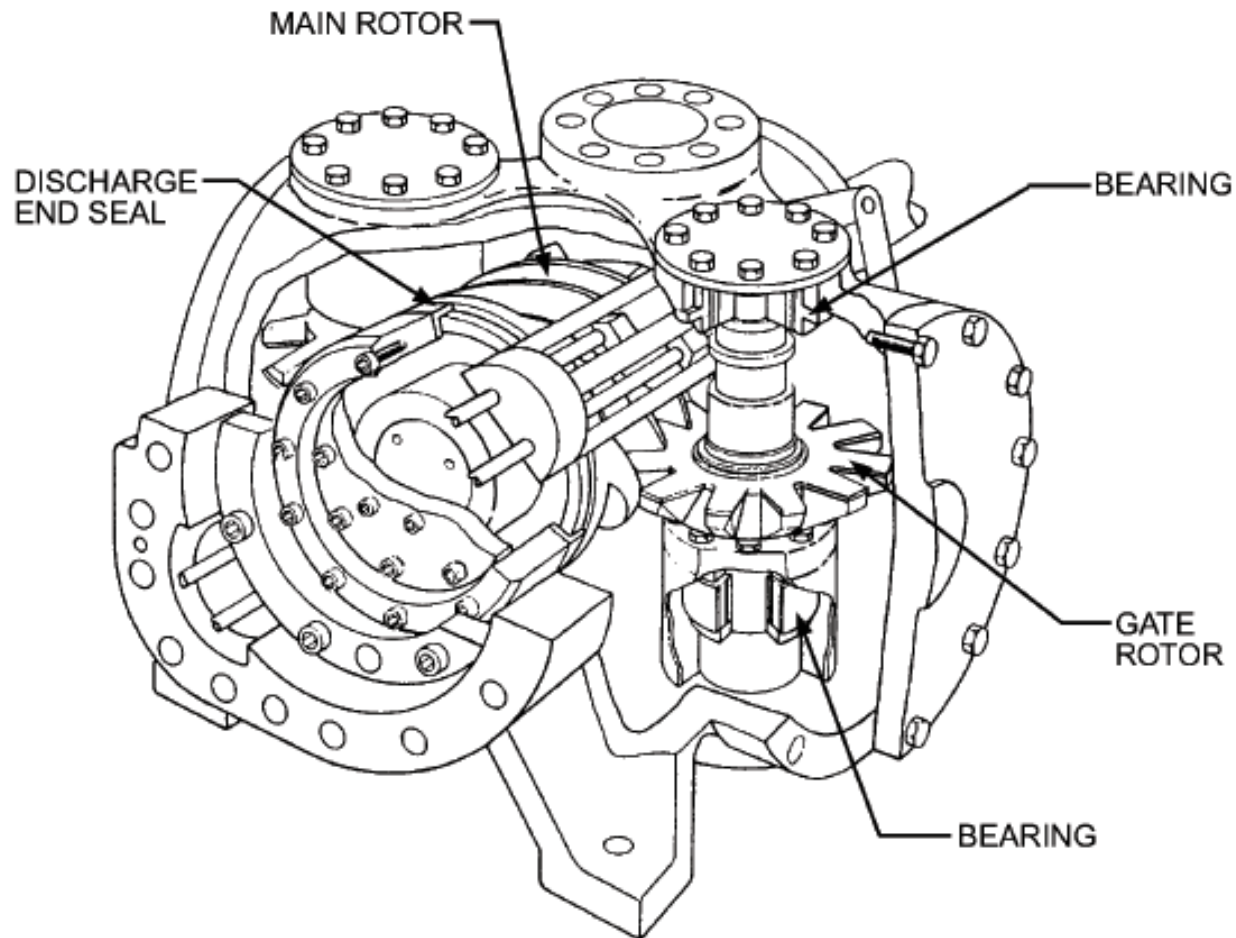
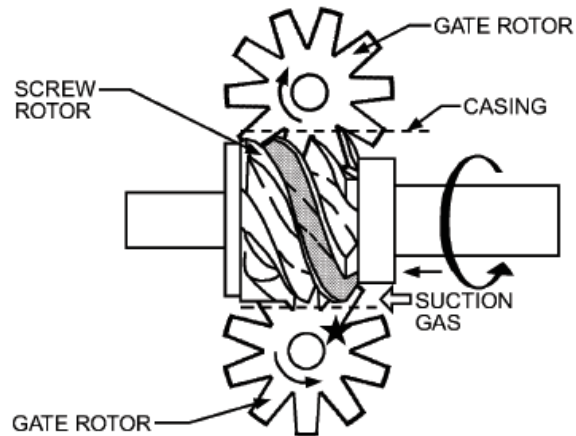
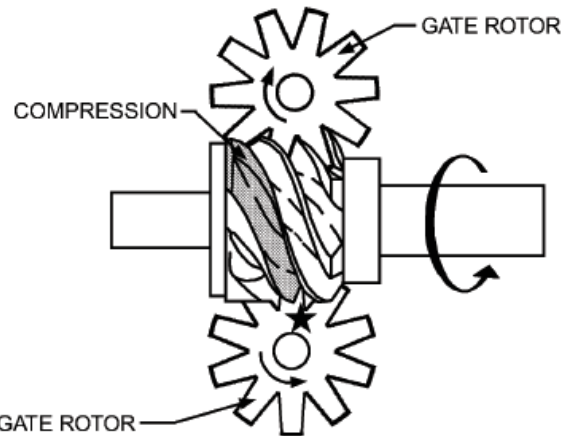


