An “Industrommercial” CO_2 System

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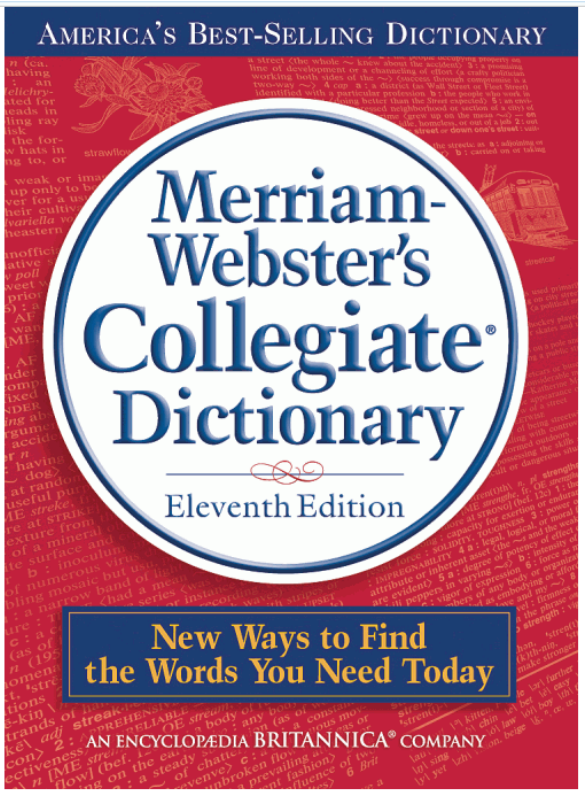
What does Industrommercial mean?

[in-duhs-truh-mur-shuh l]

noun

1. of, relating to, industrial and commerical markets
2. of, pertaining to, the nature of or resulting from industrial or commerical use
3. suitable or fit for industrial and commerical markets



The Case Study:
An Industrial System Using Compressors Traditionally Used in Commercial Applications

Commercial (Supermarket) vs. Industrial (Cold Storage / Blast Freezing)

	Commercial	Industrial
Load Size (Tons)	10 to 150	50 to 1,000
Load Size (kBtu/h)	120 to 1,800	600 to 12,000
Load Ratio	Higher Medium Temp	Higher Low Temp
Typical Design Sat. Suction Temps	-28°F to +25°F	-40°F to +25°F
Typical Design Sat. Discharge Temps	115°F to 125°F (Air Cooled)	95°F to 105°F (Evap cooled)
Piping	Copper	Steel
Refrigerants (Historically)	H(C)FCs	Ammonia

Overlap

Overlap

Commercial (Supermarket) vs. Industrial (Cold Storage / Blast Freezing)

	Commercial	Industrial
System Technology	Direct Expansion	Recirculation
Compression Technology	Recips [Scrolls / Screw])	Screws [Recips]
Compressor Motor	Semi-Hermetic	External (Open-Drive)
Compressor Units	Racks (>3 in Parallel)	Packs (1 or <3 in Parallel)
Oil Type	Miscible	Non-Miscible
Oil Management	Common Oil Separator (w/System Oil Return)	Individual Oil Separator (w/Oil Pot)
Capacity Control	Comp Staging, Unloaders, VFDs,	Slide Valves, VFDs, Comp Staging

Overlap

Overlap

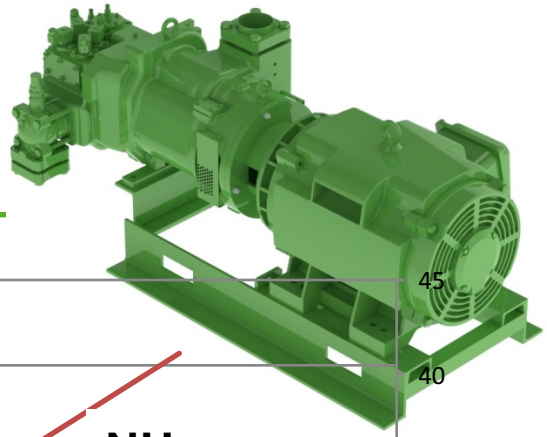
Commercial (Supermarket) vs. Industrial (Cold Storage / Blast Freezing)

