Frigoglass - Crossing over from HFCs to Natural refrigerant R290

Presented to:
Green Cooling Solutions - Unlocking the South African market uptake
20th June, 2019
Frigoglass at a glance

- Frigoglass established in 1996
- In 1999, Frigoglass was listed on the Athens Stock Exchange
- Today, Frigoglass operates 6 production plants and serves customers in more than 100 countries globally
- Frigoglass Products being used in ALL countries in AFRICA.

**Business Description**

- Headquartered in Athens, Greece
- The Frigoglass Group is a leader in innovative, ice-cold merchandizing solutions as well as a strategic partner to the world’s top beverage brands
- Operates through two segments:
  - Ice Cold Merchandise (ICM): beverage coolers and integrated services offering
  - Glass: glass bottles, containers, plastic crates and metal crowns, primarily for the beverage industry

**Serving Customers Through a Global Presence**

**Key Customers**

- Coca-Cola
- Carlsberg
- ABInBev
- Heineken
- Diageo
- Efes
- MOLSON Coors
- Danone
- Pepsi

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**ICM Operations**

**Glass Operations**
Serving customers through a global presence

- 6 ICM production plants
- 2 Glass + 2 Plastic Crates + 1 Crowns plants
- Sales in more than 100 countries

Group Sales by Geography

- Africa 39%
- EE 34%
- Asia 7%
- WE 20%

Group Sales by Customer

- CC 59%
- Breweries 23%
- Other 18%

ICM production plants
Glass production plants
Sales offices

2018

- Sales in more than 100 countries
Refrigeration time line - R22/R12 and R134a

1996

2000

2009

2014

2019

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Refrigeration time line- R744

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Refrigeration time line - R290 and R600

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Why Change to HC’s

- Environmental impact  GWP, Energy consumption.
- Responsible corporate citizen.
- Our customers global strategy to move from CO₂ (R744) to Natural refrigerants R290.
- Multiple component supplier- making the HC component more accessible with competitive pricing.
- Similarities between the operation of the R134a and R290 systems being normal Transitional effect as opposed to R744 being a gas cooler system with very high operating pressure
Global numbers

- Frigoglass is one the largest global manufacturers of beverage coolers.

<table>
<thead>
<tr>
<th>Region</th>
<th>2014 % Split Region</th>
<th>2015 % Split Region</th>
<th>2016 % Split Region</th>
<th>2017 % Split Region</th>
<th>2018 % Split Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFRICA - Africa</td>
<td>91 0%</td>
<td>2260 2%</td>
<td>6857 4%</td>
<td>14234 5%</td>
<td>63943 20%</td>
</tr>
<tr>
<td>ASIA - Asia</td>
<td>16233 10%</td>
<td>2901 2%</td>
<td>14288 9%</td>
<td>4317 2%</td>
<td>4207 1%</td>
</tr>
<tr>
<td>EUROPE - Europe</td>
<td>153183 90%</td>
<td>130937 96%</td>
<td>146611 87%</td>
<td>257814 93%</td>
<td>256100 79%</td>
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<tr>
<td>Grand Total</td>
<td>169507</td>
<td>136098</td>
<td>167756</td>
<td>276365</td>
<td>324250</td>
</tr>
</tbody>
</table>
CO$_2$ technology pros & cons

- **Pros**
  - Environment - No ozone depletion (natural refrigerant) GWP=1
  - Non Flammable
  - Non Toxic

- **Cons**
  - Operating conditions - High pressure & temperature → main drivers for cost upcharge & impact on component lifetime
  - Supply base: Limited compressor range & long lead times.
  - Servicing: requires training and appropriate tooling. So far only in refurbishment centers
  - Noise level: quality of noise
  - CO2 becomes less efficient above 31deg
HC technology pros & cons

**Pros**

- Environment - No ozone depletion (natural refrigerant) GWP=3
- Non Toxic
- Extended compressor range
- Cost competitive
- Service infrastructure exists due to household appliances
- Low operating pressures in cooling systems

