CO2 in Vending Machine

SANYO Electric Co., Ltd.
Commercial Solutions Company
Daiki Shiomi
1. Company Profile
2. CO2 Compressor / Refrigeration System
3. CO2 System Performance
4. VM Market Forecast / Achievement
5. Cost Analysis
6. Future Road Map
<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>President</td>
<td>Seiichiro Sano</td>
</tr>
<tr>
<td>Founded</td>
<td>February, 1947</td>
</tr>
<tr>
<td>Incorporated</td>
<td>April, 1950</td>
</tr>
<tr>
<td>Head Office</td>
<td>Osaka, Japan</td>
</tr>
<tr>
<td>Capital</td>
<td>2,731 Million USD</td>
</tr>
<tr>
<td>Net Sales</td>
<td>18,775 Million USD</td>
</tr>
<tr>
<td>Number of</td>
<td>94,906</td>
</tr>
<tr>
<td>Employees</td>
<td></td>
</tr>
<tr>
<td>Subsidiaries*</td>
<td>275</td>
</tr>
</tbody>
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(As of March 31, 2007)

* Exchange Rate at 31 March, 2007 (1$=118)
SANYO’s Corporate Vision

General consumer-electronics manufacturer

Think GAIA

Leading Provider of Environment & Energy related Products and Services

- Absorption Chiller
- Solar Battery
- Heat Pump Water Heater
- HEV Battery
- Secondary Battery
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Characteristic of CO2 Refrigerant

Challenges:
1. High working pressure & large pressure difference
   : 3 ~ 5 times higher than conventional refrigerant
2. System efficiency
   : Lower theoretical efficiency with normal refrigeration system

Advancements are required,
especially for Compressor and Refrigeration system.

Advantages:
1. Worldwide availability
2. High volumetric cooling capacity and heat transfer
3. Heat pump ability at low temperature ambient
4. No recovery or recycling required
5. Environmentally friendly (no ODP, GWP=1.0)
6. Nonflammable, Nontoxic

Contribute Green Environment
Internal Intermediate Pressure Structure
- High Reliability
- Light Weight

Two Stage Compression Mechanism
- Reduce Leakage Loss
- Lower Vibration
- Cycle Option (ex: Intercooling, Split cycle)

Various Availability
- Fixed Speed / Vertical: 300W ~ 1400W
- Fixed Speed / Horizontal: 300W ~ 750W
- Variable Speed / Vertical: 500W ~ 3000W
- Various Power Source

Experiences
- Production History Since Y2001
- Assembly Technology
CO2 Refrigeration Cycle

1st Suction → Inter Cooler → 2nd Suction → SLHX → Capillary Tube → Strainer → Evaporator → 1st Discharge

2nd Suction → SLHX → Capillary Tube → Strainer → Evaporator → 2nd Discharge
Reduce the Dis. Gas Temp. and Compression load.
→ Big Improvement of Cooling Effect and Efficiency.
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CO2 system for European Vending Machine was optimized to have the same pull down performance as baseline R134a system without changing fan, fan motor, electric light and physical dimension of the installation room.

Energy Consumption of CO2 system is 10% less than that of R134a system at 32 degree C / 65 % RH.
10 CO2 systems and 2 R134a systems were installed to the field. Their energy consumption and ambient temperature were measured by DAQ system.

Energy Consumption of CO2 system is 17% less than that of R134a system in the field test during the summer season.
In many regions, the dominated ambient temperatures are less than 24 degree C.

70% of world average temperature is less than 24 degree C and only 5% of world average temperature is more than 32 degree C.
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Total quantity of CO2 systems installed to Japanese vending machine market is more than **30,000** as of today.

Sanyo's production quantity includes Heat Pump Water Heater and other refrigeration usage.
**SANYO CO2 Achievement**

**Athens Olympic 2004**
50 CO2 compressors for vending machines

**Torino Olympic 2006**
1,000 CO2 compressors for glass door merchandisers

**FIFA World Cup 2006**
2,400 CO2 compressors for glass door merchandisers

**Beijing Olympic 2008**
5,000 CO2 compressors for glass door merchandisers

**Others**
As total, more than 15,000 CO2 compressor produced for many coolers including 5,000 for Beijing all around the world.

In addition, 150,000 compressors have been produced for Heat Pump Water Heater without any serious reliability issue in the field since 2001.
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Parts and materials used for CO2 compressor are almost same as those for conventional HFC or HCFC rotary compressor for AC.

If the production quantity of CO2 compressors is closer to that of the conventional rotary compressors for AC, the incremental cost of CO2 compressor will ultimately become the difference of material usage.
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SANYO CO2 Road Map

Ref: Refrigeration

Application Expansion

Heat Pump

Water Heater

Other Size and Temp Application

Energy Saving

Split Cycle are applied to maximize cooling capacity even at very cold ambient

Hot and Cold Vending Machine with CO2 HP cycle achieve 40% energy saving!!

Market Expansion
Floor Heating ➔ Europe

Efficiency Improvement

Split Cycle
Outdoor Temp: -20°C, 4kW, 40→55°C

Main Cir.

Bypass Cir.
SANYO New VISION

Think GAIA

Restore a beautiful earth to future generations