Design and Manufacturing of High Performance, Reduced Charge Heat Exchangers (HPRC-HX)
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University of Maryland
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Design and Manufacturing of High Performance, Reduced Charge Heat Exchangers

Team

• **University of Maryland, College Park (UMCP, Performer & Lead)**
  – Reinhard Radermacher (PI); Vikrant Aute (Co-PI), Yunho Hwang (Co-PI), Jiazhen Ling, Jan Muehlbauer; Graduate Research Assistants: Ellery Klein, James Tancabel
  – **Expertise:** 30+ years of experience in R&D of heat pumps, refrigerant, HVAC&R components and systems, modeling and optimization software development; system and component test facilities; funded by industry and government

• **Oak Ridge National Laboratory (ORNL, Performer)**
  – Patrick J. Geoghegan, Co-PI, R&D Staff; Researchers: Ayoub Mehdizadeh Momen, Mingkan Zhang
  – **Expertise:** Computational heat transfer, additive manufacturing, testing

• **Heat Transfer Technologies (HTT, Performer)**
  – Yoram Shabtay, Co-PI; President; John Black, VP, Market Development
  – **Expertise:** 20+ years of experience in design and mfg. of heat exchangers for pre-production evaluation; development of innovative joining techniques for small diameter tubes and manifolds

• **Industry Partners**
  – 9 Industry partners, including tube manufacturers and HVAC OEMs.
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Need/Challenges

• Heat Exchangers (HX) are a key component in HVAC&R systems
  – Hold refrigerant charge; Impact on system efficiency

• Improved heat exchangers lead to:
  – 30% less refrigerant amount
  – 25% less weight; 25% more compact
  – Lower energy consumption, lower emissions
  – Lower costs

• Challenges in bringing new HX Technology to market
  – Novel designs, need to be at least 20% better
  – Novel tools that leverage developments in computing, fluid and structures analyses
  – Lack of basic heat transfer and flow fundamentals and correlations
  – Availability of components
  – Joining/manufacturing techniques
  – Flow maldistribution
  – Fouling and wetting
  – Noise and vibration
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The Solution

- **Novel Optimization Framework**
  - Small hydraulic diameter HX
  - Shape optimized tubes
  - Potential finless designs
  - Minimize charge and weight, while maintaining thermal and structural performance

- **Focus on manufacturing**
  - Investigate manufacturing of non-round tubes and related joining methods

- **Focus on field performance**
  - Wetting, fouling

- **Active industry involvement**
  - New prototypes to be tested by industry partners; at their labs, with their systems
  - Immediate feedback on commercial viability and design modifications
Impact & Target Market

• Impact
  – New HX designs are expected to have 30% reduced charge and at least 25% reduced weight for the same performance
  – 30% reduction in refrigerant charge has the potential to reduce 35MT of CO2 emission*
  – HX design framework applicable to other HXs in HVAC&R industry
    • HX design independent of refrigerant choice and can be optimized for new refrigerants/blends
  – Size/weight reduction can lead to savings in material and logistics costs
  – Non-round tube manufacturing and joining methods will help reduce barrier to entry for potential OEMs and accelerate commercial use
  – Industry involvement in developing and testing of new designs with immediate and iterative feedback on commercial viability and tech to market

• Target Market
  – Residential and commercial air conditioners and heat pumps
  – New construction and retrofit applications
Thank You

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