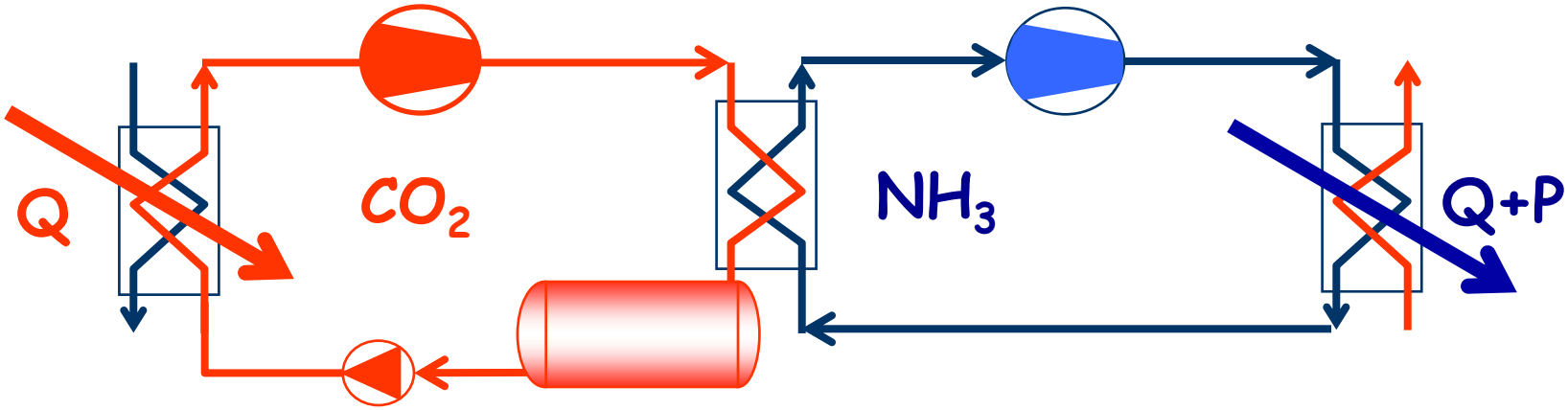
NH_3/CO_2 Cascade Refrigeration System



ASHRAE

June 29, 2003

Charles R. Taylor, P.E.

The Stellar Group

Disclaimer

THIS INFORMATION WAS PRESENTED AT AN ASHRAE SEMINAR HELD AT THE 2003 SUMMER MEETING IN KANSAS CITY, MO. THE SEMINAR FORMAT IS TO PRESENT INFORMATION OF CURRENT INTEREST AND TO PROVIDE A VENUE FOR INTERACTION BETWEEN ASHRAE MEMBERS. THESE SEMINARS SHOULD NOT BE CONSIDERED PEER-REVIEWED (OR THE FINAL WORD ON ANY SUBJECT). ASHRAE HAS NOT INVESTIGATED, AND ASHRAE EXPRESSLY DISCLAIMS ANY DUTY TO INVESTIGATE ANY PRODUCT, SERVICE, PROCESS, PROCEDURE, DESIGN, OR THE LIKE WHICH MAY BE DESCRIBED HEREIN. THE APPEARANCE OF ANY TECHNICAL DATA OR EDITORIAL MATERIAL IN THIS PRESENTATION DOES NOT CONSTITUTE ENDORSEMENT, WARRANTY, OR GUARANTY BY ASHRAE OF ANY PRODUCT, SERVICE, PROCESS, PROCEDURE, DESIGN, OR THE LIKE. NEITHER ASHRAE, THE AUTHORS OR THEIR EMPLOYERS WARRANT THAT THE INFORMATION IN THIS PRESENTATION IS FREE OF ERRORS. THE ENTIRE RISK OF THE USE OF ANY INFORMATION IN THIS PRESENTATION IS ASSUMED BY THE USER. BEFORE MAKING ANY DECISION OR TAKING ANY ACTION ON THIS SUBJECT, YOU SHOULD CONSULT A QUALIFIED PROFESSIONAL ADVISOR.

Changing Times

Increased regulation

Increased concern over liability

Increased cost

Kyoto Protocol

The need for an alternative is increasing!

