



Low-GWP, EE HCFC Replacement Technologies in RAC sector – SA Regional Workshop PNUMA

GTZ Proklima Project examples in Europe and Asia



GTZ Proklima

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Outline of Presentation

- 1. Introduction**
- 2. Issues – Appliance Replacement**
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 - 3.2 Johnson Controls – Chillers (Ammonia/ HC)
 - 3.3 Lidl Supermarkets – Futron Technology HC RAC equipment



Introduction:

IPCC estimates 10% of Global Warming relates to man-made GHG in RAC systems.

- **In Europe, bans and taxes have been established.**
- **Requirements for both contractors and owners/operators:**

For leakage reports/testing;
Operation and maintenance;
Handling of hazardous waste;

Consequences:

- HCFCs and Fluorinated refrigerant - based systems are getting more difficult and expensive to use



GTZ/Proklima assistance under the Montreal Protocol

Challenge is to make safe, reliable and suitable refrigeration systems for the markets, facilitating access to alternative technology during the HPMP phase-out process.

GTZ Study Cases/Partners focus in on alternative options to HCFC in CHILLERS - typically used for air conditioning .

AMMONIA and HYDRO-CARBONS are refrigerants presently used in Europe



General Info about the company

- Gree is the unique World Brand“ A/C in China;
- Product sold in 20 countries;
- Since 2005, Gree´s sales volumes of residential A/C took the first place in the worldwide ranking;
- In 2008 190 million units were sold globally;

GTZ Project Description

- GTZ/Proklima commissioned by BMU – Federal Ministry of Nature Conservation and Nuclear Safety (outside the MLF) in partnership with the Chinese Ministry of Environmental protection/ Foreign Cooperation Office and CHEAA



Objectives

- Establish and replicate “best practice“ model on the conversion of room A/C; Reduce rate of HCFC conversions to HFCs (410A)
- Introduce Hydro carbons in the fast growing A/C production sector in China
- A/C HCFC emissions in China account for 260 million tonnes of CO₂eq;
- Study extra financial instruments and incentives
- Comprehensive training for production and service technicians; this covers the responsible and safe handling of flammable refrigerants as well as maintenance of the equipment ;



Innovations

- Additional features include a special compressor design and refrigerant leak alarm system. The R290 air conditioners will achieve CE marking (i.e., conform to all EU legislation)
- Narrower tubes can be used in the condenser and evaporator since R290 has better heat transfer properties and a lower pressure drop.

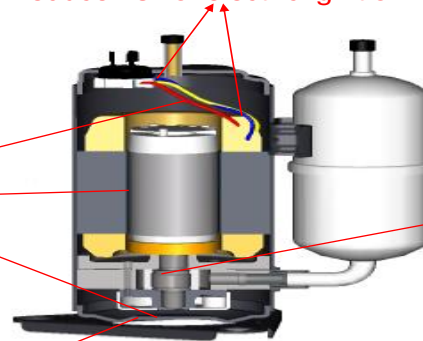
2.2 R290 Compressor

2.2 R290 Compressor

Improved Electric connector to reduce risk of electric ignition



Special material inside: compatible, anti-aging design



Exhaust structure: more suitable compression ratio, improved efficiency

Special lubrication oil: make compressor operation more stable and reliable

The compressor COP reached up to 3.4 which is higher than that of other companies' R290 compressors. Gree's R290 compressors currently cost only as much as a R410A compressor. Cost is likely to go down when production increases.





Innovations

Refrigerant Leak Alarm System

- As refrigerant leaks out, the performance of the system will drop;
- As the A/C system leaks, the system pressure, refrigerant and air temperatures, electric current, etc. will all change;
- An electronic control device detects this intelligently and recognises that a leak is really happening, thereby triggering the alarm and shutting the AC down.