**Cons**

- Safety – Flammability during service and additional investment in manufacturing plants
- Servicing: precautions to be considered Safe handling certification required
- Charge size limitation: max 150gr; coverage of big coolers
Comparison of compressor’s efficiency

<table>
<thead>
<tr>
<th>Sanden Test Conditions</th>
<th></th>
<th>Sanden Test Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>amb 32C, liq 32C, ret 32C</td>
<td>evap -5°C</td>
<td>amb 41C, liq 41C, ret 35C</td>
<td>evap -5°C</td>
</tr>
<tr>
<td>W</td>
<td>COP</td>
<td>W</td>
<td>COP</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sanden SS 220V 50Hz</td>
<td>250</td>
<td>1.2-1.5</td>
<td>100-180</td>
</tr>
<tr>
<td>EMT45HDR (R134a)</td>
<td>293</td>
<td>2.4</td>
<td>256</td>
</tr>
<tr>
<td>Danfoss TL3CN (R290)</td>
<td>276</td>
<td>1.95</td>
<td></td>
</tr>
<tr>
<td>Secop TL4CN (R290)</td>
<td>341</td>
<td>2.01</td>
<td>302</td>
</tr>
<tr>
<td>Sanden MS 220V 50Hz</td>
<td>450</td>
<td>1.5-1.6</td>
<td>200-350</td>
</tr>
<tr>
<td>EMT6144Z (R134a)</td>
<td>401</td>
<td>2.4</td>
<td>348</td>
</tr>
<tr>
<td>EMT6144U (R290)</td>
<td>450</td>
<td>2.5</td>
<td>390</td>
</tr>
<tr>
<td>Secop DLE5,7CN (R290)</td>
<td>603</td>
<td>2.28</td>
<td>544</td>
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<tr>
<td>Sanden S 220V 50Hz</td>
<td>720</td>
<td>1.5-1.8</td>
<td>300-550</td>
</tr>
<tr>
<td>NE K6210Z (R134a)</td>
<td>794</td>
<td>2.19</td>
<td>689</td>
</tr>
<tr>
<td>NEK6210U (R290)</td>
<td>849</td>
<td>2.34</td>
<td>750</td>
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<tr>
<td>Secop DLE7,5CN (R290)</td>
<td>766</td>
<td>2.22</td>
<td>690</td>
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<tr>
<td>Sanden M 220V 50Hz</td>
<td>1100</td>
<td>1.5-1.7</td>
<td>500-850</td>
</tr>
<tr>
<td>NE K6212Z (R134a)</td>
<td>905</td>
<td>1.99</td>
<td>788</td>
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<tr>
<td>NE K6213U (R290)</td>
<td>1169</td>
<td>2.16</td>
<td>1033</td>
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<tr>
<td>Secop NLE10MNX (R290)</td>
<td>1111</td>
<td>2.42</td>
<td>1002</td>
</tr>
</tbody>
</table>

ASHRAE(MBP) TEST conditions:  
*CECOMAF TEST conditions:  
Condensing temperature 55°C 45°C  
Liquid temperature 46°C 45°C  
Suction temperature 35°C 32°C  
Ambient temperature 35°C 32°C

- CO₂ compressors have lower COP values
- the higher the ambient temperature the lower the COP of the CO₂ compressors
- Frequent launching of HC compressor with even better COP values

***COP – Coefficient of performance
Potential of CO₂ technology related to Total Cost of Ownership elements

- **Total Cost**
  +12% ~ 16% of TCO
  - Drivers of higher incremental costs vs. R134a and HC are the advanced specs of components to withstand high pressures, the overpressure safety device kit, the extra tubing for the internal heat exchanger and the extra labor for the high pressure test.

- **Energy consumption**
  54% ~ 66% of TCO
  - When comparing identical configurations, rather than refrigerant compressors and cooling circuits, a CO₂ system consumes more energy that a HC system.