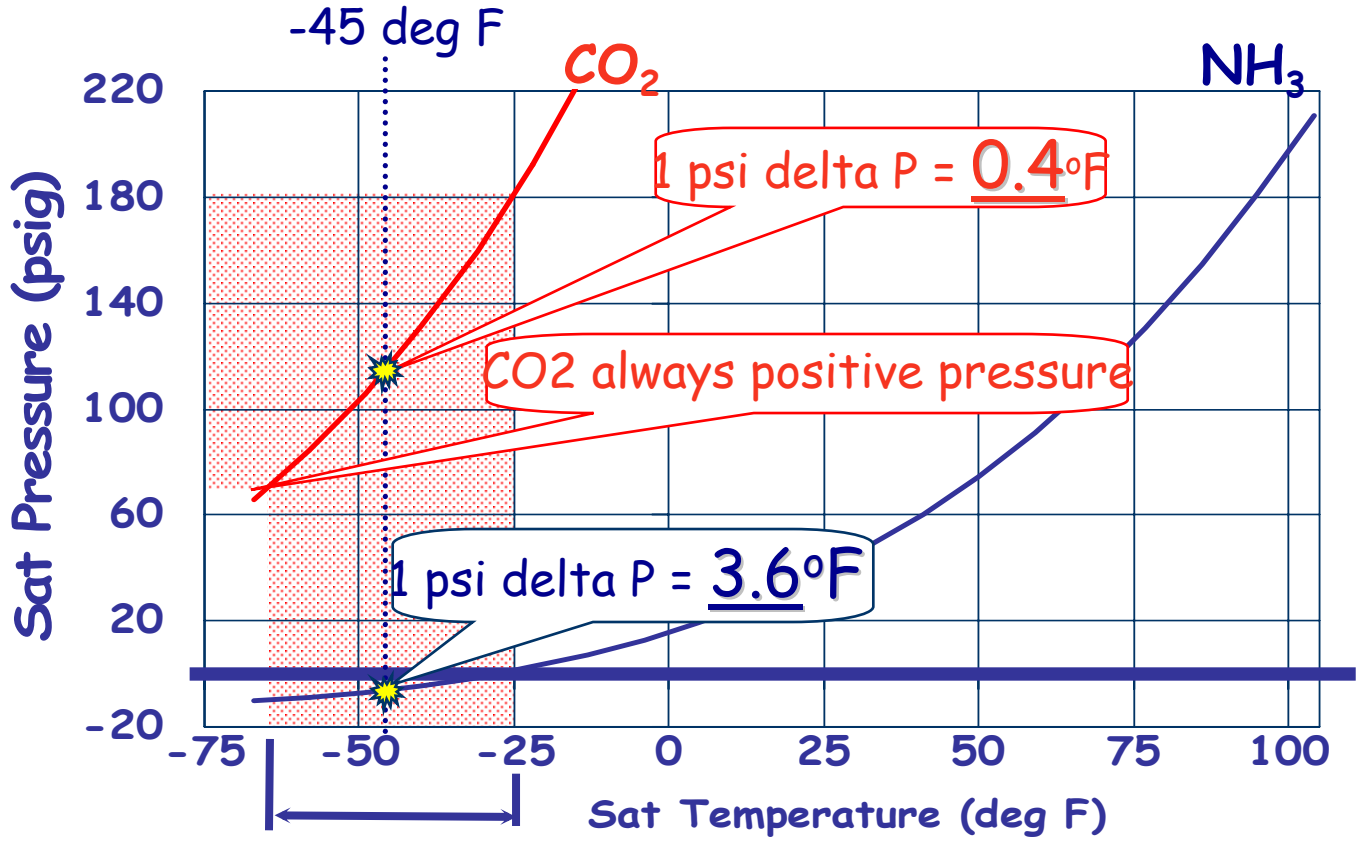
Why CO_2?

Evaluation Criteria

- Conventional NH3 vs. Cascade C02 / NH3
- Capacity 2600 TR at –50F / 400 TR at –30F
- **Safety**
- **Reliability**
- **Cost**

Why CO_2?