Conclusions

Cost-Benefit

- The R290 containing air conditioners can be produced cheaper than R22 products, because:
 - R290 refrigerant is even cheaper
 - R22 air conditioners are cheaper than R407C and R410A units

Performance

- The COP is ≥ 3.52 --- This is better than the “A” rating of the EU efficiency labelling for air conditioners
- Gree R290 designs achieved lower refrigerant charge size than is currently required by international standards for R290 air conditioners (IEC 60335-2-40)
- R290 air conditioners will be much cheaper than R410A units



General Information about demonstration cases

Chiller Appliances – Ammonia and Hydro carbons in Denmark , Germany and in the UK

Company Johnson Controls

- Low charge Ammonia (NH₃) chillers are now in widespread use for air conditioning loads, particularly in Europe.
- Recent technical developments mark a definite turning point in that most refrigeration engineers now also accept that such equipment can be applied safely to many commercial applications in urban areas.





Drivers for the Alternatives

- Depending on location, R22 either has been phased out, or is so close to being phased out, that it is no longer worth considering.
- Taxation has proven to be a very effective weapon against the use of HFC. In Denmark, the taxation of HFC usage is linked with the taxation of CO₂ emissions and regulation is via the rules governing waste management. The current CO₂ tax is DKK 0.15 and the end-user price for 1 kg R404A is about 150€/kg. Industry should expect same trend for high ODP-GWP gases.
- Most refrigeration engineers understand that HVAC owner/operators need to be convinced of the benefits of low charge Ammonia chillers and how they can be used safely.



- One of the most impressive systems is that serving Terminal 5 of London Heathrow International Airport where four units provide a total cooling capacity of about 25MW. Each unit holds only 1,370 kg of Ammonia.
- In Aarhus, a major hotel and congress center had an Ammonia system installed in 1995/6. Each system has a cooling capacity of 600 kW when cooling water from 12°C to 7°C. The building is very close to the city centre and particularly the City Hall/Theatre. An scrubber was fitted into the plant room for increasing security;
- Numerous small shopping centers have now been equipped with NH₃ chillers in several European countries. In Denmark, a shopping mall recently installed low charge Ammonia chillers to replace a R22 system.
- In a recent project a R12 turbo chiller was replaced by three newly developed, inverter driven, low charge Ammonia screw chillers in the middle of a shopping center in Aarhus, Denmark. The required capacity was about 3 MW and, as local regulations forbid use of HFC charges over 10 kg, the owner/operator had to consider alternatives. (SEE RESULTS NEXT SLIDE)

Case 2 – Johnson Controls Inc.



The result is the successful removal and destruction of 1,200 kg of Ozone depleting material and the installation of a more modern and more efficient refrigeration system using less energy and a refrigerant with zero global warming potential. Each of the Ammonia chillers has a charge of 56 kg.



Absorbed Power (season)KWh	Old System	New System
Refrigeration	513.15	324.77
Pumps	82.00	64.50
Fans cooling tower	55.50	44.40
Total absorb. Power (season) KWh	650.65	433.17
Reduction in absorbed power kWh	216.99	
Annual CO2 reduction - Tonnes	(216.983 x 0.547) / 1000 = 118.70	



Innovations - Plants include air-cooled or liquid-cooled condenser.

- PARTS AND COMPONENTS

Both types of plant are equipped with a single piston compressor, plate heat exchanger, liquid separator, automatic oil return, and electric board including electronic control in front panel.

- At request it is possible to achieve more customized plants including different options. For instance twin and triple plant.
- Increased efficiency and reduced ammonia charges , due to the advantageous modern heat exchange technology , allowing the design of smaller chiller plants.



Conclusions

Ammonia Chillers

- Refrigerant being environment-sounding and adapted for future requirements;
- Low operation cost compared to HFC plants
- Compact design – easy to place;
- Design prepared for acoustic housing;
- Factory test of plant;
- Low mounting costs;



- Several customers who have exchanged their HFC or HCFC chillers for a Hydro-Carbon solution have been very impressed by the energy efficiency of the new equipment.
- There are over 400 Hydro Carbon chillers in Denmark from 40Kw to 400Kw . Several typical air conditioning loads, and capacities.