Fig. 17 Section of Single-Screw Refrigeration Compressor

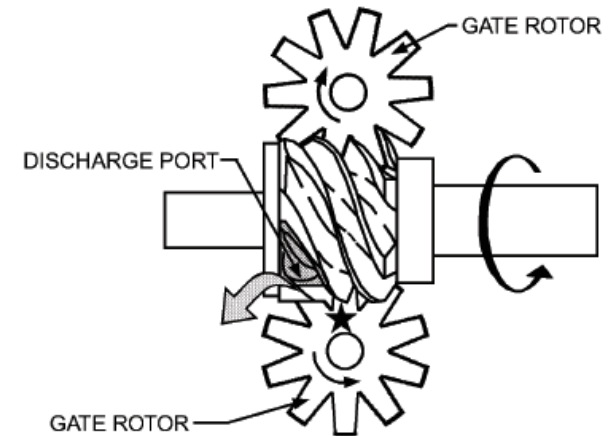
Single Screw



Suction. During rotation of the main rotor, a typical groove in open communication with the suction chamber gradually fills with suction gas. The tooth of the gate rotor in mesh with the groove acts as an aspirating piston.



Compression. As the main rotor turns, the groove engages a tooth on the gate rotor and is covered simultaneously by the cylindrical main rotor casing. The gas is trapped in the space formed by the three sides of the groove, the casing, and the gate rotor tooth. As rotation continues, the groove volume decreases and compression occurs.



Discharge. At the geometrically fixed point where the leading edge of the groove and the edge of the discharge port coincide, compression ceases, and the gas discharges into the delivery line until the groove volume has been reduced to zero.

Twin Screw

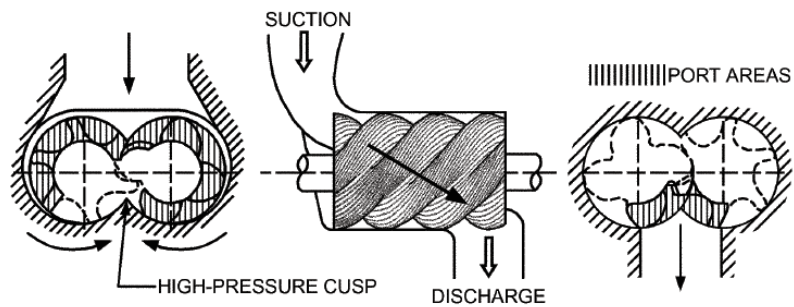


Fig. 32 Twin-Screw Compressor

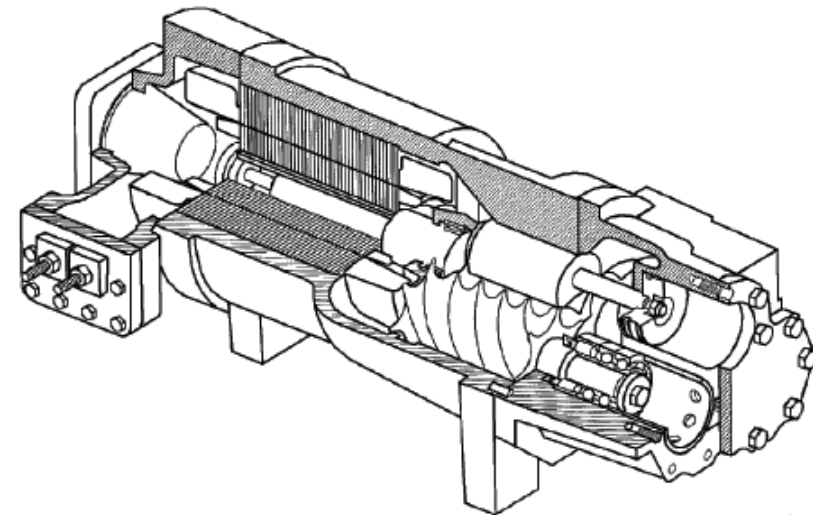
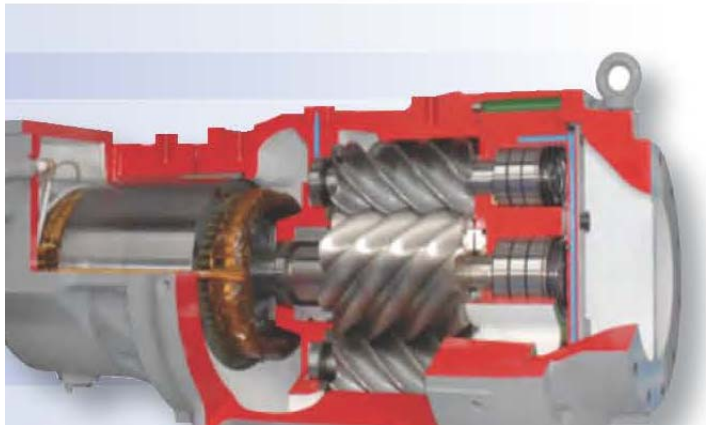


Fig. 38 Semihermetic Twin-Screw Compressor with Suction-Gas-Cooled Motor and Slide Valve Unloading Mechanism

