U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

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: Ayyoub 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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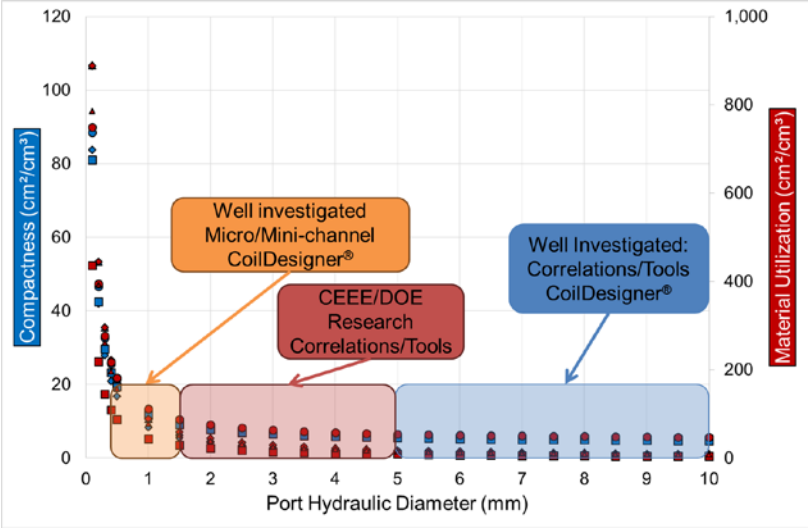
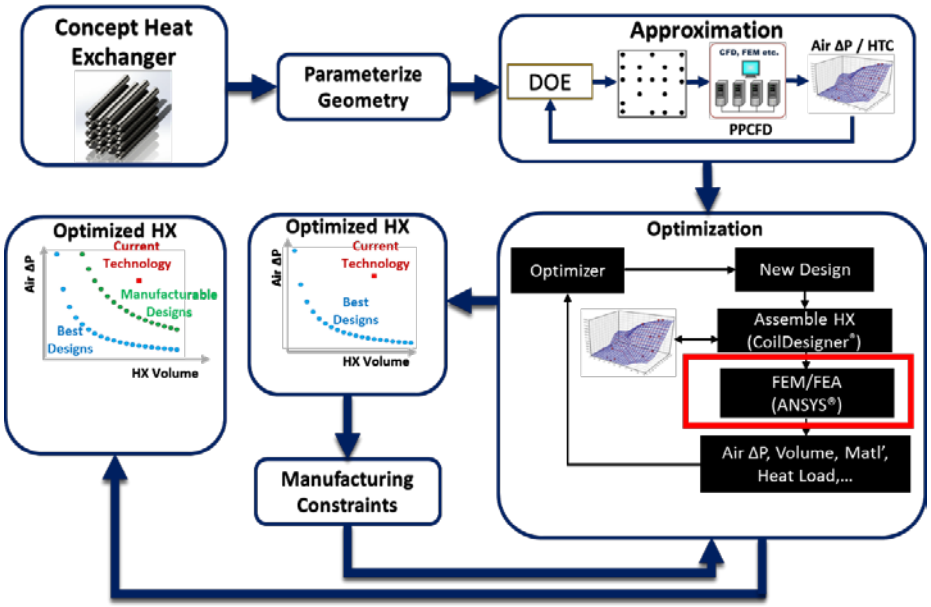
The Solution

- **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





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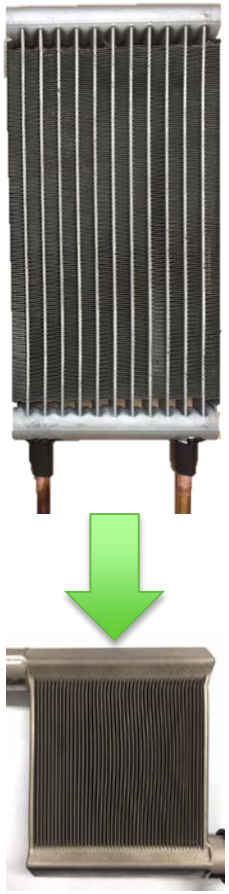
Impact & Target Market

- **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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