Objective

Develop a comprehensive model framework for characterizing the performance of a novel spool expander and refining expander design for use in heat recovery applications.

Approach

- Develop a deterministic simulation model based on the expander geometry, including sub-models for friction, leakage and heat transfer in the expander.
- Construct an experimental prototype and validate model results.
- Conduct parametric studies using the validated model and refine expander design.

Benefits of Technology

- Improved efficiency over other rotary designs due to better tradeoff between leakage and friction.
- Ability to control the expansion ratio using a novel mechanically-driven suction valve mechanism.
- Can be manufactured over a broad capacity range.
- Easily manufactured components contributes to lower costs.
- Design allows for creative seal solutions, since seal is located external to the expansion process.
Results

- P-V plots obtained from the model provide valuable insights into various performance characteristics.
- Spikes at low volumes are due to initial vacuum in suction chamber and recompression during discharge process.
- Under-expansion results in the sudden expansion of the charge during the expansion process and a loss of recoverable work.
- Over-expansion results in a pressure lower than the line discharge pressure. The gas and has to be recompressed to achieve a high enough pressure to exit, resulting in a pumping loss.
- Over-expansion results in a steep drop in efficiency. When considering a range of operating conditions from a system-component matching perspective, under-expansion is preferable to over-expansion.

Future Work

- Validate and refine model based on experimental results from a prototype.
- Utilize model to optimize expander design.