Introduction of R290 (propane) in split air conditioning and chillers in Western Cape

Edgar Timm, HEAT GmbH, commissioned by GIZ
Stellenbosch, South Africa, 21 / 06 / 2019
R290 in Split Ac and Chillers for South Africa
…some kind of wrap up
R290 in Split Ac and Chillers for South Africa
…some kind of wrap up
Refrigerants: The ideal candidate? **Environmental friendly** AND ?

Vapour pressure curves

Quelle: https://efficient-energy.com/kuehlturm-schillerwasser-als-kaeltemittel aufgerufen 7.9.2017
A little refrigerant cooking cooking session in the witches kitchen
Refrigerant cooking session – the ingredients

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

Back to Basics

2019-06-20/21

Edgar Timm, HEat GmbH

Source: ETSuS UG

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Refrigerant cooking session – the ingredients – What's left?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
<td>VII</td>
<td>VIII</td>
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<td></td>
</tr>
</tbody>
</table>

- **Lithium 1**
- **Beryllium 2**
- **Magnesium 12**
- **Sodium 11**
- **Sulfur 16**
- **Fluorine 9**
- **Oxygen 8**
- **Neon 10**
- **Helium 2**

**Source:** ETSuS UG

**Do not form gases**

**Ozone depleting**

**Remaining candidates**

**Do not react at all**

**Greenhouse effect**

**Toxic**
Refrigerant cooking session – the ingredients

Source: ETSuS UG
Refrigerant cooking session – the ultimate solution

Source: ETSuS UG
Refrigerant cooking session – the ultimate solution

Source: ETSuS UG
The ultimate solution of refrigerant use – leapfrog HFCs

Chances to leapfrog to Green Cooling Technologies

- CFCs...
  - are ozone depleting and contribute to global warming
  - deplete natural resources
  - are phased out by the Montreal Protocol

- HCFCs...
  - were introduced as transitional substitutes for CFCs
  - deplete natural resources
  - are less ozone depleting but contribute to global warming
  - are phased out by the Montreal Protocol

- High-GWP-HFCs...
  - were introduced as transitional substitutes for CFCs and HCFCs
  - deplete natural resources
  - contribute to global warming
  - are controlled by climate regime and may be phased down by the Montreal Protocol

- Low-GWP-HFCs...
  - were developed as climate-friendly alternatives
  - deplete natural resources
  - produce dangerous hydrogen fluoride when they burn and transform to trifluoroacetic acid in the atmosphere
  - are patented and manufactured by chemical industry and costly

Green Cooling
- Natural refrigerants...
  - are naturally occurring substances that can be used as refrigerants in almost all RAC applications
  - are typically more energy efficient than F-gases
  - do not harm the environment
  - can be handled safely with Due Care
  - are not patented by chemical industry and less costly than HFCs
- Energy efficiency

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Energy efficiency under high ambient temperature conditions – AC and chillers

Source: TEAP XIX/8 Task Force Report 2010
Energy efficiency: The TEWI concept

- Combines the Greenhouse effect of direct and indirect emissions

- TEWI = DIRECT + INDIRECT

DIRECT: \[ m_{RFa} \cdot n + (m_R - m_{Rec}) \cdot GWP \]

INDIRECT: \[ Ea \cdot n \cdot C \]
TEWI simulation for equal Chiller capacity with different refrigerants

Annual GHG emissions [kg/a]

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>R134a</td>
<td>1.317</td>
<td>1.339</td>
</tr>
<tr>
<td>R410A</td>
<td>1.392</td>
<td>1.453</td>
</tr>
<tr>
<td>R290</td>
<td>1.326</td>
<td>1.339</td>
</tr>
<tr>
<td>R717</td>
<td>1.313</td>
<td>1.339</td>
</tr>
<tr>
<td>R718</td>
<td>1.314</td>
<td>1.339</td>
</tr>
<tr>
<td>R1234yf</td>
<td>2</td>
<td>1.453</td>
</tr>
<tr>
<td>R32</td>
<td>324</td>
<td>1.453</td>
</tr>
</tbody>
</table>

Source: ILK Dresden
Background - Energy efficiency: refrigerant impacts

Summary of efficiency benefits of R-290 & R-1270 over R-22 in window and split RACs

- Implies major advantages in for cost-efficient, compact design
R290 in Split Ac and Chillers for South Africa
…some kind of wrap up
Applications Markets

• Applications – Markets
  – Domestic
  – (Light) commercial
  – Commercial
  – Industrial
  – UAC
  – Summary
Domestic refrigeration: Hydrocarbon success story

More than 700 million domestic refrigerators already use hydrocarbons today

HC is the standard for 50% global production of new domestic refrigeration equipment