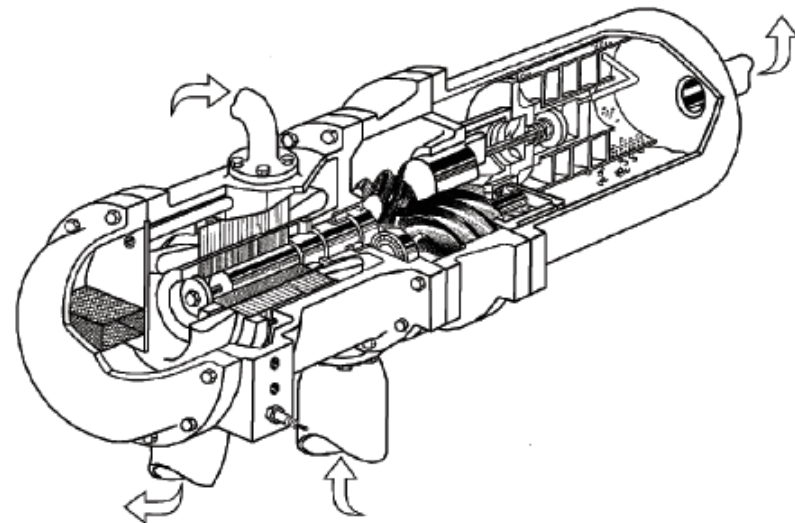


Fig. 39 Semihermetic Twin-Screw Compressor with Motor Housing Used as Economizer; Built-In Oil Separator, and Slide Valve Unloading Mechanism