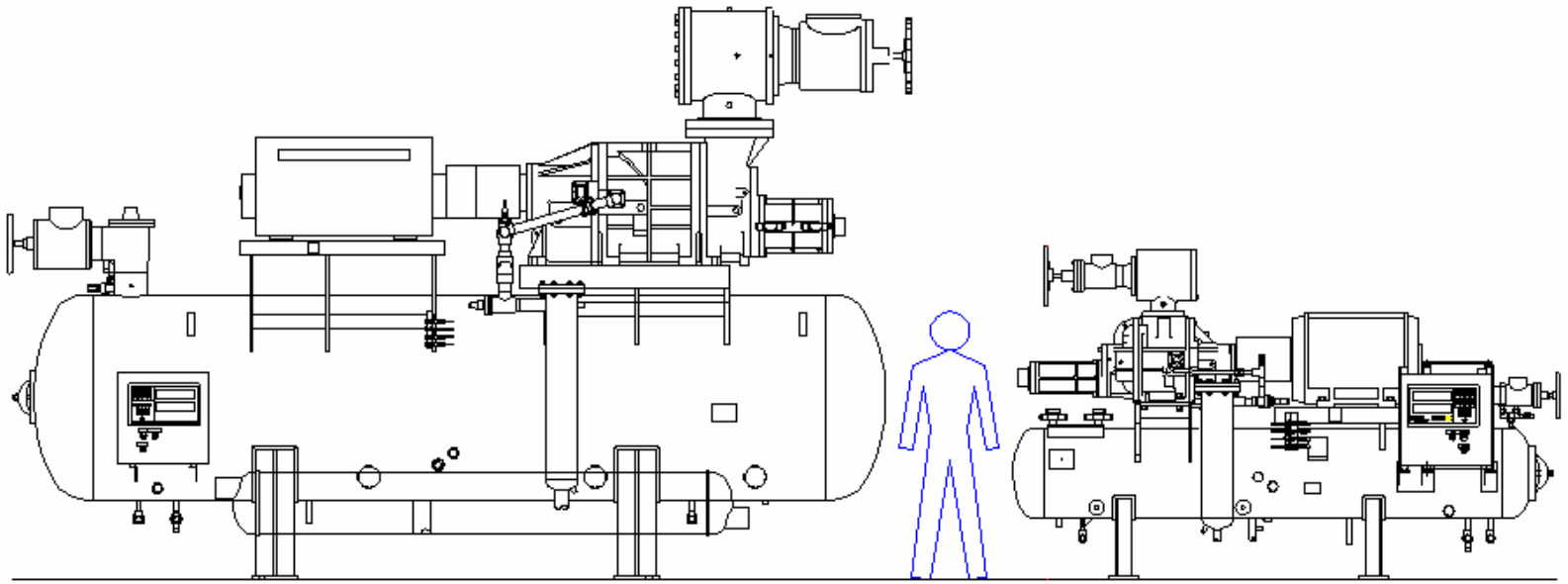
Physical properties are very different



Why CO_2?

Physical properties are very different

- CO_2 more dense than NH_3



Why CO_2?

Physical properties are very different

- CO_2 more dense than NH_3
- CO_2 has much higher saturated pressures than NH_3

Temperature (F)	Pressure (psig)	
	NH_3	CO_2
80	138	954
35	66	514
-45	12*	115
* Inches of mercury (vacuum)		

Why CO_2?

Physical properties are very different

- CO_2 more dense than NH_3
- CO_2 has much higher saturated pressures than NH_3
- CO_2 has a triple point of –69.9F / 61.5 psig

Liquid turns to solid in atmosphere

<u>Good</u> from a release standpoint

<u>Bad</u> from a relief valve standpoint

Why CO_2?

Physical properties are very different

- CO_2 more dense than NH_3
- CO_2 has much higher saturated pressures than NH_3
- CO_2 has a triple point of –69.9F / 61.5 psig
- CO_2 is heavier than air

R E T H I N K

Leak Detection

Ventilation

Access

Why CO_2?

