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Working Fluids and Refrigerants Sessions

by Roger Hitchin

Two of the sessions during the IEA Chicago Heat Pump Conference focused on reducing the global warming impact of refrigerants, specifically R-410A, through the use of alternatives with lower global warming potential (GWP). The papers presented explored various possibilities using thermodynamic calculations, system modeling, and experimentation. The adoption of R-32 by manufacturers for heat pumps was discussed, but there was recognition of the need for even lower-GWP fluids in the future.

The presentations highlighted the use of blends of R-32 and R-1234yf with varying GWP and flammability levels, as well as the potential of R-290 (propane) and other refrigerants, particularly in split air-to-air heat pumps. Tools and models were developed to explore the design and performance of systems using unfamiliar refrigerants and to optimize system performance while reducing refrigerant charge.

The evaluation of direct and indirect global warming emissions of heat pumps for various refrigerants revealed that several fluids had GWP values lower than 150, significantly lower than R-32 (GWP = 675) and R-410A (GWP = 2,088). The US Environmental Protection Agency (EPA) identified safe alternatives to R-410A for air conditioners with low flammability. Optimized systems using refrigerants with a GWP lower than 150 were found to reduce life cycle CO_2 emissions by 8.5%-28.6% while fitting into existing casings.

Studies investigated refrigerants with different GWP values, such as R-454B, DR-4, R-479a, R-454A, R-454B, and R-454C, and evaluated their performance in existing heat pump systems. Compressor speeds were adjusted to compensate for capacity penalties, resulting in comparable or superior performance to R-410A with lower GWP options. Further improvements in system design are expected to enhance overall efficiency.

The testing of refrigerant blends containing R-1132a, including R-468C, showed slightly lower capacity values in a commercially available R-410A packaged heat pump. System optimization and the use of an electronic expansion valve were suggested to improve performance. Feasibility tests with high-pressure, low-GWP refrigerants, such as R-744 and LFR3, demonstrated promising results for first-generation prototypes.

The design of heat pumps using R-290 (propane) as a refrigerant was explored, focusing on achieving maximum power within limited indoor usage. Specific heating capacity and design considerations were outlined, indicating the potential of propane for heat pump applications. Lastly, the study on new refrigerants for automotive use, particularly electric vehicles lacking waste heat from engines, examined R-474A. This blend showed increased heating and cooling capacity compared to R-1234yf and improved coefficient of performance (COP) compared to R-744.

Overall, the research presented in these papers contributes to the understanding of working fluids and refrigerants in heat pumps and automotive systems. Efforts are being made to find environmentally friendly alternatives with reduced GWP while maintaining or improving system performance.

Lukas Oppelt presentation: Results from using abandoned mines as a heat source for heating and cooling. (Photo: Carlos Jones, ORNL)