Twin Screw

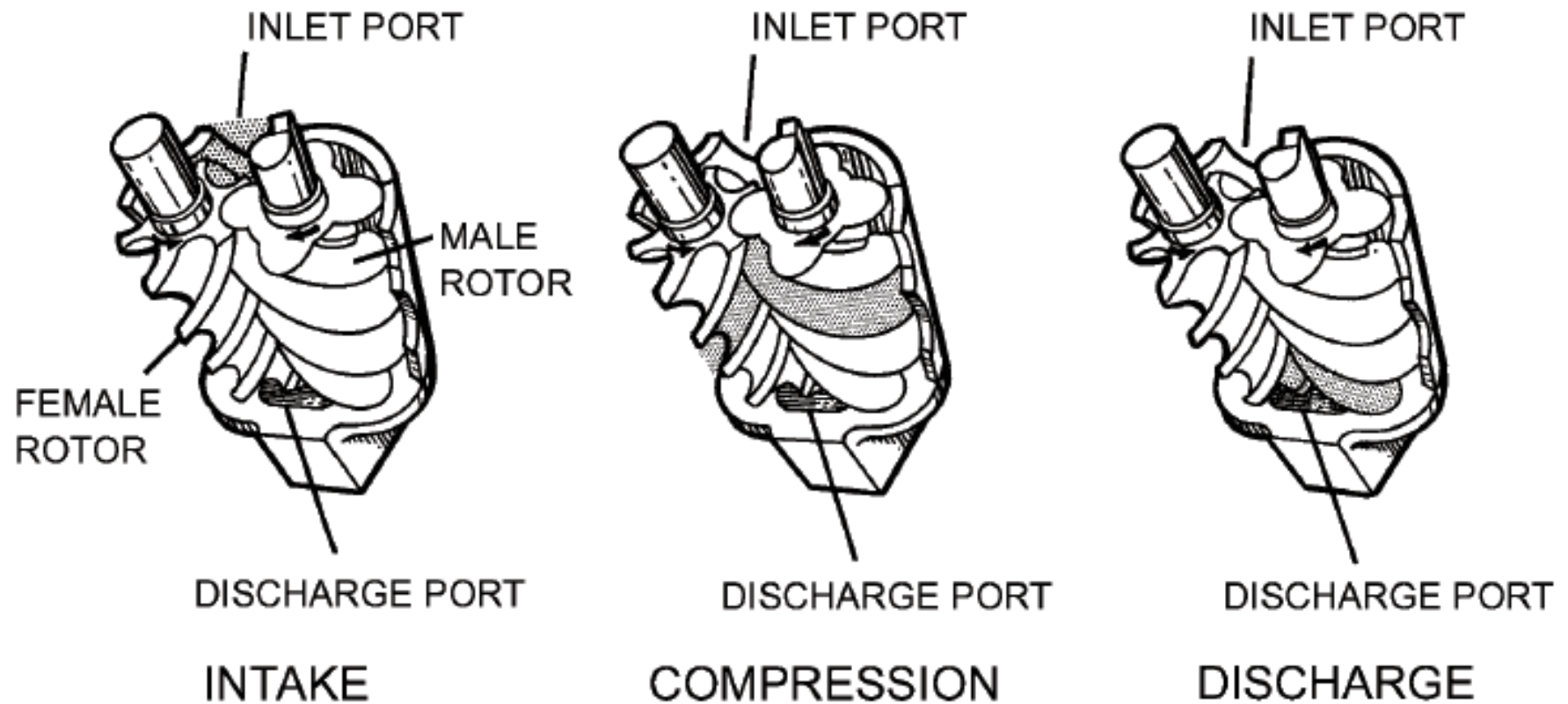


Fig. 33 Twin-Screw Compression Process

Heat Exchangers

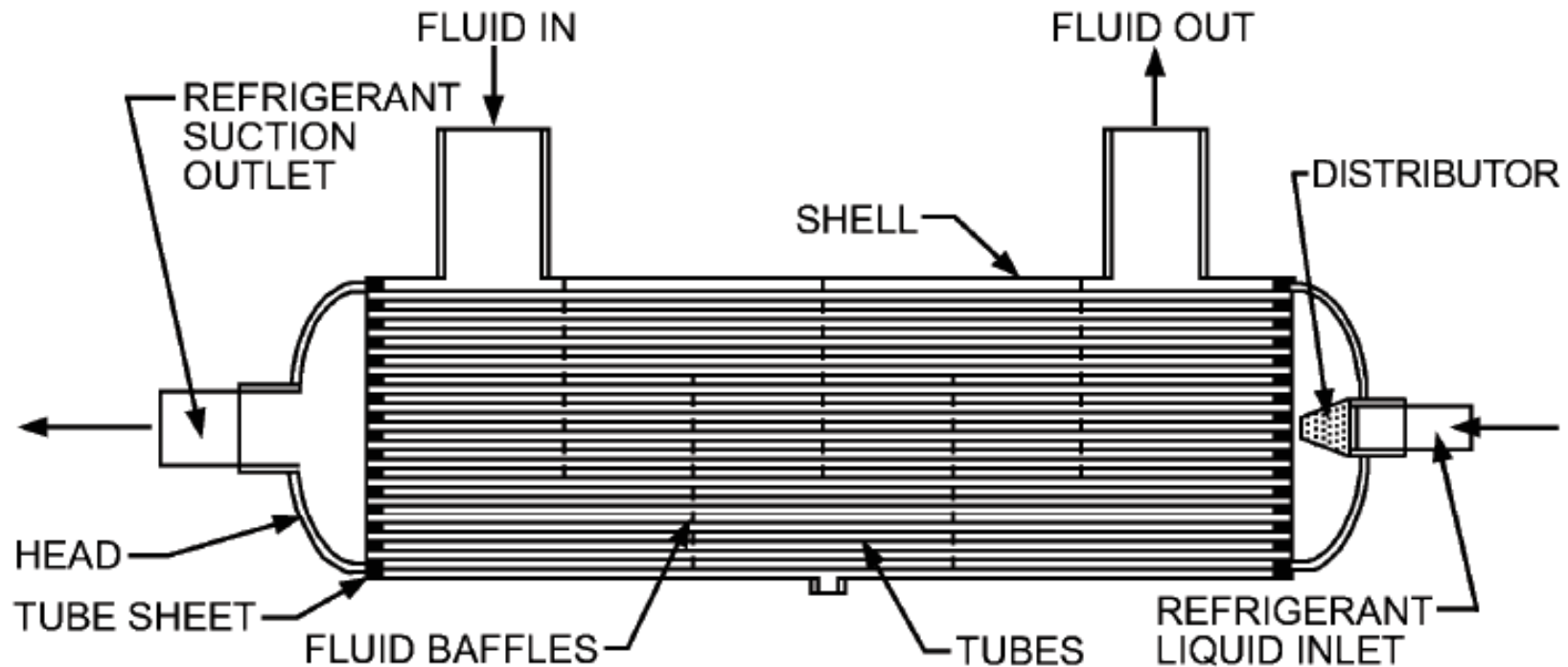