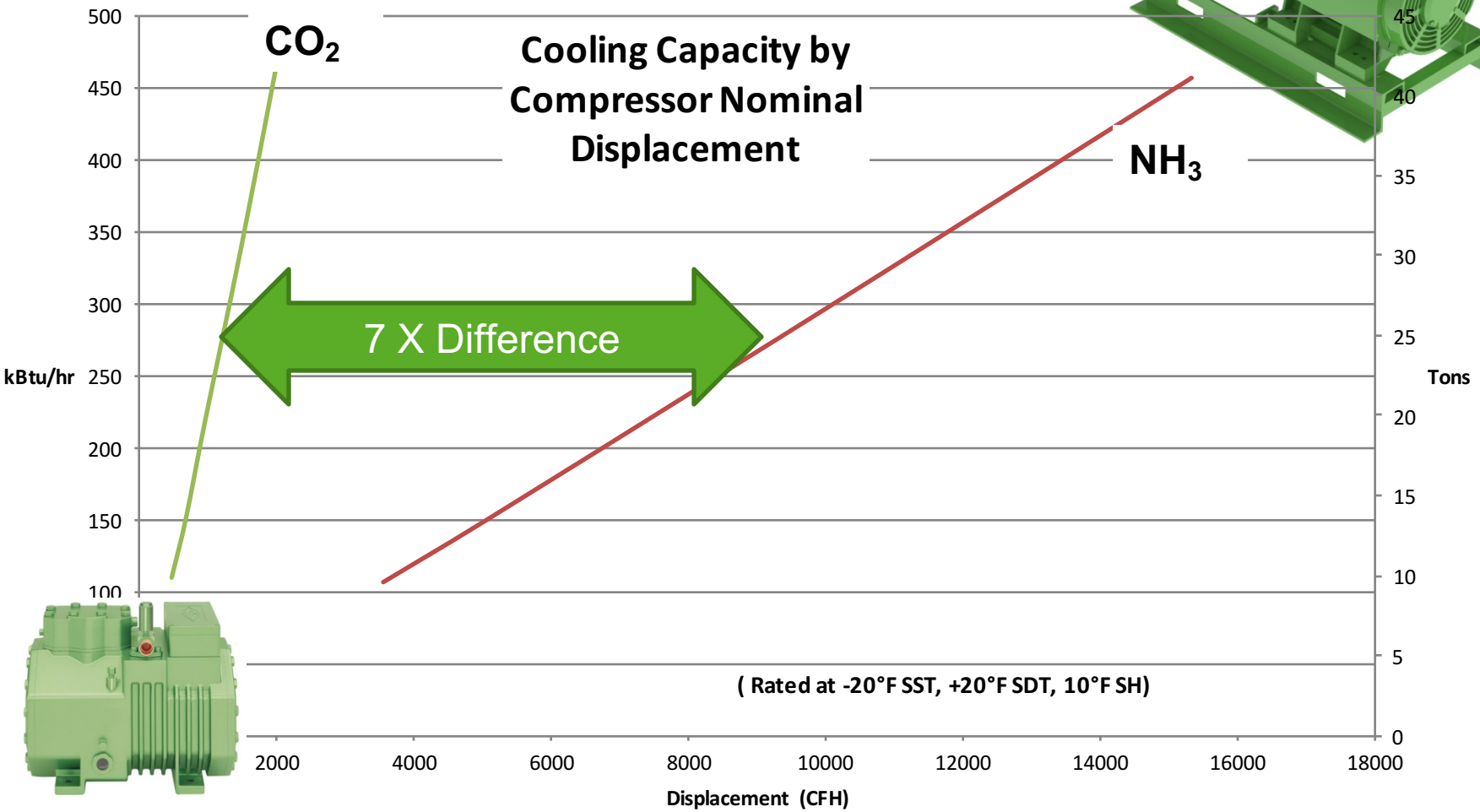
	Commercial	Industrial
Challenges	GWP / Carbon Footprint (EPA, DOE)	Safety (EPA, OSHA, HSA) Note: EPA NOPR does not include industrial!
Future Refrigerant Potential	Carbon Dioxide, HFOs, HFCs blends	Carbon Dioxide, HFCs

- Exchanging Information and technologies between Commercial and Industrial will ensure natural refrigerants success

Using Ammonia Requires Open Drive Compressors → CO_2 Does Not!

