Low Capacity CO₂ Systems

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**CO$_2$ as a refrigerant**

<table>
<thead>
<tr>
<th>Environment - OK</th>
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<tbody>
<tr>
<td>• Refrigerant phase outs</td>
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<tr>
<td>• Companies policy</td>
</tr>
<tr>
<td>• Natural substance ✓</td>
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<tr>
<th>Safety - (OK)</th>
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<tr>
<td>• High concentrations ?</td>
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<td>• High pressure ?</td>
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<td>• Non flammable or toxic ✓</td>
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The Challenge

- High pressure
- New components
- Efficiency?
- Cost?

Pressure in bars

- R744
- R134a
1) “By the 2004 Olympic Games in Athens, we will no longer purchase new cold drink equipment using hydrofluorocarbons… wherever cost-efficient alternatives are commercially available.”

2) “We will require suppliers to significantly improve the energy efficiency of the cold-drink equipment they sell to our system, making it 40-50 percent more energy-efficient by the end of this decade.”

Environmental policy for cold drink equipment, June 27, 2000

Moving Towards Sustainable Refrigeration
Commercial Applications

Natural refrigerants in commercial applications

In contrast to industrial refrigeration, no universally accepted alternatives to HFC refrigerants are currently commercially available. Considering its very diverse range of refrigeration requirements Nestlé has therefore embarked on an active programme pursuing appropriate technical solutions also for smaller commercial refrigeration systems.
**CO₂ compressor technology**

Most critical for performance:
- Leakage
- Heat transfer
- Specific piston load

Our Choice:
**Reciprocating compressor with**
- Piston rings
- Minimized heat exchange
- Maximized bearing area
Thermal high pressure controller
- tested in SME at changing ambient conditions -
Pressure & temperature

Good match between requirement & result in 10 - 45 DegC ambient
CO$_2$ application examples

Next options:
- Low temp
- Heat pumps
- Larger platform

Our present focus is on bottle cooling
CO$_2$ system integrated in SME

Modified split system by changing:
- Compressor
- Control valve
- Refrigerant
- Heat exchangers

CO$_2$ system integrated in SME
CO₂-process efficiency study

Test results:
18% energy savings compared to standard R134a machine

Work for days to come:
- Optimum system design / topology
- Extensive field testing
- Industrialization
- Range expansion

Relative Energy Consumption

R134a   CO₂
Compressor comparison

CO$_2$ versus HFC / HC compressor technology

... potential of cost parity
(at equal production conditions)

Similar conclusions for
other components required ...

CO$_2$  Reciprocating compressor technology  HFC / HC
The Venture for the Future …

<table>
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<tr>
<th>Year 2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<tr>
<td>Development</td>
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Pilot Production

- Prototypes for few key customers

Production in Denmark
Line capacity: 60 k/year

- One compressor platform
  5 models
- Controls and line components
“Dream Team” for CO₂ systems

Reciprocating compressor:
- "Hermetics concept"
- One cylinder
- Piston rings
- Direct suction and discharge
- Standard motor

Thermal high pressure control:
- Matching compressor characteristics
- Optimal system operation at varying ambient condition