Fig. 1 Direct-Expansion Shell-and-Tube Cooler

Heat Exchangers – DX Cooler



Heat Exchangers

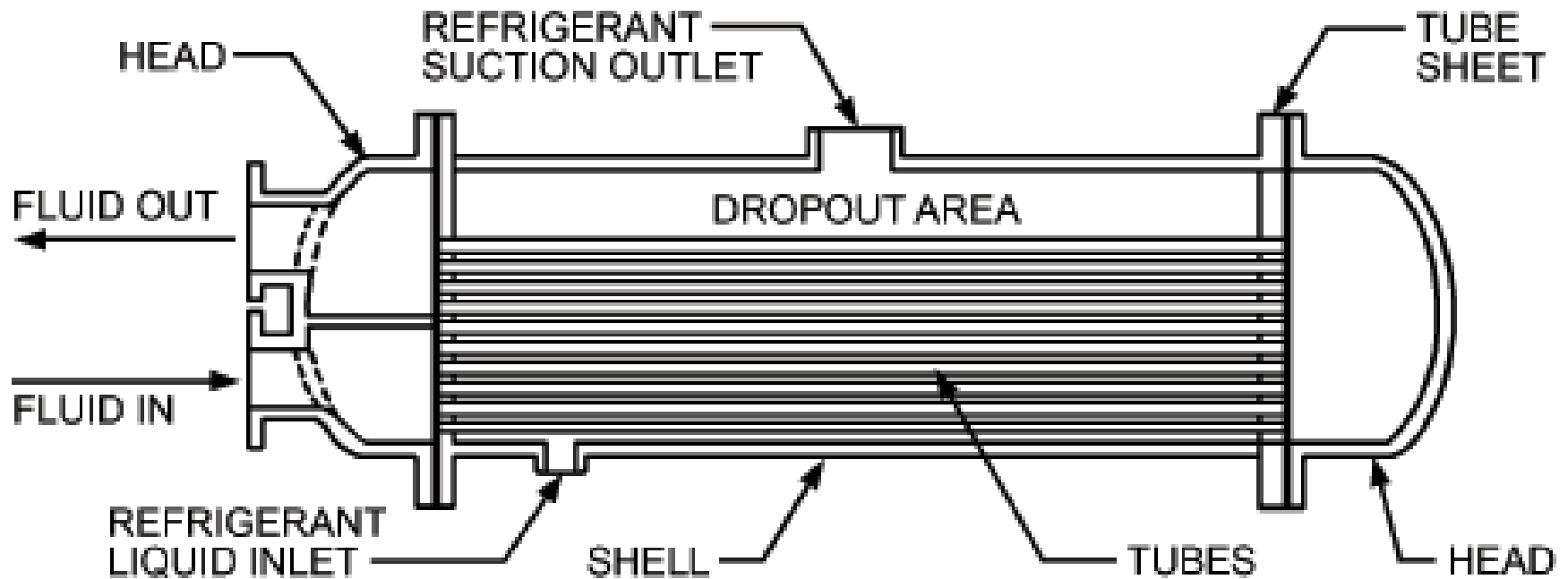
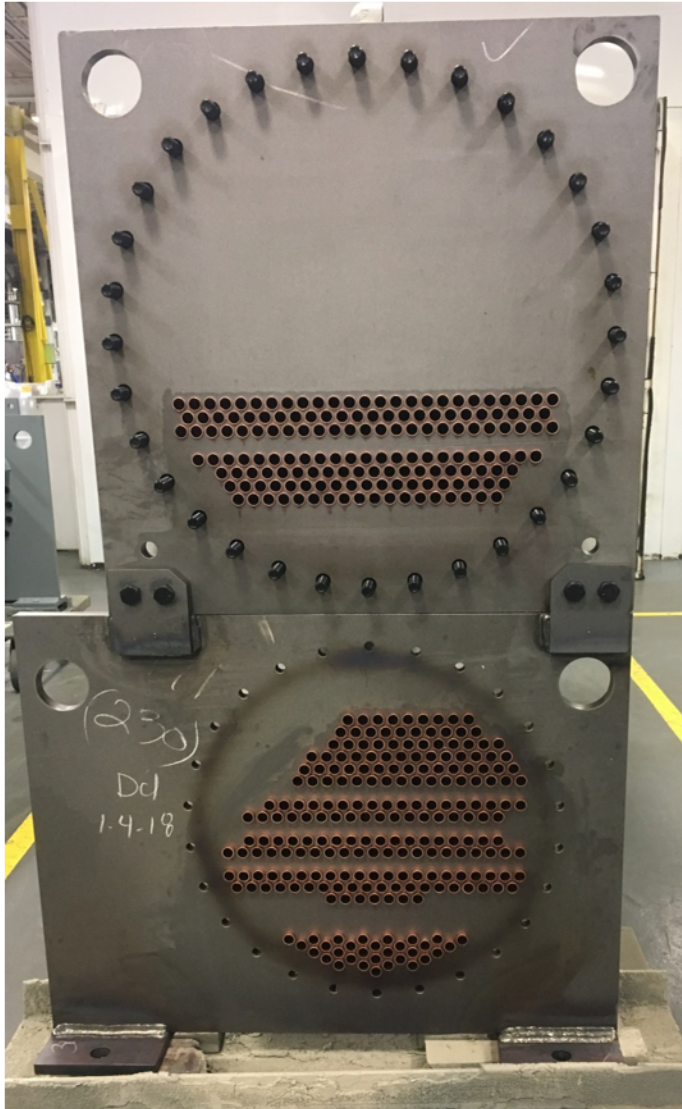


