DEPARTMENT OF CIVIL AND ARCHITECTURAL ENGINEERING
COLLEGE OF ENGINEERING AND APPLIED SCIENCES

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE students

FOR APPLICATION YEAR: 2024

PROJECT TITLE: Cost-Effective Integration of PCM Thermal Energy Storage and Wet Compression for High-Efficiency Industrial Heat Pumps

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Project Description

Project Objectives: The proposed project has the following objectives:
Prototype Development: Design and construct an Industrial Heat Pump IHP prototype capable of operating at high temperatures (up to 200°C) with improved energy efficiency and performance.
Testing and Evaluation: Conduct thorough testing and evaluation of the IHP prototype to validate its performance, efficiency, and environmental benefits.
Technology Optimization: Optimize the design and operation of the IHP prototype to enhance energy efficiency, cost-effectiveness, and overall system performance.
Market Transformation: Assess the market feasibility of the high-temperature IHP prototype and develop a comprehensive commercialization plan to facilitate its entry into the market and promote widespread adoption.

Project Description:
The proposed project aims to develop an advanced high-temperature IHP prototype that surpasses existing technology by incorporating two groundbreaking concepts: the utilization of Phase Change Material (PCM) thermal energy storage as intermediate intercoolers and the implementation of wet compression technology. These concepts, along with optimization design, control strategies, and refrigerant selection, offer exceptional potential for energy efficiency, waste heat utilization, high temperature range expansion, zero global warming potential (GWP), and demand control capabilities.
The project will involve rigorous research, engineering design, and experimental validation to demonstrate the feasibility and effectiveness of

these concepts. Through systematic investigation and testing, the project aims to optimize the design and operation of the IHP prototype to achieve maximum energy efficiency and performance. The integration of PCM thermal energy storage allows for efficient heat storage and recovery, enabling the system to utilize waste heat and improve overall energy efficiency.
Additionally, wet compression technology utilizing water generated from vapor condensation in the thermal energy storage eliminates the need for additional water injection, resulting in higher compression ratios and improved system performance.
Overall, the proposed project offers a promising solution for high-temperature IHPs, addressing key challenges in energy efficiency, temperature range expansion, waste heat utilization, and demand response capabilities. It holds the potential to advance the state-of-the-art in industrial heating systems, leading to significant energy savings, reduced carbon emissions, and improved process efficiency.