MGT recuperator requirements

ETN meeting on MGT Technology challenges

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- MGT recuperator requirements
- Manufacturing technology and cost
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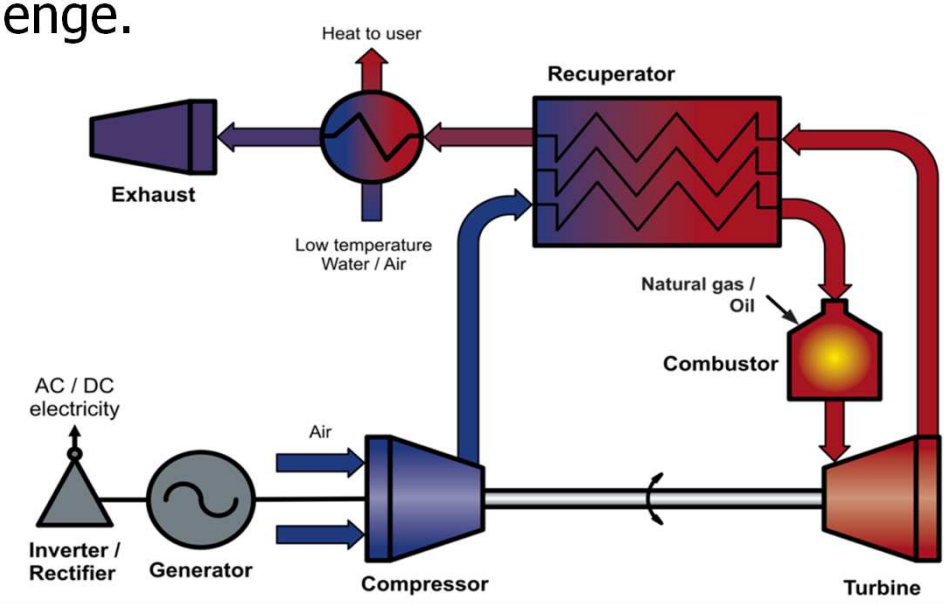
Introduction

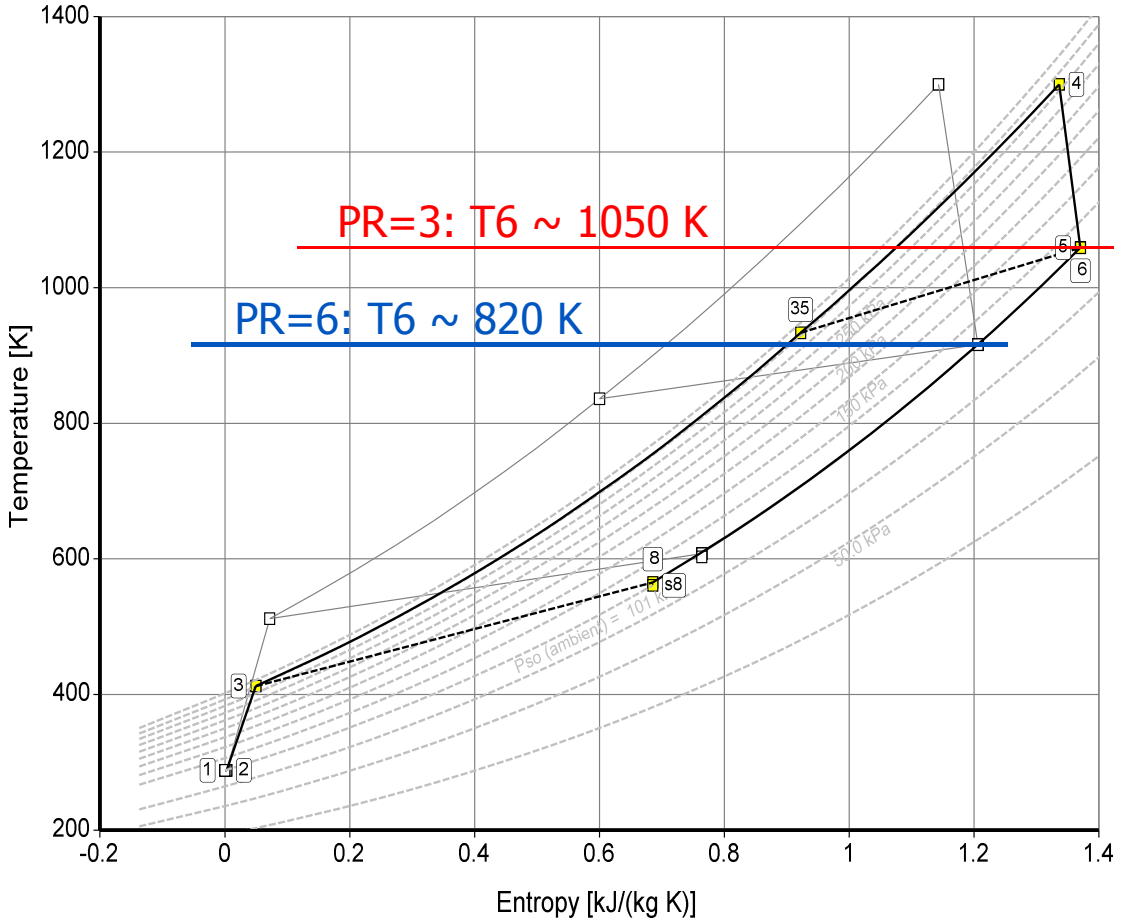
- A gas turbine recuperator is a gas to gas heat exchanger for recovering gas turbine exhaust heat for pre-heating combustor entry air in order to save fuel.
- In terms of (usually counter flow) heat exchanger design, the combination of requirements imposed by the gas turbine cycle makes successful development of a recuperator an extraordinary tough challenge.