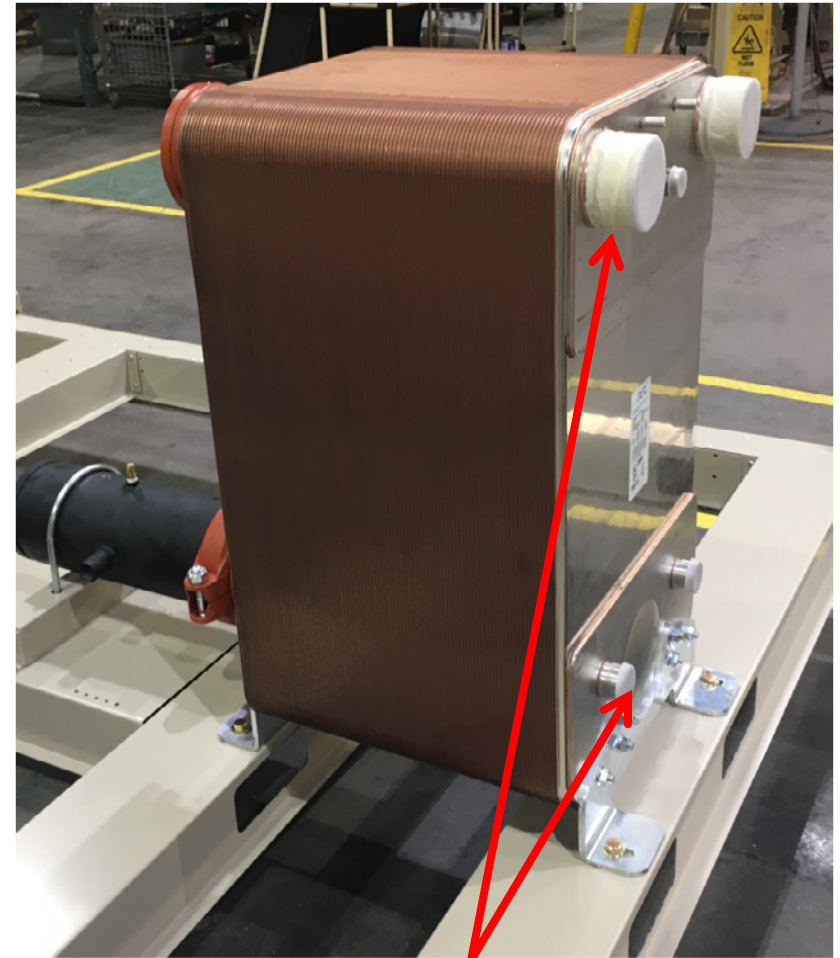
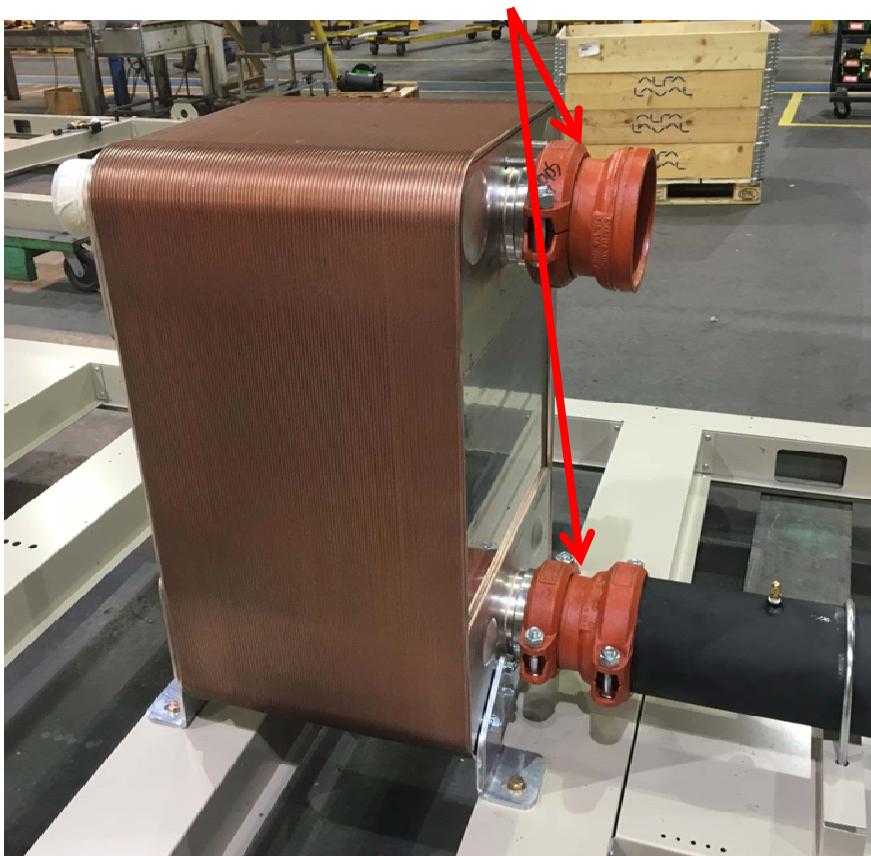
Fig. 2 Flooded Shell-and-Tube Cooler

