System drop in test of R-410A Alternative Refrigerant DR5A, L41-1, L41-2, R32 and ARM71a in a water chiller

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Context and challenges?

European and global context

• F-Gaz 2 in application since Jan 15
• Japan trend for R32 as a replacement for R410A
• Investigations done in the frame of AREP 2 of AHRI

• Target: assess low GWP alternative refrigerants to R410A => as drop in solutions
Experimental Setup and procedure

9 kW cooling capacity water chiller

- Tests with and without a liquid receiver (refrigerant charge of 3.2 kg and 2.7 kg identical for all candidates)
- Full capacity @ 35, 40 et 45° C ambient temperature and 7° C chilled water output
- Lubricant type Emkarate RL 32-3 MAF
- TXV opening adjustment
- Tested refrigerants: R410A reference, R-32, DR-5A (from DuPont), L-41-1 and L-41-2 (from Honeywell), ARM71A (from ARKEMA)
TXV adjustment impact

- Hunting phenomenon example with DR05

![Graph showing normalized refrigerant mass flow rate over time with hunting phenomena and percentage deviations. The graph compares the flow rate before and after expansion valve regulation, indicating +/-15% and +/-50% deviations.]
Test results

Cooling capacity and COP (EER) without receiver

- Higher cooling capacity but lower EER with R32
- HFO based mixtures lead to equivalent EER but lower cooling capacities
Test results

Cooling capacity and COP (EER) with receiver

- Higher cooling capacity at high ambient temperature with R32
- HFO based mixtures lead to slightly improved EER but lower cooling capacities
Test results

High pressure and compressor discharge temperature without receiver

- High discharge temperature and pressure with R32
- HFO based mixtures lead to acceptable pressures and temperatures
Test results

High pressure and compressor discharge temperature with receiver

- Receiver allows reducing high pressure levels for R-32
- Lower discharge temperatures but still high for R-32
Test results

Exergy analysis of R410A vs R32

- Most of the exergy losses occur in the compressor (63.6% higher in case of R-32).

- Condenser exergy losses are ranked 2nd (with 104% more for R-32). Mainly due to high discharge temperature.
Conclusions

- No miracle solution

- In high ambient conditions R32 presents discharge temperature problems

- A EER vs cooling capacity compromise may be found

- Liquid receiver allows reducing high pressure but penalizes subcooling and so the cooling capacity and the EER

- TXV adjustment is required