An inverter driven, screw, air-cooled Propane [R290] chiller on test



Two indoor Hydro-Carbon chillers



Technical Innovations / Properties

- Hydro-Carbon chillers are designed to use as little charge as possible, to minimize the points of potential leakage and to limit the circulation of the refrigerant to within the confines of the chiller frame.
- All non-essential valves are eliminated and the type of valve is carefully selected e.g. uncapped valves are a potential leak risk, regardless the type of refrigerant.
- Selection of Hydro-Carbon refrigerant is determined by the type of load, temperatures required etc.
- In Australia and New Zealand, it is mandatory to use HC with an added stench so that it “smells like gas”. However the smell can be absorbed by filters and oil.

HC chillers – Demonstration case



Conclusion based in case study

As an example, the University Hospital of Aarhus replaced its existing chiller, which had a CoP of 3.0, with a new Propane chiller that performed with a CoP of 4.5.



	Existing Plant	New Plant
Refrigerant	R22	R290
Charge	100	20
Cooling Capacity	105	105
Energy Expenditure	Euros 42.252	Euros 20,002
Free cooling	no	yes



General Info about the company/technology

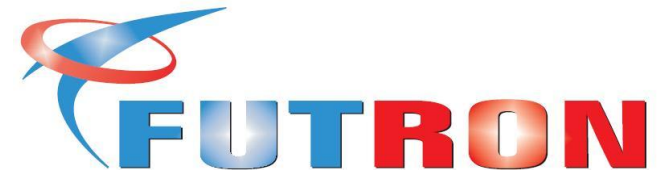
- Lidl is a 9000-store supermarket chain in Germany
4 plants in operation/ all newly built stores = approx. 200 by 2012
- Futron is a customized HRAC technology company that uses only natural refrigerants



Project Description/Followed approach

REPLACEMENT of RAC EQUIPMENT in food retail industry by using R290 refrigerant

1. CESR guidelines for sustainability sought for environment sounding applications
2. Study of economic feasibility and technical options viability;
3. Consultations with equipment manufacturers as a large refrigerant end-user
4. Reformulated design to attend safety requirements in Europe





Innovations and Technical Specs

- Design as a connected unit within a gas-proof enclosure ;
- Integral Plant set up outside the property e.g. (roof top);
- All pipe work is produced with welded connections between the system's components i.e. heat exchangers, valves, pressure switches, control units pumps etc;
- At least one gas sensor, if exceeding pre-set limit of HC concentration it switches off all electric components and separates them from electricity supply;
- Additional leak-proof pan in the bottom of the enclosure/ oil leakages are also kept by the pan;
- Ventilation system according to ATEX guidelines;
- Pre-assembled plant with minor assembling on-site (including the electric installation, pumps brine(oil) circuit, etc)
- Safety standards/ operations by an appointed certified technician

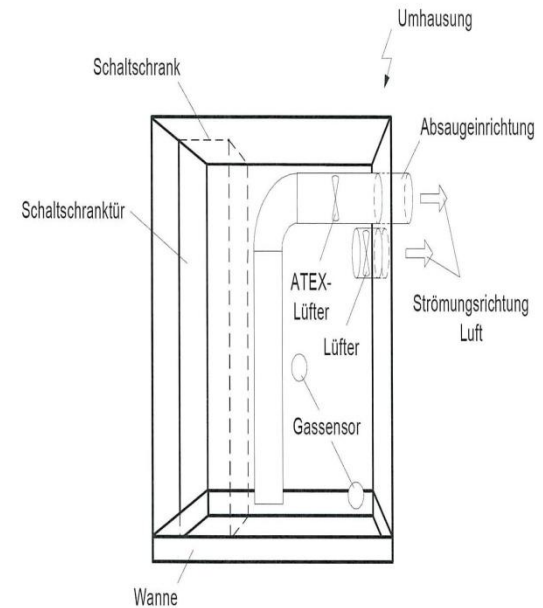


Abbildung 2: Umhausung der Kälteanlage mit Schaltschrank und Absaugeinrichtung mit Sensoren und Lüftern



Possible Applications and combinations (R744, R290 + water or temper secondary systems)

- Cold production medium temperatures -
- Cold production low temperatures
- Cold production A/C
- HEAT production through waste heat utilization
- Measuring, controlling and regulating systems/building control systems



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