Recuperated cycles for MGTs

- Radial turbomachinery
- Assume no turbine cooling
- TIT <1300 K (1027 C)

- T6 hot recuperator inlet temperature
  - Low PR (~3)
    - High T6 (<775 C)
  - High PR (5-6)
    - Lower T6 (<670C)



MGT recuperator requirements (1)

- High effectiveness (typically >80%)
- Low pressure losses
  - typically not more than a few % (<2-3%) for both hot and cold flow paths
  - pressure loss and effectiveness can be often exchanged: high effectiveness can often only be obtained with relatively high pressure loss for the same volume.
- Resistance to high temperatures
  - Steady state: creep life and corrosion resistance.
  - Hot inlet max temperatures
    - With high cycle pressure ratios (>5) usually 650-700 C (stainless steels)
    - Low cycle pressure ratios (<4) >750 C (advanced/nickel based high temperature alloys)
- Resistance to thermal shock and large temperature gradients in the structure (low cycle fatigue life)

MGT recuperator requirements (2)

- Significant pressure difference between hot and cold flow.
  - E.g. with a cycle pressure ratio of 6 it would be 5 bar, meaning significant structural loads in the heat exchanger matrix
- Compact / low weight design
- Minimal heat loss (insulation)
- Affordable costs
  - Minimal use of expensive materials
  - Low manufacturing costs

Manufacturing technology and cost

- MGT recuperator manufacturing costs currently very high
- Several projects are running focused on automated/high volume production
- No design has yet seen real high-volume/low cost production, such as seen in automotive with turbochargers for example.
- Many projects have failed.
  - Of course, this is due to the absence of high volume production of (micro) gas turbines.
- Development of low cost/high volume manufacturing concept
  - Key objective
  - Expensive.
  - Chicken and egg problem.
- Big steps should be made towards this objective in order to make micro gas turbines efficient (using recuperation) and competitive with alternative prime movers.

EU collaboration

- Collaboration within Europe and EU programs
- Difficult to identify common and generic areas of collaboration outside the technical intellectual property areas.
- Best bet on *vertical* collaboration programs
  - See the last few slides in the presentation I gave May 12 2015
  - Vertical may well involve a micro turbine OEM
- Perhaps it is possible to collaborate *horizontally* on automation of the elements outside the recuperator matrix, i.e. the manifolds, ducting etc. that requires complex welding and sealing technology that often also represents the major (manual) manufacturing cost.

Conclusion

- Survey among European recuperator/MGT OEMs on their views on areas for collaboration.
- Suggestion areas
  - Horizontal
    - *(I am sure one of the recuperator OEMS can make better suggestions)*
    - Advanced modelling (CFD) for optimizing heat transfer, flow distribution, minimizing pressure loss, size etc.
    - Specific manufacturing technologies common to different concepts (if at all applicable)
  - Vertical
    - With recuperator supply chain partners: manufacturing cost reduction
    - Integration into micro turbines, with micro turbine OEM's on specific designs
- Select best options
- Work towards proposals for vertical and horizontal collaboration programs