Heat Exchangers – Flooded Evap



Heat Exchangers – Brazed Plate

Water Connections



Refrigerant Connections

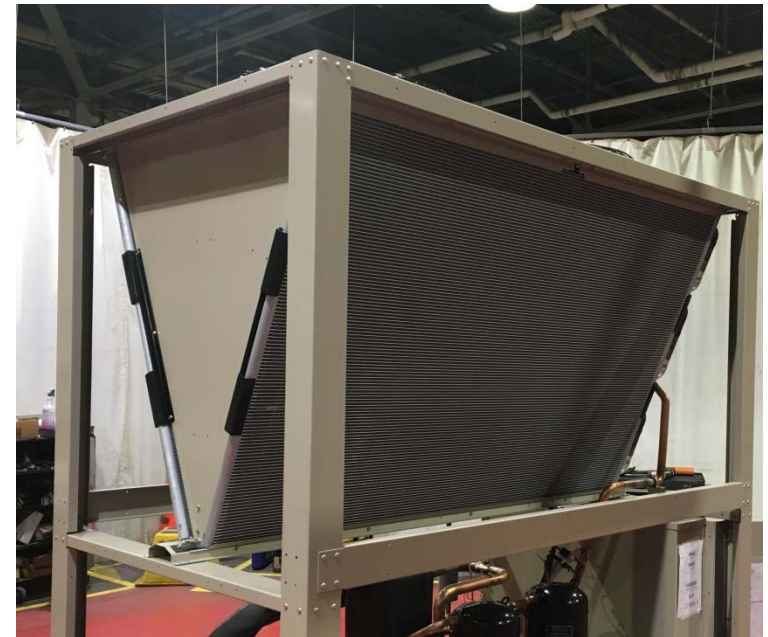
Heat Exchangers – Condensers

- Water cooled
 - Typically shell and tube
 - Brazed plates also used



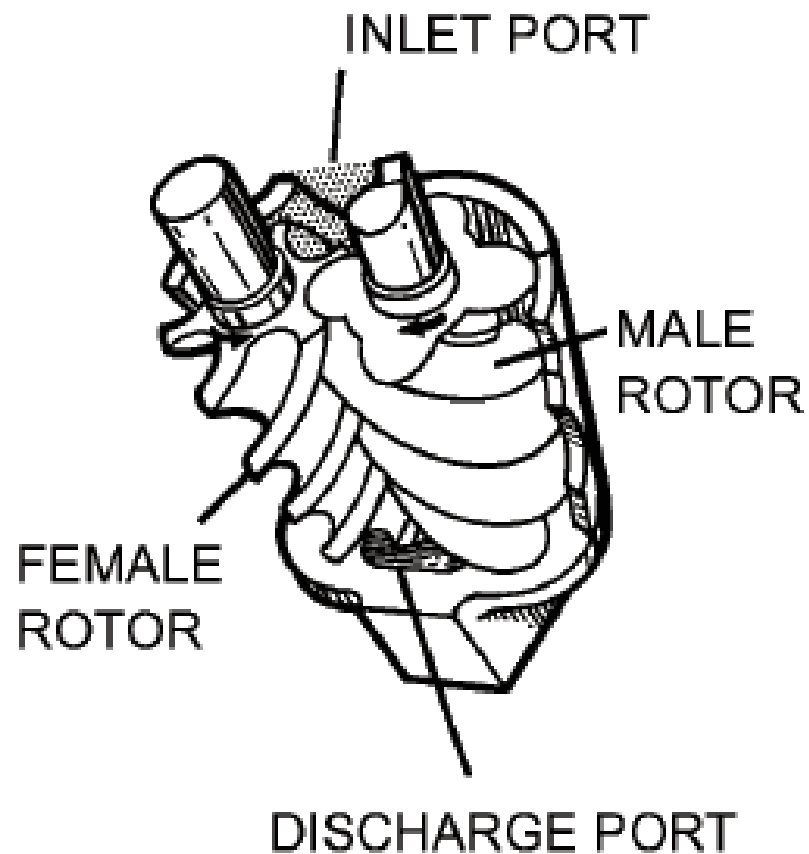
Heat Exchangers – Condensers

- Water cooled
 - Typically shell and tube
 - Brazed plates also used
- Air Cooled
 - Copper tubes/Aluminum fin coil
 - Microchannel



Design Decisions

- Compressor Control - Fixed or variable speed?



Design Decisions

- Compressor Control - Fixed or variable speed?
- Oil management
 - Key issue for screw compressor machines



