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Unique Measurement Campaign Launched to Reduce Refrigerant Charge in Heat Pumps With Propane

The Fraunhofer Institute for Solar Energy Systems ISE is developing refrigeration circuits for heat pumps which shall operate as efficiently as possible with low amounts of the climate-friendly refrigerant propane. This research is carried out in project "LC150 - Development of a Refrigerant-reduced Heat Pump Module with Propane", funded by the German Federal Ministry for Economic Affairs and Energy BMWi. In an automated cross-evaluation, a team from the institute is testing various components of heat pumps on the large scale, in which dozens of component combinations under different operating parameters are investigated. The main objectives are to further reduce the volume of required refrigerant, to identify methodological correlations and to obtain data for the simulation of heat pump design. The measurement campaign collects an abundance of parameter variations 24/7 over one year, thus generating a unique database.

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Between forty and eighty prototypes of brine heat pumps are constructed for the measurement campaign, in which the individual components (evaporator, compressor, condenser, internal heat exchanger and expansion valve) are assembled in different constellations. The tests run in parallel on three identical test stands 24 hours a day for one year, with between 30 and 150 operating points being measured per prototype and the measured values recorded by 26 sensors. The Fraunhofer ISE team is developing a system for automatic refrigerant charging and discharging to avoid the time-consuming task of manually handling the propane by trained specialists.

"The measurement campaign thrives on the broad participation of component suppliers, who contribute to the project by providing marketable and customized components such as heat exchangers and compressors. With the automated testing technology, developed in close cooperation with the company EP Ehrler Prüftechnik Engineering GmbH, we can now carry out as many measurements as possible and operate the test stands around the clock. This setup enables us and the project partners to acquire an extensive, multidimensional dataset in a comparatively short time, thus laying the foundation for the rapid market implementation of refrigeration circuits with significantly reduced refrigerant charge," explains Dr. Lena Schnabel, Head of Department of Heating and Refrigeration Technology at Fraunhofer ISE. During the tests, sensors record temperature, pressure, power consumption and volume flows in the prototypes, and the data is automatically loaded into the

evaluation software. Heat sinks and heat sources as well as temperatures and operating states are varied in order to determine their effects on the components. With this data, the seasonal efficiency of each heat pump assembly with its respective refrigeration circuit can be estimated. Furthermore, the quantity and type of oil in the compressor are being varied.

"The challenge we face is the methodical comparison of the singular measurements on the components with the measurements on the entire refrigeration circuit. It should be possible to derive the performance of the entire refrigeration circuit from the measurements of individual components and vice versa. Simulations carried out in parallel are validated by the measurement operation, which together generate a large database," explains Clemens Dankwerth, project manager.

Based on the measurement results, the Fraunhofer ISE researchers will select the component combinations, which show the most promise for further reducing the amount of propane, to undergo long-term tests.

Data Base for Further Simulations

With the start of the measurement campaign in the project "LC150, Development of a Refrigerant-reduced Heat Pump Module with Propane", the main task of generating and evaluating the large data base begins.

From the acquired database, the researchers aim to derive methodical correlations which can be used to design refrigerant-reduced heat pumps with less effort in the future. To this end, the Technical University of Valencia (UPV) is developing a tool for predictive simulations with its IMST-Art software. During the measurement campaign, the simulation results are compared with the actual measured values, and the software will be thus continuously improved.

All partners of the LC150 project consortium can access the browser-based database, which contains the measurement results prepared by Fraunhofer ISE. They can then evaluate the data according to their own specifications.

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In the measurement campaign, dozens of heat pump component combinations are tested under different operating parameters. © Fraunhofer ISE

Further information:

Key Research topic: Heat Pumps

<https://www.ise.fraunhofer.de/en/key-topics/heat-pumps.html>

Heat Pump Refrigerant:

<https://www.ise.fraunhofer.de/en/key-topics/heat-pumps/heat-pump-technology.html>

TestLab Heat Pumps and Chillers:

<https://www.ise.fraunhofer.de/de/fue-infrastruktur/akkreditierte-labs/testlab-heat-pumps-and-chillers.html>

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