MIXED COMPONENT HEAT PUMP CONFIGURATION WITH INTERNAL CASCADING

2025-AGRA-71094

PROBLEM

Existing heat pumps require multiple external heat pump loops and cascades at increased cost, carbon dioxide emissions, and number of heat pump compressors.

SOLUTION

Researchers at Purdue University developed a novel heat pump configuration that uses a mixed component heat pump fluid with internal cascading. This enables heat transfer from one or more lower temperature heat sources to one or more high temperature heat sinks. This technology is versatile as it can easily be adapted for any number of heat sources and heat sinks while using only one heat pump compressor. This technology is also advantageous for numerous industrial applications because it increases efficiency of plants by reducing energy costs and carbon emissions.

VALIDATION

The heat pump technology was validated through simulation-based case studies involving industrial distillation processes. Results showed significant improvements, including reduced pressure ratios and lower compressor costs when compared to conventional systems. These outcomes confirm the system's efficiency and versality for heat pumping from plurality of heat sources to plurality of heat sinks.

ADVANTAGES

- Versatile
- Low energy costs
- Carbon dioxide emission reduction
- Utilizes multiple sources and sinks

APPLICATIONS

- Chemical manufacturing
- Petrochemical manufacturing
- Food manufacturing
- Pharmaceutical manufacturing

INTELLECTUAL PROPERTY STATUS

Application Date: March 31, 2025 | **Type:** Provisional-Patent | **Country of Filing:** United States

Interested in developing or commercializing?

Jacob Brejcha | *Licensing Associate – Physical Sciences*
jjbrejcha@prf.org

PURDUE INNOVATES

ELECTRICAL HEAT EXCHANGER APPARATUS AND REACTION TECHNOLOGY (E-HEART)

2024-AGRA-70615

PROBLEM

Heated apparatuses are particularly important for facilitating endothermic and exothermic processes such as cracking or thermal decomposition. However, available apparatuses fail to directly integrate renewable energy sources due to intolerance to changes in feedstock and power delivery conditions. Energy storage has been used to combat these pitfalls, but this solution incurs high costs and compromises product integrity. Methods to achieve precise temperature control for productivity improvement are still direly needed.

SOLUTION

Researchers at Purdue University have developed a mechanism termed Electrical Heat Exchanger Apparatus and Reaction Technology (E-HEART) that dynamically modulates reactor temperature in processes involving variable feedstock and power delivery conditions.

E-HEART helps chemical manufacturers and hydrocarbon processors efficiently conduct thermal processing for reactants and hydrocarbons. Simpler and more efficient than existing heating apparatuses, E-HEART excels in decarbonizing chemical reactors and directly integrates renewable energy sources.

VALIDATION

The researchers compared cracking processes of a feed stream in a conventional heated reactor with E-HEART. The E-HEART units exhibited superior performance for variable process conditions compared to conventional units. Results also demonstrated E-HEART's ability to efficiently handle diverse operating conditions by independently controlling heating elements.

ADVANTAGES

- Multi-stage design enables precise control of temperature and heat profile across the unit
- Precipitates dramatic carbon emission reductions while simultaneously boosting production quality
- Tolerates changes in process conditions and regulates temperature control
- Direct integration with renewable energy sources

APPLICATIONS

- Chemical manufacturers
- Hydrocarbon processors
- Large oil and chemical companies

INTELLECTUAL PROPERTY STATUS

Application Date: March 6, 2025 | **Type: PCT-Gov. Funding** | **Country of Filing:** WO

Interested in developing or commercializing?

Jacob Brejcha | *Licensing Associate – Physical Sciences*
jjbrejcha@prf.org

PURDUE INNOVATES

PROCESS HEAT CO-PRODUCTION WITH HEAT PUMP ASSISTED DISTILLATION

2024-AGRA-70601

PROBLEM

Adoption of heat pumps and heat recuperation is recognized as a pivotal technology for decarbonization. However, a major drawback of heat pump systems in the context of distillation is the energy rejection that occurs at the condenser's cooling water.

SOLUTION

Researchers at Purdue University have developed a heat pumped distillation system that enables the coproduction of steam to repurpose waste heat. By recovering the energy used to power the condenser as heat to the reboiler through steam production, the overall energy efficiency of the heat pump can be increased. This technology has applications in various industries that use distillation columns, including chemical processing, fermentation, and water purification.

ADVANTAGES

- Coproduction of steam
- Recovery of waste heat
- Increase of heat pump efficiency

APPLICATIONS

- Heat Transfer
- Distillation
- Chemical Processing
- Water Purification

INTELLECTUAL PROPERTY STATUS

Application Date: February 20, 2025 | **Type: PCT-Gov. Funding** | **Country of Filing:** WO

Interested in developing or commercializing?

Jacob Brejcha | *Licensing Associate – Physical Sciences*
jjbrejcha@prf.org

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