Development of Marine Thermoelectric Heat Recovery Systems

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Topics of Discussion

- Why the integration of thermoelectrics into the marine industry would be beneficial for both parties
- Milestones accomplished by our research program
- Our first prototype TEG design and its potential integration into the industry
Same Problem, Greater Magnitude

- Have similar propulsion means, but marine has a much larger scale
- Larger Economies of Scale
- Heightened Port Restrictions and Engine Emissions Standards Imminent
- 90% of International Cargo Transported via ships

Top Picture Courtesy of MMA Public Relations
Bottom Picture Courtesy of “http://www.dssglobalsecurity.com/Featured_Solutions_PRW4.html”
Advantages of the Marine Industry

- Has the greatest consistent temperature differential
  - Exhaust and Sea Water
- The equipment is much larger and has greater throughputs
- Virtually no limitations on weight and space
- Has a myriad of potential waste heat recovery locations
- The ability to retrofit *every* vessel easily
  - Regardless of use of conventional waste heat recovery
Origins - 2008

- Phase I – Mechanical Feasibility

R/V Friendship

SR30 Microturbine
Origins - Data

R/V Friendship

SR30 Microturbine
Thermoelectric Hybrid Vessel - 2010
Inside the Vessel

- CAT Genset
- HiZ 180W TEG
- Microinverters
- Step-down Transformer
Baseline THV test

Curve Fit for HiZ TEG Test on THV

Power [W]

$\Delta T$ [°C]
Creating a Marine Design

Source: Alfa Laval. “M3 Plate heat exchanger”.
Design Considerations

- Comparable to existing plate type heat exchanger design
- Will aid in engineer familiarity, so for a new technology, it will reduce maintenance down time
  - Plate replacements
  - Cleaning
Thermoelectric Power Systems TEG

- Machined at the Advanced Manufacturing Center at the University of Maine

- 20 HZ14 Bismuth Telluride modules from Hi-Z Technology, Inc.
Future Work

- Test and Evaluate the prototype TEG
  - THV to be put in water this week
- Use test data to validate existing models
  - Modify models to incorporate different plate surfaces
- Scale to larger vessel applications
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