- By 2020, 75% of new production globally will use R600a/ R290
Commercial Refrigeration: Supermarkets (plug-ins and centralised) in Europe

Source: Shecco, 2014
1.35 million beverage vending machines in Japan use either hydrocarbons or CO₂

natural refrigerants make up over 50% of the market

from 0.1% to 52% market share in just 10 years! = a clear Japanese success story
Light Commercial

- Self-contained water loop HC-based refrigeration systems are a clear trend.
- Used with leading retailers in Germany and the UK - now also coming to North America, Asia and Australia.
- 90% reduced refrigerant charge at better capacity than R404A and a fast break-even to recover investment costs.
Air Conditioning: Global Market
App. 105 Mio room air conditioner sold/year – Installed Basis >2 Billion

Sources: JRAIA, JARN, BSRIA (2015)

1 excl. China and Japan

~ 105m units
Viable application of HCs in air conditioners

- No + measures
- “Easy”

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- Application
- Efficiency
- GWP
- Training
- Safety
- Standards
- Success Stories

R290
Why to focus on AC? Solutions are available

Mobile AC

Domestic Ref.

Comm. Ref.

Industr. Ref.

AC

Foams

CO₂

HC

CO₂/HC

NH₃

HC

CO₂/HC
Green split ACs – the case and market momentum is there

- Godrej & Boyce sold more than 200,000 HC split AC units in Indian market
- Establishment of a training, certification and registration network to fully capture and control the installation, servicing and repair of R290 split ACs
- Current inverter HC-290 models are top in efficiency in their capacity category
- China market breakthrough expected for 2019
Example Godrej R290 AC approach – Safe installations and servicing

- Room size calculation
- Installation checklist
- Safe installation and servicing
- Safe working practice
- Trained technicians
- Product service manual
- Free installation and servicing
R290 production lines for AC

- China: Gree, Midea, Stage 1 HPMP: 18 lines converted to R290 (2011 – 2016); 4 compressor lines; HPMP Stage 2: 25 assembly lines, 4 compressor lines
- Installation and after-sales service: Capacity building and equipment, authorised companies only.
- Algeria (planned): Split and window (R290 and R32)
- Bahrain (planned): Split (R290 and R32)
- Brazil (planned): 3 factories to R290
- India: Godrej line conversion, 600,000 sold units
- Pakistan: R290
- Egypt (planned): 5 manufacturers to R290
R290 in Split Ac and Chillers for South Africa

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## The role of standards

<table>
<thead>
<tr>
<th>Product</th>
<th>„People“</th>
<th>Application</th>
<th>Source: ETSuS UG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>„Employer“</td>
<td>„Owner / Operator“</td>
<td>ISO 5149</td>
</tr>
<tr>
<td>„Free Trade of goods“</td>
<td>„Occupational Health</td>
<td>„Safe Operation“</td>
<td>IEC 60335</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td></td>
<td>ATEX-(Product)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ATEX-(Workplace)</td>
</tr>
<tr>
<td>ISO 5149</td>
<td></td>
<td></td>
<td>e.g. Fire</td>
</tr>
<tr>
<td>IEC 60335</td>
<td></td>
<td></td>
<td>protection rules</td>
</tr>
<tr>
<td>ATEX-(Product)</td>
<td></td>
<td></td>
<td>Level</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Standards</td>
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</tbody>
</table>

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RACHP most relevant Safety Standards

<table>
<thead>
<tr>
<th>Scope</th>
<th>Europe</th>
<th>International</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
<td>-NA- (based on ISO)</td>
<td>ISO817</td>
</tr>
<tr>
<td>Refrigerant charge limits and safety requirements</td>
<td>EN378</td>
<td>ISO5149</td>
</tr>
<tr>
<td></td>
<td>EN60335-2-40</td>
<td>IEC60335-2-40</td>
</tr>
<tr>
<td></td>
<td>EN60335-2-89</td>
<td>IEC60335-2-89</td>
</tr>
<tr>
<td></td>
<td>EN60335-2-24</td>
<td>IEC60335-2-24</td>
</tr>
<tr>
<td>Training/qualification</td>
<td>EN 13313</td>
<td>ISO 22712</td>
</tr>
</tbody>
</table>
Scope of these standards

**EN378-2** covers a lot of type of products

- Coldstores
- Even factories

**EN 60335-2-24** - freezer, fridge, ice cream maker

- Freezer, fridge
- Ice cream maker

**EN 60335-2-40**
- air to air, air to water household, shops, office...
- portable
- fixed

- Blast chiller
- Display cabinets coolers

Ground source
### Safety Standards – Principle of Charge limits, e. g. AC

<table>
<thead>
<tr>
<th>Brennbarkeitsklasse</th>
<th>Kategorie des Zugangsbereichs</th>
<th>Placement of the unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Class 2,2L,3</td>
<td>Occupancy / Accessibility</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Application / Placing</td>
</tr>
</tbody>
</table>