Oil Management

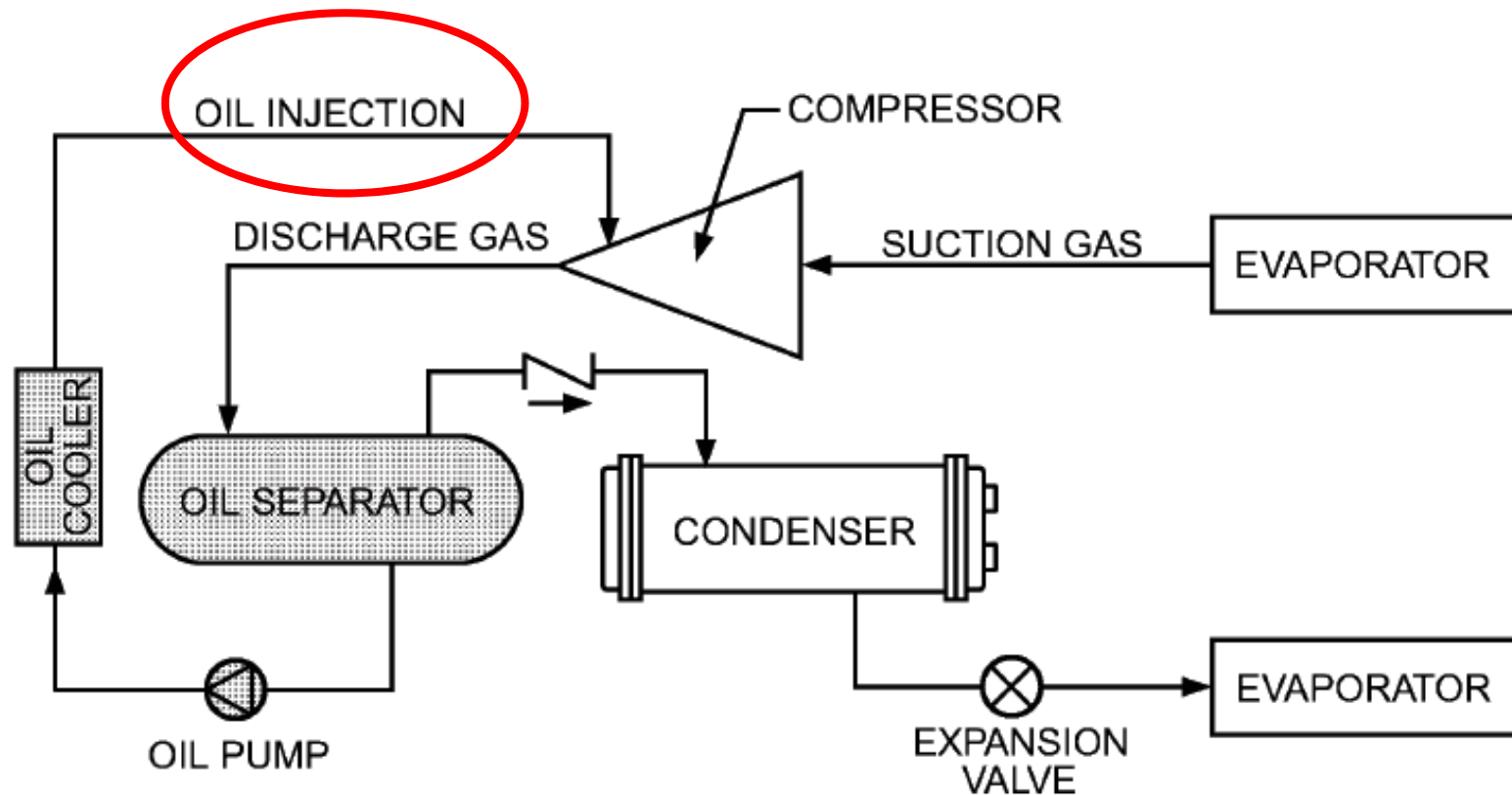


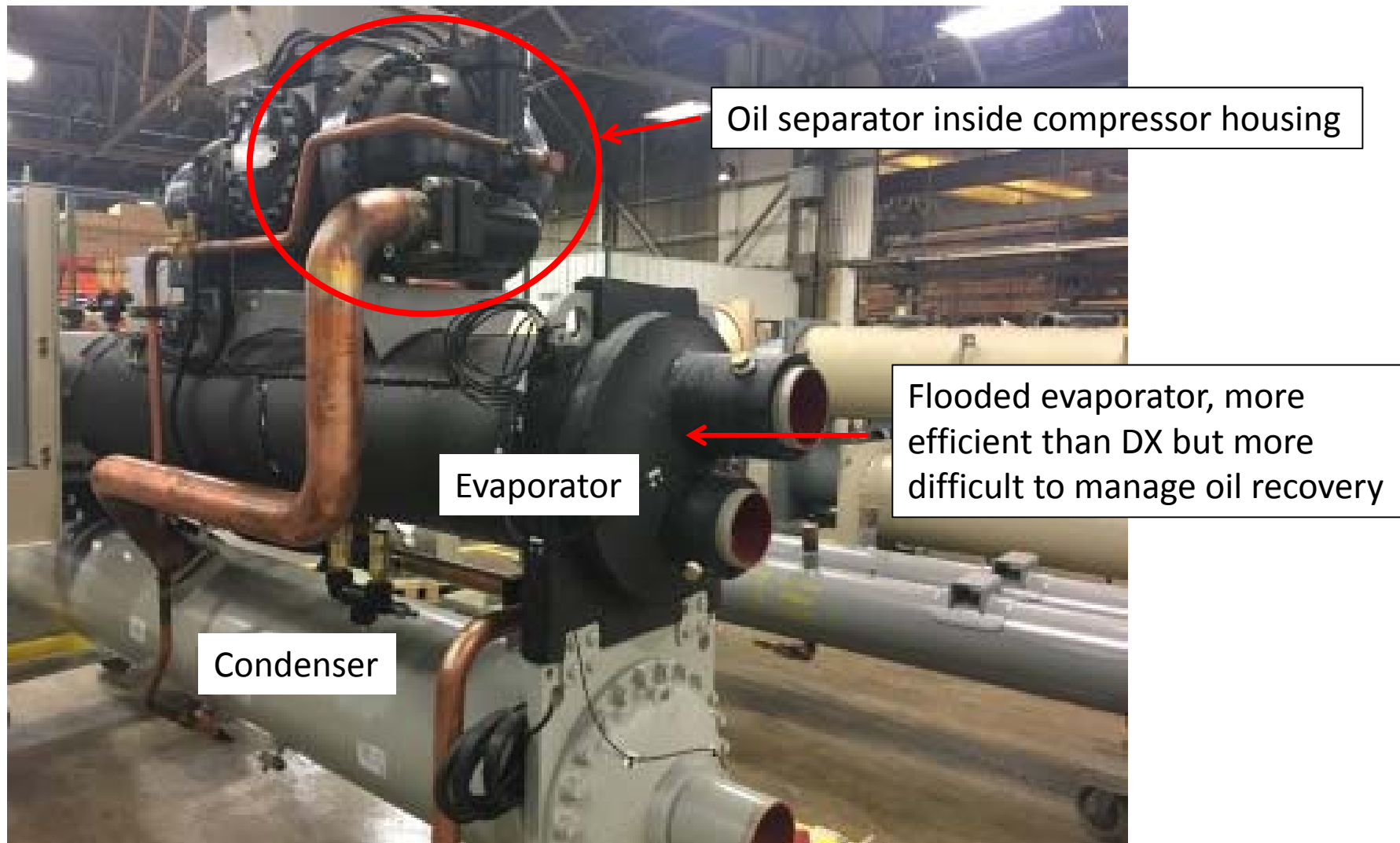
Fig. 20 Oil and Refrigerant Schematic of Oil Injection System

Design Decisions

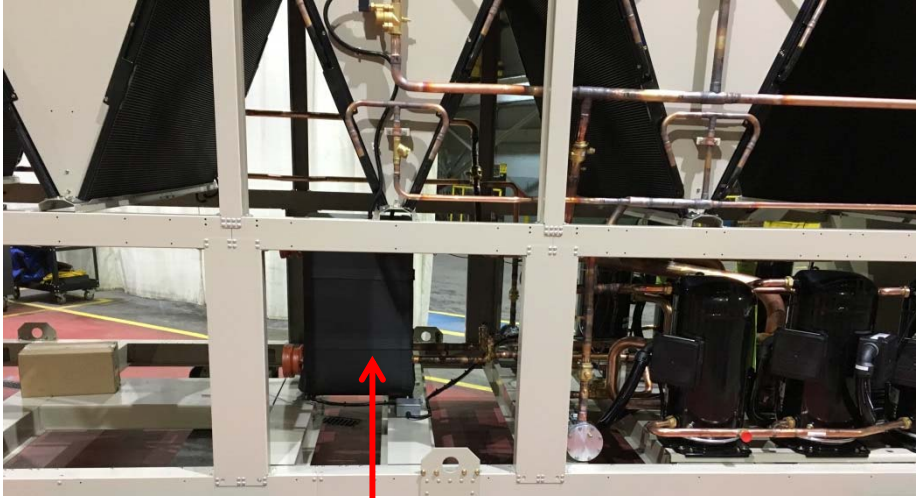
- Compressor Control - Fixed or variable speed?
- Oil management
 - Key issue for screw compressor machines
- Heat exchanger selection
 - Cost/Performance/Dimensions



Oil Management/Heat Exchanger Selection



Heat Exchanger Selection



Brazed plate evaporator

DX evaporator

These offer good oil management and lower refrigerant charge than a flooded evaporator



Design Decisions

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- Oil management
 - Key issue for screw compressor machines
- Heat exchanger selection
 - Cost/Performance/Dimensions
- Expansion device



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- Unit controls



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Summary

- Many choices to make in a system design
- Decisions in one area will often drive decisions for other parts of the system



Questions?

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