AIR REVERSING R744 AIR CONDITIONING SYSTEM

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Reversible R744 systems

- Refrigerant reversing unit
  - Several valves required
  - Additional cost
  - Heat exchanger mode changes

**Alternative:**
Reverse Air flow!
Reversible systems

- CANTABRIA = Concept of University of Cantabria
- Reversing the air flow
Reversible systems

- Controlling the air flow with flaps
Set-up (heating)

OUTDOOR cooling

INDOOR heating
Animation
Components
Evaporator configurations

- Top view

Conf. A

Conf. B

Conf. C

Conf. D
Temperature distribution
Air side - downstream of the evap.

Config: A; 1.3 kg/min

Config: B; 1.3 kg/min

Max capacity for ECU
Temperature distribution
Air side - downstream of the evap.

Conf. C; 3 kg/min
Conf. D; 3 kg/min

If applied in other applications
Measurement set-up

- Entire ECU between two climate chambers

Chamber I
Evaporator side
[-20°C – +30°C]

Chamber II
Gascooler side
[+20 – +53°C]

- Refrigerant mass flow meter and calorimetric energy balance applied to calculate capacities
Gascooler Temperature Profile

50°C ambient temperature
Picture of the R744 turn-table ECU
Results

COP Heizen
Q Heizen
COP Kühlen
Q Kühlen
Innenraumtemperatur

Umgebungstemperatur [°C]

COP [\text{-}] & Heiz-/ Kühleistung [kW]

Innenraumtemperatur [°C]

Umgebungstemperatur [°C]
Temperature bin / Climate / Location

Number of annual hours

Temperature range [°C]

24 h/day (total 8760h)

Beijing  Baghdad  New Delhi
Energy Demand & CO2 Emissions

Office hours
(8 a.m. – 5 p.m.)

- 3-3.2 MWh/a
- Dieselgenerator
  2.3-2.5 m.ton/a
- Coal power p.
  2.8-3 m.ton/a
- China / India
  2.25 / 2.7 m.ton/a
Energy Demand & CO₂ Emissions

Non-office hours (5pm – 8am)
- 4.9 - 5.1 MWh/a
- Dieselgenerator
  3.7 - 3.9 m.ton/a
- Coal power p.
  4.6 - 4.8 m.ton/a
- China / India
  3.7 / 4.3 m.ton/a
COP & Capacity limiting factors

- Lines = ok
  - no disadvantage due to current fitting technology
- Gascooler => ok (low temperature approach)
- Evaporator
  - fin pitch adjustment required (frosting)
  - refrigerant side distribution => ok
- Expansion devices
  - TBR = small adjustment of temperature pressure curve
  - MBR = ok
- Receiver = ok
- IHX (internal heat exchanger) = ok
- Compressor (3cm³ proto-type)
Summary


- An air reversing, turn-table ECU was designed and experimentally investigated.
- The refrigerant circuit can be unchanged, when directing the air through the designated heat exchanger by rotating the entire refrigeration unit. Therefore the function of the heat exchanger does not change, i.e. the gascooler can be optimized for a low temperature approaches. Refrigerant charge issues can be handled since no ‘dead’ lines are present.
Conclusion

This concept study showed that a turn-table residential AC-unit, applying R744 as working fluid, is a viable option for many global areas, where both heating and cooling is required during a year.

This concept is also feasible for ‘mobile’ HVAC system in busses and trains…
Thank you for your attention!

Questions are welcome!!!

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More real facts at www.R744.com