Charge limits R290:

- **Fixed values:**
  - 150g / (500g), 1kg, 5kg

- **Requirements depending on room size**

---

a. \( m_2 = 26 \, m^3 \times LFL \)

b. \( m_3 = 130 \, m^3 \times LFL \)

c. für die Aufstellung im Freien gilt EN 378-3:2016, 4.2 und für Maschinenräume gilt EN 378-3:2016, 4.3.
Safety Standards – Principle of Charge limits
Example: R290 for human comfort, indoor, open access

Charge limits R290:
- Fixed values: 150g / (500g), 1kg, 5kg
- Requirements depending on room size

Chillers are less critical from a charge perspective!
The role of standards:
Example: IEC 60335-89 recent developments

Flammable refrigerant limits approved in recount

9 MAY 2019

Who votes for which country?
# The role of standards: Example Germany

<table>
<thead>
<tr>
<th>Product Manufacturer</th>
<th>„People“ „Employer“</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPSD, PED, MD, LVD...</td>
<td>WSD, WPSCD;WES, ATEX-B...</td>
<td>ErP, F-Gase, EPBD, CPD, CLP, ADR,</td>
</tr>
<tr>
<td>Harmonisierte Normen:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...EN 378, EN 60335</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRBS, TRGS ASR DGUV-R</td>
<td></td>
<td>LBO, VStättV, FeuV,...</td>
</tr>
</tbody>
</table>

Source: ETSuS UG
R290 in Split Ac and Chillers for South Africa
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Training: Key learning targets

✓ Acquire knowledge of safety concepts for hydrocarbon (HC) refrigerant systems (inc. knowledge of standards & norms)

✓ Know the sources of ignition (SOI) and understanding the concept for protection against hazards

✓ Know best practice on safe handling of HC`s in SAC

✓ Become familiar with the right tools and personal protective equipment (PPE)

✓ Gain theoretical knowledge & practical experience in brazing operation

✓ Obtain practical experience in safe handling of HC refrigerants
QCR; Example Ghana

Location
Accra Technical Training Center (ATTC)

Trainings
Basic and advanced training
- Theoretical and Practice
- Brazing

- 25 participants (ATTC trainer & technicians from private sector)

- Safe handling installation of Split AC in co-operation with manufacturer
QCR: Practical training
Example Ghana
### R-290 (Propane) Split AC Pilot Fact Sheet

**Cool Contributions Fighting Climate Change (C4)**

<table>
<thead>
<tr>
<th>AC Units</th>
<th>Total Energy consumption (KWh/25 days)</th>
<th>CO2 eq. emissions (Kg)</th>
<th>Running cost (XCD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previously installed R410A</td>
<td>519.52</td>
<td>327.30</td>
<td>$493.54</td>
</tr>
<tr>
<td>R-290</td>
<td>363.67</td>
<td>229.11</td>
<td>$345.49</td>
</tr>
<tr>
<td>Savings</td>
<td>30.03%</td>
<td>98.19</td>
<td>$148.06</td>
</tr>
</tbody>
</table>

R-290 AC unit uses significantly less electricity leading to lower cost to operate and decreased CO2e when compared with the existing R-410a unit.
GIZ products

Guidelines for the safe use of hydrocarbon refrigerants
A handbook for engineers, technicians, trainers and policy-makers – For a climate-friendly cooling

Download all Proklima publications under: https://mia.giz.de/esearcha/browse.tt.html / browse for “Proklima”
R290 in Split AC and Chillers for South Africa

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R290 in Split AC and Chillers for South Africa

- Natural refrigerants (NR) are the ultimate solution
- For some applications the use of NR is in advanced stage
- Due to pure quantity and projected future development the AC market is crucial to success of climate change
- R290 is solution available for Split AC from large manufacturers
- There Barriers for the introduction of R290 in Split AC
  - Acceptance of “flammable” refrigerants
    - easy to grill – but hard to chill
    - “We do not talk about flammability
  - “Lack of qualified technicians”, “Skills Gap”
    - QCR is the basis for safe handling and upcoming success
    - Informal sector needs to be tackled:
      - “We will upskill you not kill you”
  - Regulation on different levels are not alligned and such cause uncertainty and concerns
- **Tackle the barriers – JUST DO IT!**
Thank you for your kind attention!
edgar.timm@heat-international.eu