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Update on US Cold Storage's NH_3/CO_2 Cascade Refrigeration Systems

United States Cold Storage, Inc.

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A Brief History

Founded in 1899 as the American Ice Company delivering lake harvested ice to consumers.

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United States Cold Storage, Inc.

A Brief History

Today, USCS has grown to 38 facilities across 13 states. Our logistics network provides service to some of the country's largest food producers.

Why “Low Charge” Refrigeration Systems

- Increased federal regulation and compliance on the cold storage industry:
  - EPA PSM, OSHA RMP and the DHS

- Reinforcement of USCS’ Sustainable Development Policies and initiatives:
  - Reduction in hazardous materials (refrigeration oil)
  - Reduction in carbon footprint through energy savings

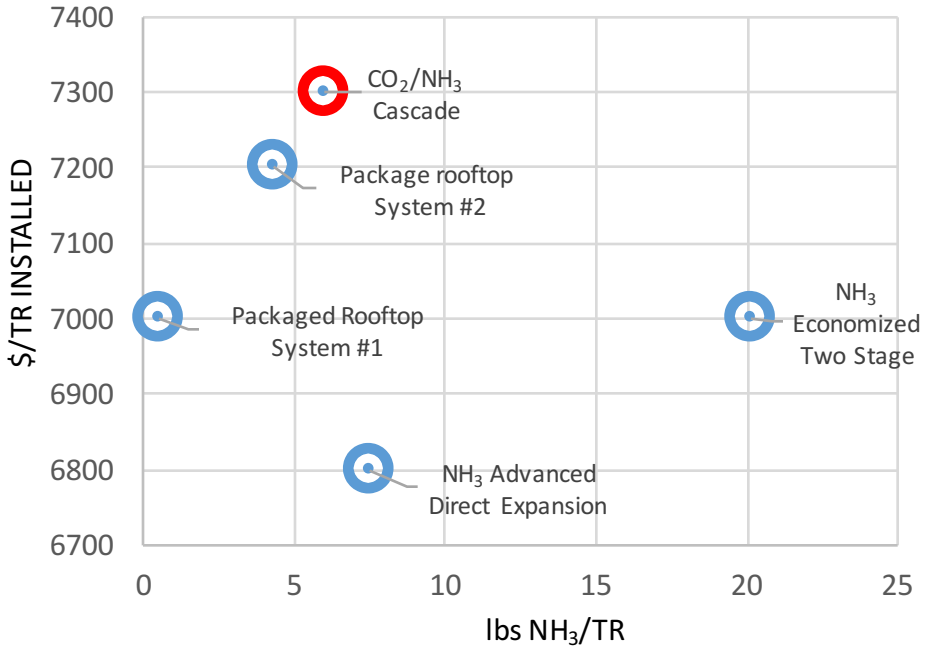
- Provide a safer work environment for our employees and our customer’s product by removing anhydrous ammonia from work and storage spaces.

- Strategic in the sense that USCS is perceived by it’s customer’s as being forward thinking and at the forefront of innovation.

- Risk mitigation from an insurance standpoint.

How to achieve “Low Charge”

- Eliminating all but the most essential ammonia charge.
- Maximizing the heat transfer from ammonia to the air or secondary fluid.
- Substituting other heat transfer fluids for ammonia wherever practical and economically viable.
- Rejecting the “more is better” philosophy when it comes to ammonia charge and system design.



USCS' approach to "Low Charge" Refrigeration Systems

- United States Cold storage has accomplished "low charge" through the use of centralized CO_2/NH_3 Cascade refrigeration systems.
- First CO_2/NH_3 Cascade refrigeration systems installed in Bethlehem, PA in 2006
- Since USCS has commissioned 12 additional CO_2/NH_3 cascade refrigeration systems.
- Reduced ammonia inventory by 27% company-wide

Lessons Learned Operating CO_2/NH_3 Cascade Systems

- **Energy.** Energy efficiency similar to that of an economized two-stage ammonia system:
  - Single Stage, Economized, Ammonia System – 0.8 to 1.3 kWh/cubic feet
  - Two-Stage, Economized, Ammonia System – 0.7 to 1.1 kWh/cubic feet
  - CO_2/NH_3 Cascade System – 0.4 to 0.8 kWh/cubic feet
- **Operation.** Very little operational difference between systems
  - USCS' experience has shown that any well trained refrigeration technician can learn how to operate a cascade refrigeration system. Its all about pressures and temperatures.
  - Except for the cascade condenser it's the same equipment
- **Maintenance.** Control of Moisture in the System is Very Important
  - Maintenance requirements similar and in some cases less than ammonia
  - Initial Charge – Ensure the appropriate grade of carbon dioxide.
  - Proper Maintenance is very important. Evacuation, Evacuation, Evacuation
  - Replacement of the filter driers on routine schedule
- **Risk.** Mitigate the risk of ammonium carbamate contamination through the use of <u>two independent</u> detection systems

What does the future for CO_2/NH_3 Cascade Refrigeration Systems

- Ammonium Carbamate Detector now commercially available. Three USCS systems currently using with no issue.
- A High pressure screw compressor now commercially available along with multiple high pressure reciprocating compressor suppliers.
- The use of stainless steel is becoming more prevalent (and affordable) as the cost of stainless steel continues to remain competitive with carbon steel.
- More and more CO_2/NH_3 Cascade systems are being built and commissioned.
- More hands-on Engineer/Operator training available.
- Advances in advanced direct expansion (DX) ammonia systems being developed with very low ammonia charge and comparable energy efficiencies.

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Thank you very much!