Bridging the Gap Between Commercial and Industrial





Bridging the Gap Between Commercial and Industrial

	Commercial Pros	Industrial Pros
Semi-Hermetic Vs. Open Drive Compressors	Semi: No Shaft Seals / Quiet ✓	Open: Slight Gain in Efficiency
Parallel vs. Single Compressors	Parallel: Better redundancy & capacity control ✓	Single: Simpler packs
Piping	Copper: Cost Effective	Steel: More Robust ✓
Compressor Size	Smaller: Lower weight & Smaller Inverters ✓	Larger: Fewer Compressors
System Type	DX: Simpler oil return	Recirculation: Suited for long piping runs ✓
Compressor Preventative Maintenance	Requires little	
Popularity / Proven	1,000s of CO_2 Systems 10,000s of CO_2 compressor	

The Case Study

An Industrial Cold Storage Blast Freezer Facility that Employs Commercial Type Semi-Hermetic Compressors

- System Manufacturer: Lee Technologies (Jasper Lee, Owner)
- 360 Tons of Refrigeration (4,320 kBtu/h)
- CO_2 / NH_3 Cascade System
- 14,000 lbs of CO_2
- Low Side:
  - -30°F SST / +20°F SDT
  - (12) 30HP Subcritical Semi-Hermetic CO_2 Compressor
  - Individual Separators
  - (6) 30 HP Inverters

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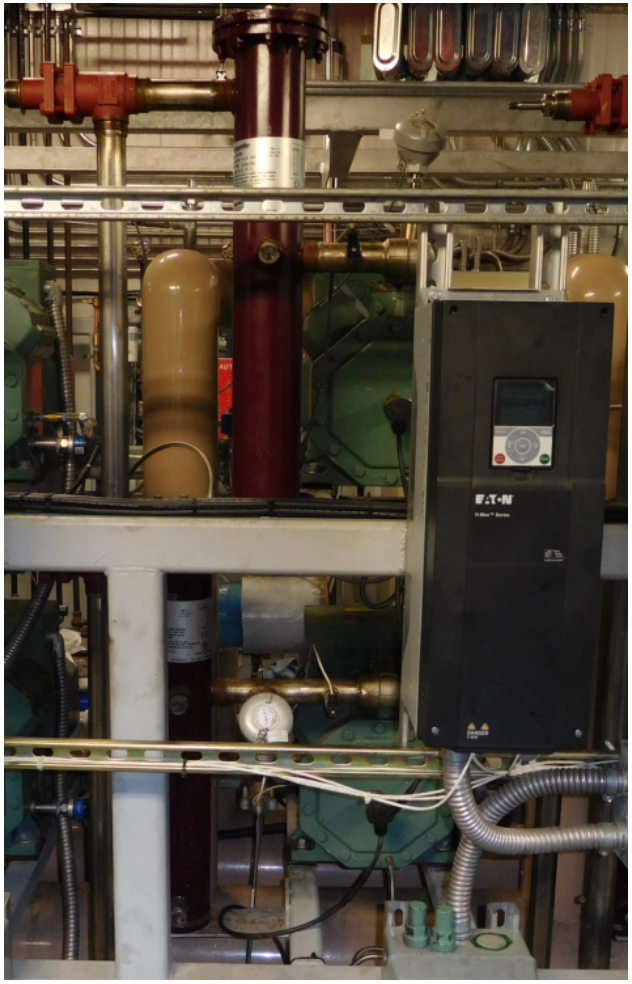
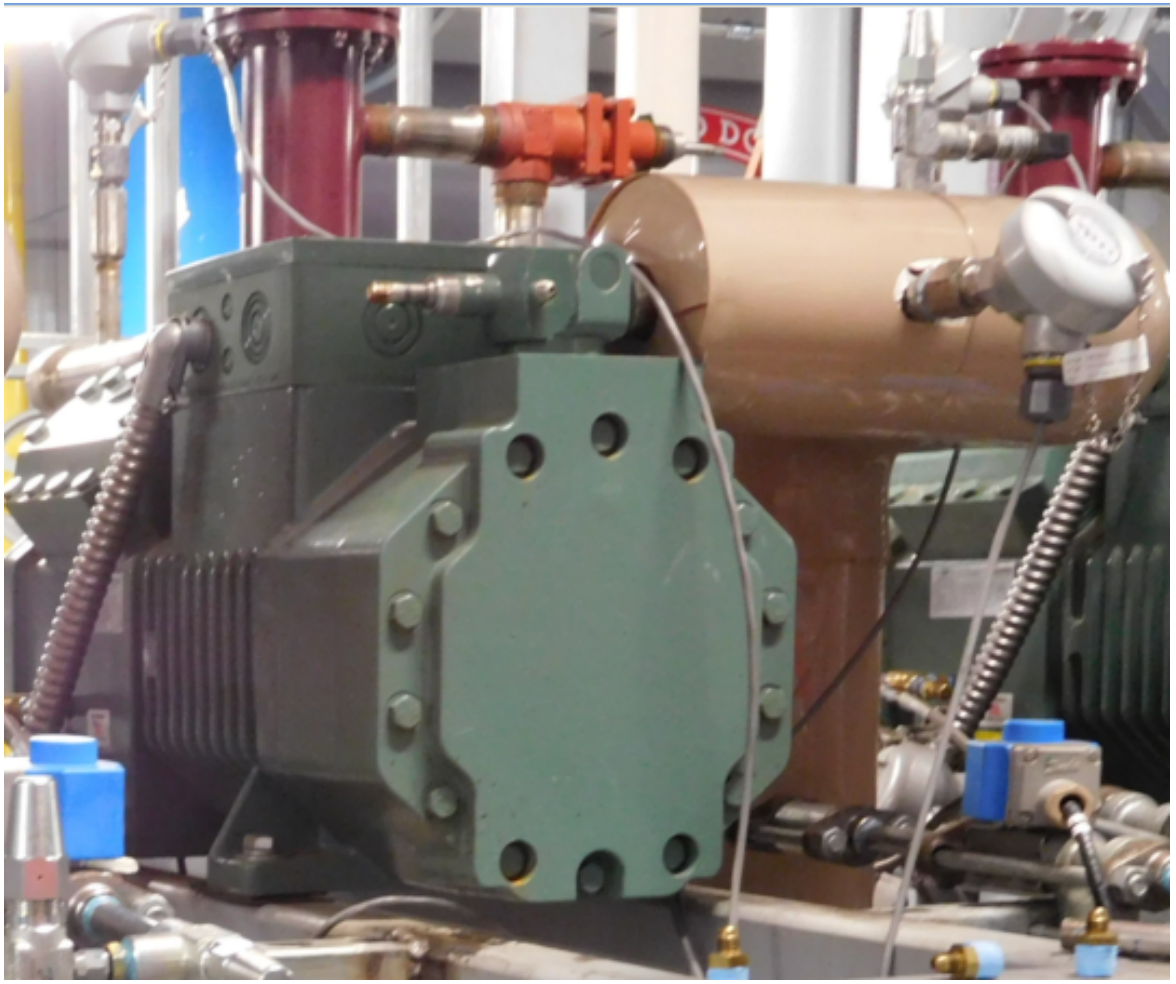
The Case Study





