Low Charge Heat Pump Module using 150g of R-290

Project overview

Steering Committee, definition of requirements, receipt of results and access to IPs

1,2 Mio. € (approx. 1-4 % of total project volume, pro rata market share)

3,6 Mio. € (75 % funding rate)
FKZ 03EN4001A

LC150 PLATFORM DEVELOPMENT OF A CHARGE-REDUCED HEAT PUMP MODULE WITH PROPANE

4,8 Mio. € project budget, 2.75 years, 1.10.2020 – 30.06.2023

- Component testing (heat exchangers, compressors, valves etc.) in single component tests and in broad cross evaluation
- Charge reduction and localization of refrigerant
- Operating strategies
- Standardization
- Network and platform for manufacturers
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Performing a cross evaluation

- Carry out a large cross evaluation of refrigerant circuit components
  - a large data base of measurement values and simulation data from refrigerant circuits and their components
  - 24 prototypes* x 20 operation points x 8..20 charges = ~8000 successful steady measurements

- *completed charge range, more prototypes aborted early
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Results cross evaluation

- Graph shows
  - minimal optimal Charge @B0W35SH10F100%
  - Specific charge over max heating capacity
  - 24 completed refrigerant cycles
  - Red marked = target area
Low Charge Heat Pump Module using 150g of R-290

Definition operation condition

- Definition of 4 distinct operation states
  - HPC Paper* available for detailed information
    - (A) Extreme underfill: EEV 100% open
    - (B) Underfill: starts to close
    - (C) minimal optimal charge, SC=\(\sim\)1K
    - (C – D) Overfill: until COP drop-off 10%
    - (D) extreme overfilled: starting COP drop-off 10%

*see paper ID 622. HPC/Chicago
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Definition operation condition

- Definition of 4 distinct operation states
- Confirmation using IR images
Low Charge Heat Pump Module using 150g of R-290

Cross Evaluation

RC8-21
- Min opt charge 124g @SCOP operation points
- Same compressor and condenser

RC8-24
- Min opt charge 165g @SCOP operation points
- Same compressor and condenser
**Low Charge Heat Pump Module using 150g of R-290**

Heat map of refrigerant cycles

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- **Table view**
- **Definition of state:**
  - **Underfill:** EEV opens up
  - **Correct:** SC-0K +30g
  - **Overfill:** until COP drop-off 10%
  - **Too overfilled:** starting COP drop-off 10%

U = Underfill
C = Correct
O = Overfill
T = Too overfilled
Conclusions

- Significant reductions in charge shown
- Complete automated measurements necessary of full charge range possible
- Clear optimization conflict between efficiency and charge
  - SSH
  - Size HE’s
- Secondary optimization conflict
  - Production cost, manipulation for charge reduction possible
  - Safety margin on reliability, oil reduction
  - Safety leakage margin
- Measurements used for validation and improvement of IMST Art @University of Valencia
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Outlook

- Follow up Project LCR290 started 1.1.2023
  - Multi family housing focus
    - Centralized as well as decentralized solutions planned
- Test infrastructure
  - Automated charge varying system testbenches will be continued and improved
  - Connection to automated single component measurement testbenches will be enhanced
    - HEX as well as compressor
  - Air HEX measurement capabilities will be added to single component test bench
Thank you for your attention

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