CETIAT R&D Work on Low-GWP Refrigerants

Third Experts’ Meeting for IEA-HPT Annex 54: Heat Pumps for Low GWP Refrigerants

Pierre PARDO
Agenda

• Background and motivation
• R&D on low-GWP refrigerants
• CETIAT planned contribution to Annex 54
R&D on Low-GWP refrigerants

- Experimental performance assessment
  - Drop-in tests
  - Finned tube coil tests

- Technical data sheets on refrigerants
  - 13 technical data sheets

- CETIAT Project PR5: Low-GWP refrigerants (<150)
  - Flammability management
  - Charge reduction for flammable refrigerant use
  - Design optimization
Drop-in tests

- **Alternatives to R410A in a 10 kW air-to-water heat pump:**
  - R32, HPR2A, R447A, R454B, R459A

- **Alternatives to R407C in a 3 kW water-to-air heat pump:**
  - R455A, R454C

- **Alternatives to R134a in a split heat pump water heater:**
  - R1234yf, R513A, R450A

- **126 tests** carried out according to EN standards

![Fig 1. Example of alternatives to R410A in a 10 kW air-to-water heat pump in cooling mode](image_url)
Finned tube coil tests

- Evaporation and condensation with R410A, R32, R454B
- Evaporation with R449A (large temperature glide)
- Numerical simulations with EVAP-COND and Dymola
- Useful data to validate numerical models of finned tube heat exchangers
- **36 tests** carried out

- Next step: HEX optimization

*Fig 2. Example of comparison between experimental results and simulation (evaporation mode)*
Technical data sheets on refrigerants

• 13 technical data sheets:

• Content:
  1. Product identification
  2. Physico-chemical properties
  3. Thermodynamic and thermal aspects
     a. P-h and T-P diagrams
     b. Theoretical performance of the vapor compression cycle (COP/EER)
     c. Theoretical cooling capacities
     d. Theoretical heat transfer coefficients
     e. Theoretical compression ratios
     f. Theoretical discharge temperatures
  4. Standards and regulations

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<table>
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<th>Evaporation temperature (°C)</th>
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<tbody>
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Fig 3. Simulation of a vapor compression cycle with EES (Engineering Equation Solver)
PR5: Low-GWP Refrigerants (<150)

- PR5 is a CETIAT project in collaboration with French HVAC manufacturers
- Duration: May 2020 - April 2023
- Objectives:
  - To update the knowledge on refrigerants and to inform national HVAC manufacturers
  - To support manufacturers in the process of replacing HFCs to have solutions ready in 2030
  - To allow the use of (highly) flammable refrigerants according to the regulatory constraints
- Work Program:
  - Task 1: Refrigerants follow-up
  - Task 2: Knowledge of the risks associated with flammability and toxicity
  - Task 3: Risk management for flammability and toxicity
  - Task 4: Development of solutions using flammable refrigerants by 2030
Planned CETIAT contribution to the Annex 54

- Experimental results of the drop-in tests
  => input for Task 1/ Annex 54

- Experimental results of the heat exchanger tests
  => input for Task 1/ Annex 54

- Technical data sheets on refrigerants
  => input for Task 1/ Annex 54

- Numerical optimization of a finned tube coils using low-GWP refrigerants (R32 and R454B)
  => input for Task 2/ Annex 54

- Results from PR5, if extension of Annex 54 on 2022
Thank you for your attention!

pierre.pardo@cetiat.fr
PR5: Low-GWP refrigerants (<150)

- Task 1: Refrigerants follow-up
  - State-of-the art
  - Participation to Annex 54

- Task 2: Knowledge of the risks associated with flammability and toxicity
  - Analysis of the EU normative and regulatory framework
  - Analysis of the studies on the risk assessment of A2L, A2 and A3 refrigerants

- Task 3: Risk management for flammability and toxicity
  - Identify the technical solutions to reduce the refrigerant charge
  - Leakage detection and control

- Task 4: Help in developing solutions for 2030
  - Use Low-GWP refrigerants (<150)
  - Simulations
  - Prototyping
  - Experimental evaluations