The Case Study

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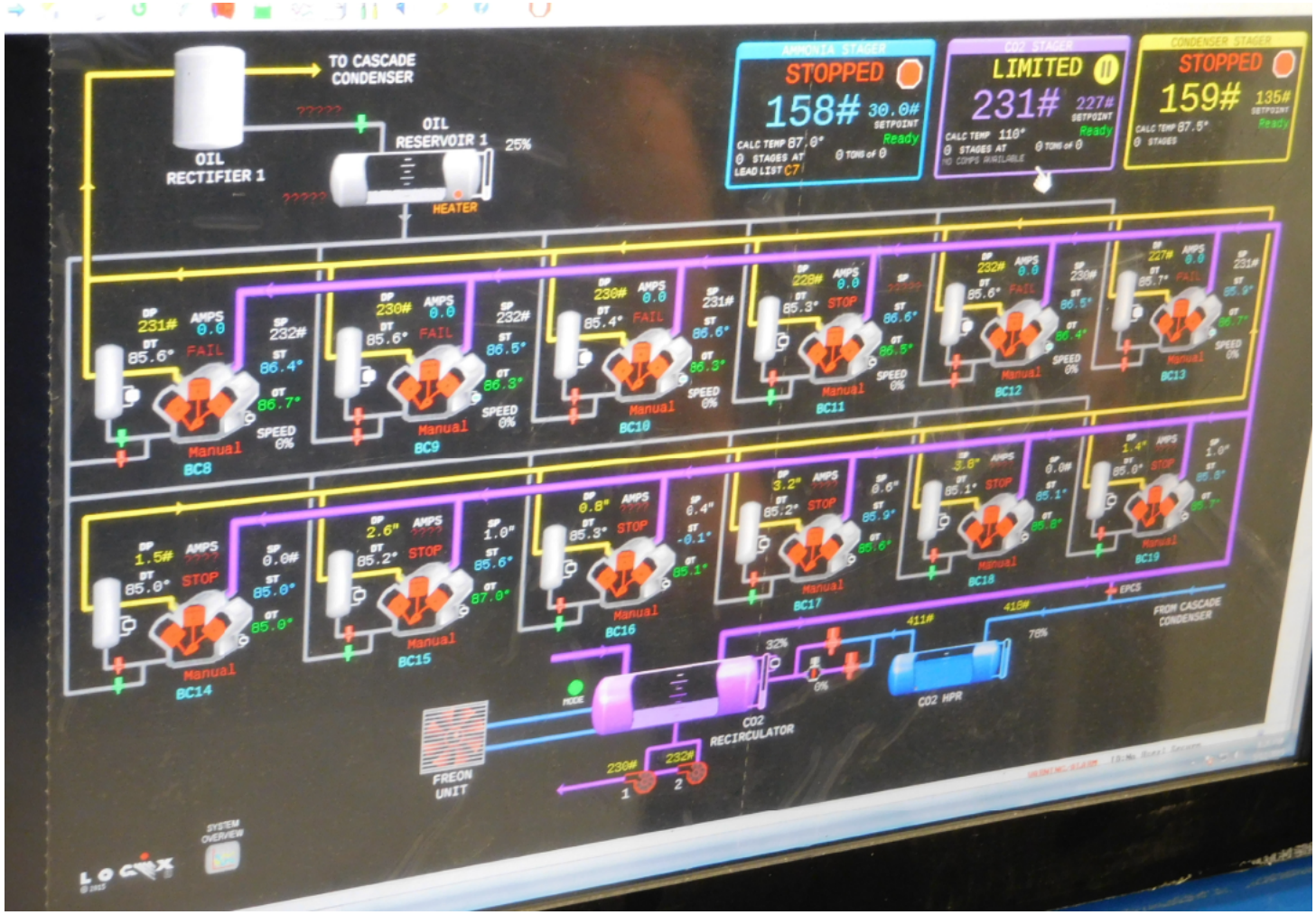

Oil Management

An Industrial System Will Log Oil in Liquid Recirculators

- Oil is Homogenous with the Liquid CO_2
  - Multiple skimming points not required
  - Rule of thumb is rectify 1% of mass flow
- Oil Rectifier:
  - Vessel that holds a CO_2 / Oil Mixture
  - Uses a heater or higher temperature fluid to boil the CO_2 out of the mixture
- Challenge:
  - How to get oil back to compressors?

Oil Management

Oil Return

- Thermosyphon – Oil is drawn up to oil-holding vessel that feeds compressors
  - Most Efficient Method
  - Difficult to get oil velocity high enough (part load?)
  - Not a lot of existing data on the subject
- Pressure Differential – Drives oil back to oil vessel
  - More forceful, better guarantee of what's going on
  - Less Efficient
  - Requires more valves and control logic
- DX - Suction Gas pulls the oil through an expansion device
  - More forceful, better guarantee of what's going on
  - Less Efficient

Case Study – Lesson Learned

Oil Rectification

/ Needed better data on oil rectifier / calculation of the velocities

/ Difficult to prove out in the field

/ Had to install a pressure driving system

→Consider a DX HX for rectifying out the oil

Oil Separation

/ Individual oil separators

/ Dedicated oil charge, Low pull down capacity, High psid delivery

→Consider a common oil separator (per 3 or 4 compressors) with a reservoir (typical commercial rack set up)

/ Shared Oil Charge, More forgiving during pull down (one compressor on), Reservoir can be at lower pressure

Case Study – Capacity Control

Compressors of same size only need two inverters to have perfect stepless capacity (assuming 2:1 inverter turndown):

- / Comp1 w/ Inverter starts and ramps from 50% to 100%
  - System capacity ramps: 4.2% to 8.4% (w/12 Compressors)
- / Comp2 w/ inverter starts at 50% and Comp1 back down 50%
  - Ramp 1 then 2 100%.
  - System capacity: 8.4 to 16.7%
- / Comp3 comes on at 100% and Comp1 and 2 back down to 50%
  - Ramp 1 then 2 100%.
  - System capacity: 16.7% to 25 %
- / And so on, and so on.

/ BITZER Compressors can ramp to 70Hz for added flexibility

/ Could still have one or two extra inverter for back up if desired

ATMO AMERICA sphere

business case

natural refrigerants

25 & 26 June 2015 - Atlanta, Georgia

Bitzer

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