



High-Efficiency High-Temperature Heat Pumps with Refrigerant Blends for Temperature Glide Applications

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Abstract

High-efficiency high-temperature heat pumps (HTHP) with refrigerant blends designed for temperature glide applications offer promising enhancements in industrial heating and cooling systems. The Swiss Bridge Discovery Project addresses widespread scepticism towards high-glide refrigerant mixtures, which have historically been designed for minimal glide.

By experimentally and theoretically investigating mixtures with glide temperatures ranging from 20 K to 40 K, the project demonstrates that tailored refrigerant blends can significantly enhance heat pump performance.

The project highlights how refrigerant mixtures, such as propane/pentane (60%/40%), closely match temperature glide profiles in heating processes, such as heating water from 65 °C to 100 °C while cooling sources from 60 °C to 25 °C. This matching results in COP improvement of up to 20%, not only in modelling but also in experimental studies. It should be noted that mixtures not only enhance the COP but can significantly increase the volumetric heating capacity, thus offering more output for a given compressor size.

Large-scale screenings identified versatile "all-rounder" refrigerant mixtures capable of covering a diverse range of industrial applications with consistently high efficiency by adjusting their compositions. The project contributes to building confidence in high-glide refrigerant blends, promoting their adoption as a new norm in industrial heat pump technology, with potential COP improvements between 20% to 40% and substantial energy transition benefits.

The project also took a deep dive into modelling and experimental work on mixtures with glide for transcritical cycles. Albeit a niche topic, this could help heat pumps to achieve even higher temperature lifts needed in various industrial applications, particularly for drying.

This work supports sustainable energy solutions by optimizing thermal energy conversion with innovative refrigerant design and system integration. The most important project result is an industrial consortium that will install an industrial heat pump using a customized refrigerant mixture in the food processing industry.

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