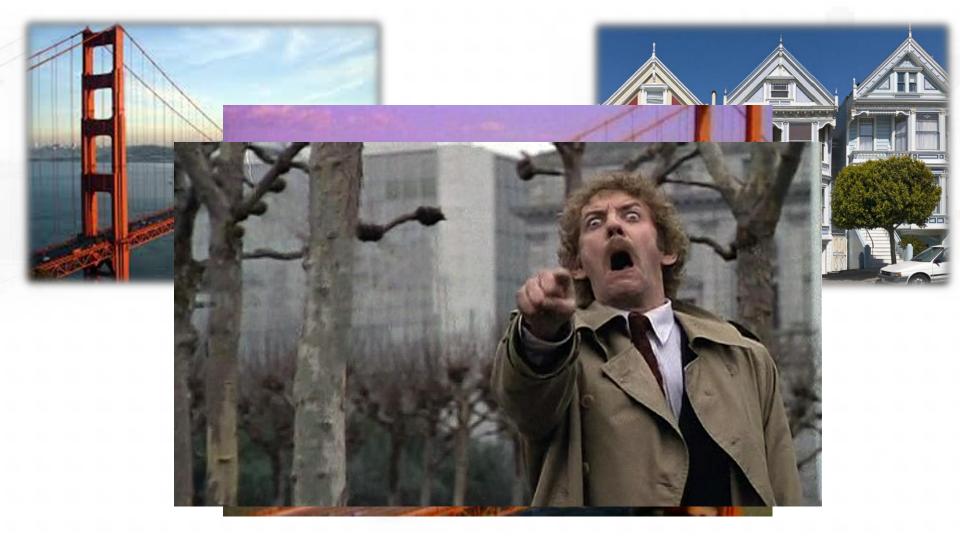


June 18-19, 2014 - San Francisco

Opportunity Through Adversity: Natural Refrigerants in North America



Everywhere you look...



#





Data Points

"...ammonia is environmentally benign...and offers superior thermodynamic properties, cost and self-alarming odor (unlike natural gas, ammonia is its own warning agent). These facts suggest that the expanded use of ammonia as a refrigerant in light of the HCFC situation is not just highly worthy of consideration, but <u>necessary and practical</u>."

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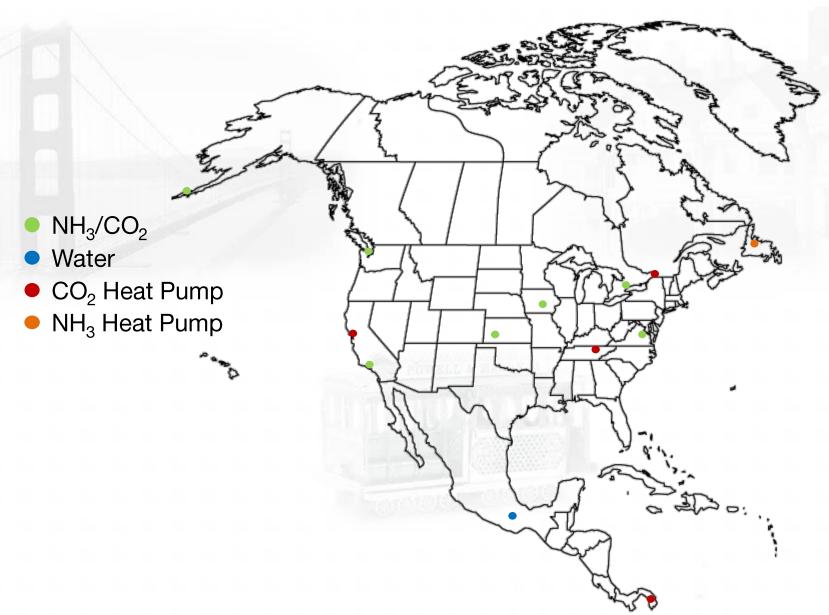
> -Forum: Ammonia as an alternative refrigerant ASHRAE Journal December 1990 p27 ff



#3

Flagship Installations

Natural Five







State of the Industry

Where are we now?

- Trending Observations
 - Industrial
 - Dominated by conventional ammonia refrigeration
 - Strong drive to find charge reduction solutions
 - Commercial
 - Strong interest in natural refrigerants, but hesitant to adopt a complete solution
 - Great opportunities for "whole store solution" (hot and cold)







State of the Industry

Where are we now?

- Technical viability of natural solutions proven
- 2nd Generation solutions moving to market
- Greatest adoption risk remains economics
- Ability of equipment and service providers to establish a viable economic model of implementation critical to advance past demonstration projects
- Continued engagement on the part of all stakeholders to continue to advocate natural solutions
- Join us in the Food & Retail Session for a more detailed discussion





Compact Systems Next Generation







- Redundancy in components
- Size & Weight Reduction
 - ~15% Price Reduction





Refrigerant (Natural Five)	NH₃ Ammonia	CO ₂ Carbon Dioxide	HC Hydro Carbon	H ₂ O Water	Air
90°C		Utility hot water			
60°C	Utility hot water Heating		Utility hot water	Heat recovery	
10°C	Chilled water Ice making	Chilled water	Heating HVAC	E Chiller	
-15℃ -25℃	Standard cold storage, Fish boat				
-40°C -50°C	Freezer, Freezed-dry, Super Low temp storage				
-60°C					Cryogenic
-100°C					$\overline{}$





Application Potential

Integrated Thermal Solutions





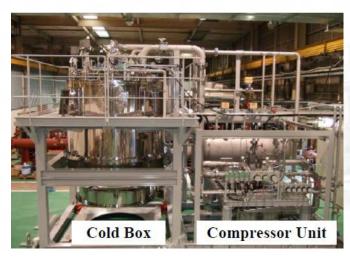




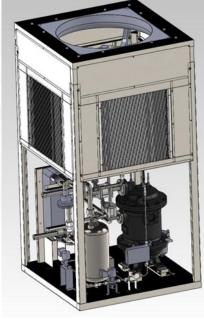
Developing the Future



#1**0**











Groundhog Day

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-Forum: Ammonia as an alternative refrigerant

ASHRAE Journal December 2020

AMERICA ATANO Sphere business case

natural refrigerants

June 18-19, 2014 - San Francisco

Thank you very much!

МАҮЕКАШ