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High-Temperature Auto Cascade Heat Pumps for Industrial Manufacturing Applications Especially Distillations

A single-compressor system that efficiently lifts heat up to ~200 °C for industrial distillation and chemical processing at lower cost and energy use.

Researchers have developed a high-temperature internal cascade (HTIC) heat pump that efficiently transfers heat between above-ambient temperature sources and sinks in industrial settings, especially distillation processes. This single-compressor system handles temperature lifts, up to 200Â°C, with practical pressure ratios, avoiding the inefficiencies and high costs of conventional multi-compressor systems.

HTIC cycles use special fluid mixtures and partial condensation to boost heat transfer and compressor performance. They can be set up in one or more stages to move heat across different temperatures, making them flexible and efficient. They are adjustable for one or more stages for the transfer of heat between different temperatures and are thus efficient and multi-functional.

Technology Validation: The HTIC heat pump technology was validated through simulation-based case studies involving industrial distillation processes. Results showed significant improvements, including reduced pressure ratios, lower compressor power, and up to 84% reduction in volumetric flow rates when compared to conventional systems. These outcomes confirm the system's efficiency and suitability for high temperature lift applications.

Advantages:

- Reduced capital costs

- Lower pressure ratios for improved efficiency

- Reduced energy consumption and compressor size

Technology ID

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Category

Semiconductors/Packaging & Integration

Energy & Power Systems/Power Generation

Chemicals & Advanced Materials/Materials Processing & Manufacturing Technologies

Further information

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Applications:

- Above-ambient distillation systems

- Chemical and petrochemical plants

- Waste heat recovery in industrial processes

TRL: 4

Intellectual Property:

Provisional-Gov. Funding, 2025-03-31, United States

Keywords: Lasers, LEDs, Optoelectronics, organic emitters, Perovskite materials, quantum yield