Sobeys’ Natural Transition to CO\textsubscript{2}

FMI – Energy and Store Design
Atlanta, September 21\textsuperscript{st}, 2011
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• Sobeys Québec in a nut shell.
• 7-minute video.
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Who is Sobeys?

- Founded in 1907.
- Wholly-owned subsidiary of Empire Company Limited.
- Canadian company.
- Headquarters in Stellarton, Nova Scotia & Toronto.
- Annual sales over 15 B$.
- More than 1300 stores in 10 provinces.
- Atlantic, Québec, Ontario, West.
- 800 communities across Canada.
- 85,000 employees.
- Corporate and franchisees operations.
- Full services, fresh services, community services, convenience, discount, drug, others...
The various banners
Sobeys Quebec in a nut shell...

- **IGA** & **IGA extra** No.1 banner in Québec.
- 260 stores, mostly franchisees.
- +250 major projects over the last decade.
- $200 M, capital growth investment per year.
- A peak of 28 projects under construction at the same time.
- A record of 12 openings in a month.
- First LEED certified supermarket in Canada.
- First Gold certified refrigerated warehouse in Canada.
- « Most active company in Canada » as per the NRCAN.
- Many active R&D projects with various partners.
Market shares IGA
Programme d’encouragement pour les bâtiments commerciaux

En reconnaissance d’une conception de bâtiment éconergétique visant à réduire les gaz à effet de serre

In recognition of an energy-efficient building design aimed at reducing greenhouse gas emissions

Canada
IGA St-Pascal de Kamouraska
7-MINUTE VIDEO
Refrigerant leaks.

- In North America, 30% of the refrigerants are lost every year in the atmosphere.
- Actually, on the lifecycle of a refrigerant, we have to realize that it is 99%....
- 1000 pounds = 400 cars on the road for 1 year
- Tolerance 0 for the leaks...
CFC phase-out *(R22)*


- Gradual phase-out of the CFC.

- Expectation is that by 2014 demand > availability.

- Cost of R22 will increase...

- Drop-in or replacement gas?
What has been done?

2004, R22 + Heat reclaim with gaz...
2006, R134 + Turbocor + Glycol heat Reclaim
2006-07, Phase-out of freon in all our distribution centers.
2007, Australia trip (Norway, South Africa, Russia)
2008, Trois-Rivières project.
2008, Canmet (NRCan) meeting.
2008, The vision... And we will achieve it.....
2008, 9 suppliers, 5 invited, 2 official proposals.
<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>2008-09</td>
<td>Negotiation with the AEE for subsidies.</td>
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<td>2008-09</td>
<td>2 R&amp;D Laboratories.</td>
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<td>May 09</td>
<td>Nicolet.</td>
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<td>June 09</td>
<td>First CO$_2$ sub critical project</td>
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<td>July 09</td>
<td>First CO$_2$ trans critical project</td>
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<tr>
<td>Oct 09</td>
<td>Visit to UK, France, China (we’re ahead…)</td>
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<td>Nov 09</td>
<td>Third supplier is on board</td>
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<td>Jan 10</td>
<td>Technology Award, 1st place in North America.</td>
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<tr>
<td>Feb 10</td>
<td>First project delivered that meets the vision!!!!!!</td>
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<tr>
<td>Oct 10</td>
<td>CGF in Chicago.</td>
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<td>Nov 10</td>
<td>Cancun Summit.</td>
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<td>Sept 11</td>
<td>CGF in Atlanta.</td>
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The vision.

- Smaller system.
- Simpler system.
- Lower energy consumption system.
- Lower initial cost.
- Lower maintenance cost.
- No HFC.
- Retrofit kit for convenience stores.
- System that will be installed coast to coast.
Contents of the Presentation

- History

- CO$_2$ refrigeration systems
  - Cascade
  - Transcritical

- Challenges

- Applications in North America
CO2 utilized as refrigerant in sub- and supercritical refrigeration systems

Proposal to use CO2 as a refrigerant (Alexander Twining, British patent)

The peak of utilizing CO2 as refrigerant

Reinvention of CO2-refrigeration technology (G. Lorentzen)

1850

1920 -------1930

1960

1993

Focus on food
History

Wisconsin, 1934
CO2 refrigeration systems

- CO2 difference with other refrigerants:
  - Critical point at lower temperature
  - Below critical point: liquid and vapor regions are separated by the saturation curve
  - Over critical point: there is no difference between liquid and vapor
  - Concept of transcritical vs sub-critical

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>R404a</th>
<th>NH3</th>
<th>CO2</th>
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<tr>
<td>Critical point (psi/F)</td>
<td>542/162</td>
<td>1640/270</td>
<td>1067/88</td>
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CO2 refrigeration systems