- **Maintenance / repairs**
  7%~15% of TCO
  - For C condition ambient (32deg), the temperatures in the cooling compartment are close to the maximum operating temperatures of the compressor (43deg) and shaded pole motors (40deg), while for higher ambient or cassette layout they may exceed that limit, with a corresponding impact on component lifetime and reliability.
Continuous focus on lowering energy consumption

Energy consumption evolution on a 650Lt cabin
Noise reduction  R744 V/S R134a and R290

<table>
<thead>
<tr>
<th></th>
<th>CO₂ Existing</th>
<th>CO₂ 2nd Gen</th>
<th>R134a</th>
<th>R290</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise level (DbA)</td>
<td>64</td>
<td>59</td>
<td>63</td>
<td>43</td>
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</tbody>
</table>
Frigoglass Low charge technology

Why
Staying well within the maximum charge levels 150gr, Also set criteria for many of our customers.

Reducing the overall risk during transportation of refrigerants. Ability to use smaller 370gr cylinders for field servicing

Reducing the Total cost of ownership.

How
Optimized heat exchangers.

Reality
Best estimate of size of total number of beverage coolers in South-Africa – 500K
Average refrigerant charge of 650LT cooler – 360 Grams R744 v/s 70 Grams R290
500 K @ 290Gr= 145 000 Tons of refrigerant
Servicing the HC systems

Initial challenges:
- HC Tools availability and high cost.
- Refrigerant availability especially for R290. Logistic hurdles.
- Service infrastructure with the specific capabilities.
- Initial fears - FLAMMABILITY

Our Successes:
- Identify the suitable tool to be used and Global providers.
- Create Tool kits offered as SPs to Service partners and Customers. At competitive prices lower initially investment when compared to CO₂.
- SOP with Best Practices and Safety precautions on Repairing HC cooling Circuits.
- SOP aligned and approved by compressor manufactures.
- Develop Local Technical Trainers to train the local network.
- Sessions with Customers and Service network demonstrating the Best Practices included in the SOP as well as hands on session with the technicians.
- Migration from high to low charges system. Resulting in further reduction of Flammability risk and TCO.
## Training

<table>
<thead>
<tr>
<th>Country</th>
<th>Type</th>
<th>Customer team/ Service Providers</th>
<th>Number of technicians</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>South-Africa</td>
<td>HC introduction and field repairs</td>
<td>Customer team</td>
<td>120</td>
<td>2018</td>
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<tr>
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<td>HC introduction, R744 fault finding and field repairs all Refrigerants</td>
<td>Customer team</td>
<td>18</td>
<td>2018</td>
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<tr>
<td>Namibia</td>
<td>HC introduction, R744 fault finding and field repairs all Refrigerants</td>
<td>Customer team</td>
<td>4</td>
<td>2018</td>
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<tr>
<td>Mozambique</td>
<td>HC introduction, R744 fault finding and field repairs all Refrigerants</td>
<td>Customer team</td>
<td>12</td>
<td>2018</td>
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<tr>
<td>Mozambique</td>
<td>HC introduction, R744 fault finding and field repairs all Refrigerants</td>
<td>Customer team- Train a trainer</td>
<td>5</td>
<td>2018</td>
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<tr>
<td>Mayotte</td>
<td>HC introduction, R744 fault finding and field repairs all Refrigerants</td>
<td>Customer team- Train a trainer</td>
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<td>2018</td>
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<tr>
<td>Kenya</td>
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<td>Customer Team</td>
<td>108</td>
<td>2019</td>
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<tr>
<td>Kenya</td>
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<td>Ethiopia</td>
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<td>Customer Team</td>
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<td>Zimbabwe</td>
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<td>Tanzania</td>
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<td>Customer Team</td>
<td>45</td>
<td>2019</td>
</tr>
</tbody>
</table>

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Recap

- R290 System is more energy efficient
- They are less noisy
- Easier to maintain due to reduced pressures
- Tools kits is more affordable
- Component availability has improved and is more cost effective
- Low charge system is reducing the overall cost and environmental impact
Thank You