Refrigeration for Business Resilience
Refrigerant Selection Can Impact Resiliency, Sustainability & The Healthy Building

“Healthy living and healthy working for healthy communities.” – Joseph Aicher
In too many situations, design and engineering treats the refrigeration system selection as a Black Box component.

The refrigerant choices do not necessarily align with current, near term, or system lifecycle legislation or regulations.
Refrigerant Business Decision Criteria

- Sustainability
- Performance
- Healthy Building
- Business Resilience
CO₂ – As A Refrigerant Option

Basics
Its Resurgence?
Growing Canadian Application
Profiles
Lifecycle
Basics of CO$_2$

- Non toxic, Non flammable
- ODP = 0, GWP = 1
- High refrigeration volumetric capacity
- High convective heat transfer coefficient
- Low critical points
- Higher operating pressure
- Higher discharge temperatures
- No Phase Out
Basics of CO₂

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Capacity</th>
<th>Exposure</th>
<th>ODP</th>
<th>GWP</th>
<th>Toxic</th>
<th>Flammable</th>
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<tbody>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>50ppm</td>
<td>0</td>
<td>0</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Co2</td>
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<td>5000ppm</td>
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<td>1</td>
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<tr>
<td>R-410a</td>
<td>.68</td>
<td>1000ppm</td>
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<td>2088</td>
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<td>Yes</td>
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<tr>
<td>R-407c</td>
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<tr>
<td>R-134a</td>
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<td>No</td>
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<tr>
<td>R-22</td>
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<td>1000ppm</td>
<td>.05</td>
<td>1700</td>
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<td>R-123</td>
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<td>10-30ppm</td>
<td>.0015</td>
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</tbody>
</table>

**Capacity** is a comparison to Ammonia as a Refrigerant

**Exposure** is based on OSHA’s standards being exposed for an 8 hour period.
Uptake of CO₂ In Canada

- Over 150 installations in Canada
- Locally 35 systems
- Another 30 or more locally in 2016
- Largest system is 1500TR
- Market application expanding
- Majority are design/build direct to owner
- Engineering, design & manufacturing in Canada
Profile – Leading Global Retailer (400TR)
Efficiency, Performance

Compressor, condenser, evaporators, pumps

Does not include heat reclaim.
Approximate available maximum heat exceeds 6M btu’s.
Base load provides 3M btu’s.
Sustainability
Inherent Business Risk

- Elimination of lifecycle refrigerant management issues
- Reduction in risk exposure to future costs associated with carbon taxes or utility premiums.
Profile - Winery
Efficiency, Performance

- Hydro evaluation over full fermentation cycle incomplete
- Production is double previous years
- Reduction of 42% of total gas charges
- Elimination of gas consumption for process
- CO$_2$ characteristics provide precise control
- Jacket temperatures are extremely accurate
- “Quality of wine will allow me to charge $1 - $2 more per bottle.”
  - Chief Winemaker
Sustainability

- Real GHG reduction of 5 metric tons of CO$_2$ – 40 trees
- Considering almost 100% increase in production, the GHG avoidance potentially 10 metric tons.
- Heat reclaim utilization will increased with renovations
- Received incentive
- Excellent marketing and promotion opportunity
Inherent Business Risk

- Not the primary criteria for this client
- For larger wineries, elimination of NH$_3$ reduces business risk across multiple business disciplines
Profile - Multi Purpose Municipal
Efficiency, Performance

- Reduction of 4,700,000 kWh (33.4%)
- Reduction in peak demand of 700 kW
- Reduction of $257,000 p.a. (3.9 simple payback incl. incentives)
- Elimination of evaporative cooler maintenance
- Greatly improved dehumidification – direct CO₂
- 2013 Energia Award AQME
- 2013 Award of Excellence AQLM
- Canmet Energy recognition for highest performance
Sustainability

• Displaced equivalent 3M BTU/hr (880 kW)
• Reduction of 3,241 metric tons of carbon emissions (682 passenger vehicles per year)
• GWP reduced from 1800 (R22) to 1 (R774-CO₂)
• Elimination of ODP causing agents
Inherent Business Risk

- No NH$_3$ (toxic, flammable, corrosive)
- Avoidance of various H,S & E compliance measures
- Elimination of open evaporative coolers and health risks
- Reduction in business impact under power failure as CO$_2$ system back up provides for primary refrigeration and heating.
- Elimination of future refrigerant management issues
Profile – Data Centres/ Critical Environments
Efficiency, Performance

- Thermosyphon Free Cooling (TFC) for 66% total run time
- TFC mode active up to 20°C
- For 35TR in TFC the power consumption is 3.6kW @ < -10°C and up to 7.2kW @ 15°C
- Estimated 12,492 kW savings versus most efficient alternate OEM
Sustainability

- GWP lowered from 1800 (R410) to 1 (R744)
- Reduction of approximately 200lbs of higher GWP refrigerant per system
Inherent Business Risk

- Elimination of future refrigerant management issues
- Reduction in POF
- Depending on location, significant free cooling availability in a business disruption between October and May.
Profile – Distribution Centre, Cascade System
Cold Storage, Full CO$_2$ System
Efficiency, Performance

• Same energy performance on 3-4x greater product volume
• Almost 4,000 hours of free cooling mode (8°C)
• Reduction in kWh for defrost
• 20% reduction in initial cost versus standard NH₃ design
• Seismic costs reduced with increased resiliency
• Single pipe configuration provides both heat/cool
• Intelligent heat reclaim
Sustainability

- Heat reclaim offsets almost 6M BTU/hr gas or electricity consumption
- Office space, loading bays, defrost, workshop are all heat reclaim
Inherent Business Risk

• Either complete or 90% reduction in NH$_3$ charge eliminating the need for E2 compliance measures
• Improved H,S & E for plant, staff and local community
• Elimination of product damage
• Increased assurance of total business operations
Quick Word on Lifecycle Cost vs NH₃

- Elimination of additional pump stations
- Elimination of additional structural reinforcement
- Significant pipe size reduction for install or retrofit
- Significant reduction in insulation costs
- Reduction of about 15%-20% initial install
- Elimination of outside piping
- No maintenance or repair as result of corrosiveness
- Reduction or elimination of heating components
- Significant reduction in roof penetrations
- No evaporative cooler equipment or maintenance costs
- In CO₂, additional smaller compressors will increase compressor maintenance labour by as much as 30%
Quick Word on Lifecycle Cost vs HFC

Not including future costs for refrigerant management issues of HFC synthetics
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