Eco₂-System®
Evolution, Innovation, Progress

focus on food
**CO2 refrigeration systems**

- **Sub-Critical applications : Cascade**
  - CO2 is used as a secondary refrigerant
  - Many versions:
    - LT DX CO2, MT pumped glycol
    - LT DX CO2, MT pumped CO2
    - LT pumped CO2
  - Common fact: all sub-critical applications need another refrigeration system to maintain CO2 at low pressure / temperature:
    - R404a
    - R134a
    - NH3
    - Etc...
CO2 refrigeration systems

Sub-critical:
Sub-critical:
CO2 refrigeration systems

Transcritical Booster with Gas Bypass:
CO2 refrigeration systems

Transcritical Booster with Gas

800 to 1300 psi

500 psi

375 psi

200 psi
CO2 refrigeration systems

Eco\textsubscript{2}-System

- CONTROL PANELS
- POWER PANEL
- VFD
- SUCTION ACCUMULATOR
- DEFROST RECEIVER
- LIQUID RECEIVER

WIDTH: 55”
LENGTH: 290”
HEIGHT: 85”
WEIGHT: 14 000 LBS
CO2 refrigeration systems
Challenges

• Main challenges for a rack manufacturer:

  – Oil management
  – Efficient and quick low pressure hot gas defrost
  – Pipe/components sizing
  – Power failure management
  – Electronic
  – Heat reclaim strategies
  – Training
Applications in North America

Where transcritical CO2 systems can be applied:

- Cold climate with annual mean ambient temp of 50F or less.
- Warm climate with low Wet bulb temp values using adiabatic cooling
Deviation of alternative system annual energy consumption compared to R404A reference system

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<tr>
<td>MT</td>
<td>R404A DX</td>
<td>R134A DX</td>
<td>Prop. Glycol</td>
<td>Pumped CO2</td>
<td>Pumped CO2</td>
<td>Pumped CO2</td>
<td>CO2 DX</td>
</tr>
<tr>
<td>LT</td>
<td>CO2 DX</td>
<td>CO2 DX</td>
<td>CO2 DX</td>
<td>CO2 DX</td>
<td>CO2 DX</td>
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<td>CO2 DX</td>
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Who is Carnot Refrigeration?

What is our experience?

• 2007: Sobeys Trois-Rivières
  – ASHRAE’S BEST 2010 Technology Awards
  – Refrigeration and heat recovery Design and built.
• 2008: First CO2 refrigeration experimentations in our R&D Laboratory
2009: 1st generation
  - MT: Glycol 295kW 
    (1 010 000 btu/hr)
  - 100% heat recovery

New features:
  - LT: Direct CO₂ 80kW 
    (273 000 btu/hr)
  - Hot gas defrost at low pressure
• 2010: 2\textsuperscript{nd} generation
  – LT: CO\textsubscript{2} 85 kW (290,000 btu/hr)
  – Hot gas defrost at low pressure
  – 100% heat recovery

\textit{New features:}

– MT: CO\textsubscript{2} 350 kW
  (1,200,000 btu/hr)
2010: 3rd generation
“SUPER CO₂ OL” system design for SUPER markets
  – Hot gas defrost in low pressure

New features:
  – CO₂ Transcritical
  – CO₂ Direct heat recovery
  – APD in MT
• 2010: Distribution centre “MEGA CO₂ OL” system
  – NH₃/CO₂ LT and MT
    Range 1 to 5 MW
    (1 to 1400 TR)
  – TFC
  – 100% Heat recovery
2011: In progress

- Several "SUPER CO$_2$OL" systems for supermarkets
- Several "MEGA CO$_2$OL" systems for distribution centres
SUPER CO₂OL

system by Carnot Refrigeration
Advantages

- High energy efficiency
  - Direct CO$_2$ heat recovery (no pumps, no heat exchanger)
  - APD in MT and low temperature hot gas defrost. No electrical elements, consumption and wiring (reduction of pull down energy required after defrost)
- Accessible replacement parts by local wholesalers
- HFC free; phase-out free, low maintenance cost
- Lowest installation cost of any system
- Light weight and small footprint required for skids and condenser/gas cooler
- Industrial quality skids
**Challenges**

- Technicians learning curve
- Follow-up of provisioning system
- Oil management
- New design criteria
CO$_2$ vs Sobeys September 2011

- 32 stores in operation, sub & transcritical.
- 6 generations of system, continuous improvements.
- Initial cost = conventional systems.
- 4 manufacturers so far.
- Cases & controls manufacturers = not an issue.
- Sobeys National standard = CO2 transcritical.
- 2 hottest summers ever = less concerns than conventional.
- First transaction on the voluntary carbon market, 15000 tons.
- Energy saving, initial survey = up to -18%.
- Active member of the CGF, refrigeration summits.
- Challenge is still for the R22 conversion.
A major leak in a conventional synthetic refrigerant system would have the same GWP as driving 1 200 cars on the road for a year…
A major leak in a CO2 refrigeration system would have the same GWP impact as a solitary fisherman using his motor boat on the lake…
Conclusion

• Retailers are more than welcome to come visit us.

  • CO$_2$ technology is **NOT** the technology of the future…

  • It’s today’s technology !!!
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