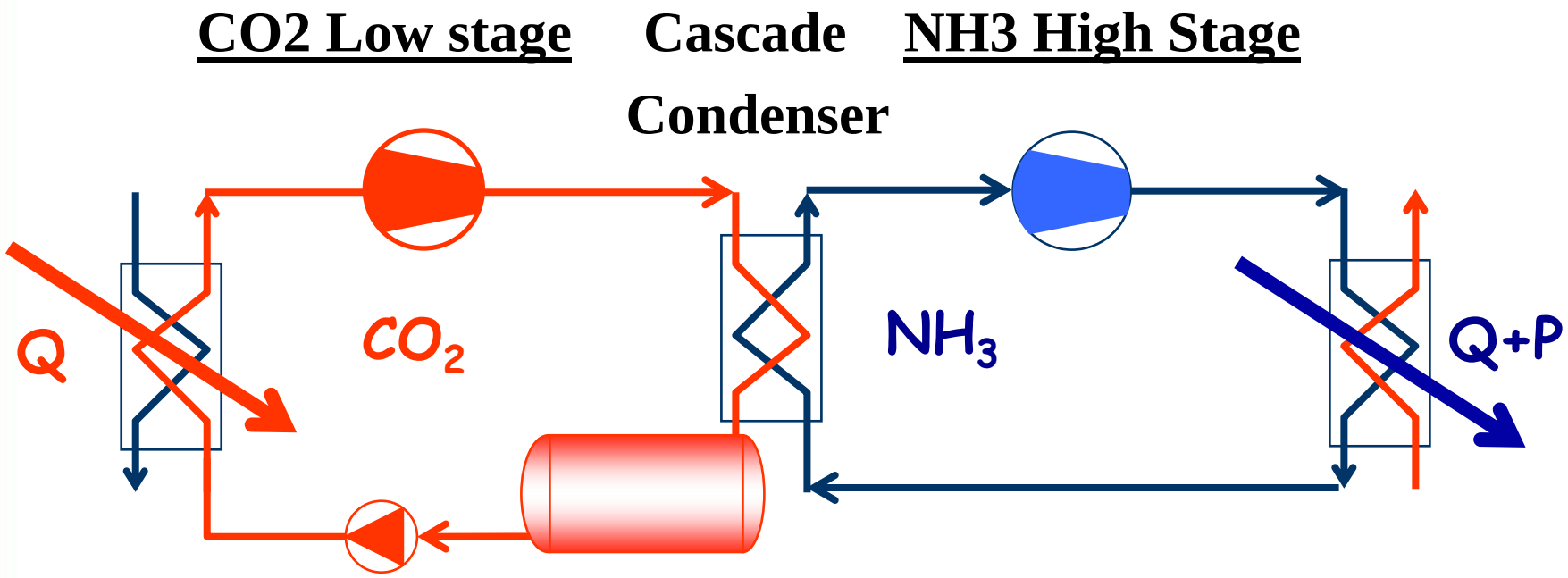
Physical properties are very different

- CO_2 more dense than NH_3
- CO_2 has much higher saturated pressures than NH_3
- CO_2 has a triple point of –69.9F / 61.5 psig
- CO_2 is heavier than air
- CO_2 mixing with NH_3 creates a solid

Compressors have a hard time compressing solids

Why CO_2?

System requirements are different



Why CO_2?

System requirements are different

- **Cascade Condenser**

Why CO_2?

System requirements are different

- Cascade Condenser
- Compressor
  - Pressure Rating
  - Bearing Life
  - Rotor Length
  - Oil

Why CO_2?

System requirements are different

- Cascade Condenser
- Compressor
- Evaporators
  - Recirculation Rate
  - Defrost

Why CO_2?

System requirements are different

- Cascade Condenser
- Compressor
- Evaporators
- Pipe
  - Pipe designed for –70F and 175 psig
  - Different weld specification
  - Stress analysis

Why CO_2?

System requirements are different

- Cascade Condenser
- Compressor
- Evaporators
- Pipe
- Relief system
    - Can a relief get plugged
    - Liquid thermal expansion protection

Why CO_2?

System requirements are different

- Cascade Condenser
- Compressor
- Evaporators
- Pipe
- Relief system
- Power outage

Why CO_2?

System requirements are different

- CO_2 will neutralize NH_3
- NH_3 contained in machine room

	NH_3	CO_2
TLV	25 PPM	5,000 PPM
STEL	35 PPM	30,000 PPM
IDLH	500 PPM	40,000 PPM
LFL	15%	Non-Flammable

Why CO_2?

Conclusion

- Safer than conventional NH3 system
- Cost effective at lower temperatures
- As reliable as conventional NH3 system

Why CO_2?

PATIENT

Why CO_2?

Why CO_2?

Why CO_2?

Why CO_2?

Why CO_2?

Why CO_2?

Why CO_2?

Why CO_2?

Thank you