the Energy to Lead

Performance & Cost Targets for sCO2 Heat Exchangers (Recuperators)

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Michael McDowell

Program Manager for sCO2 Technology

The Rocketdyne energy team is now part of the Gas Technology Institute (GTI)

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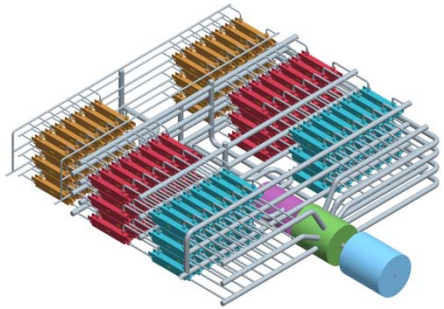
Development of Systems Level Understanding of the Recuperator

- 2007 MIT sCO2 meeting
  - Identified small channel heat exchanger risk for plugging in Sodium systems
  - Now a test project at ANL
- 2011 Boulder sCO2 Power Cycle Symposium
  - Described the large cost impact of the recuperators & concern with the large number of small recuperators required in a commercial power plant as part of 1000 MWe plant concept design & cost study



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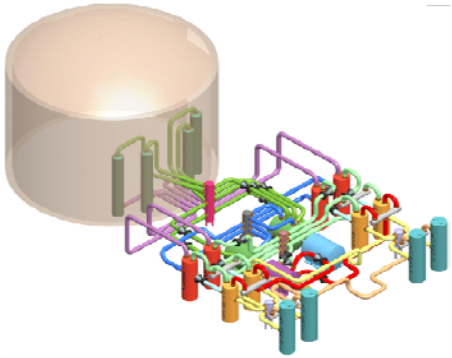

- 2014 Performed evaluation of recuperator design, cost & development issues
  - Two vendors provided input
  - One with large units, one with small units

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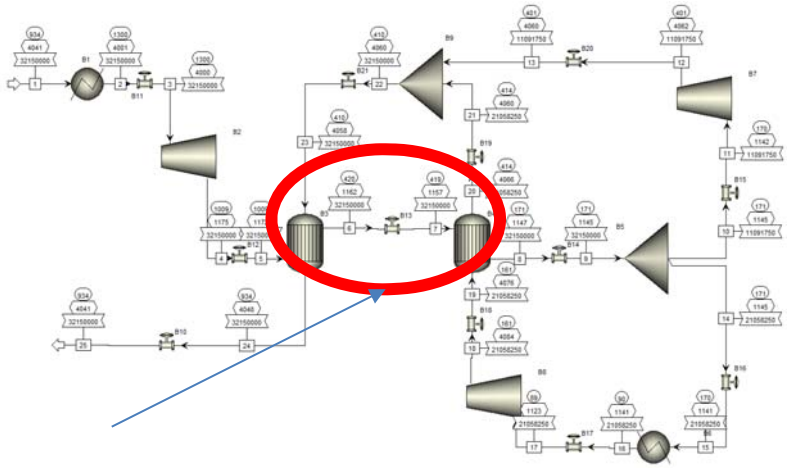
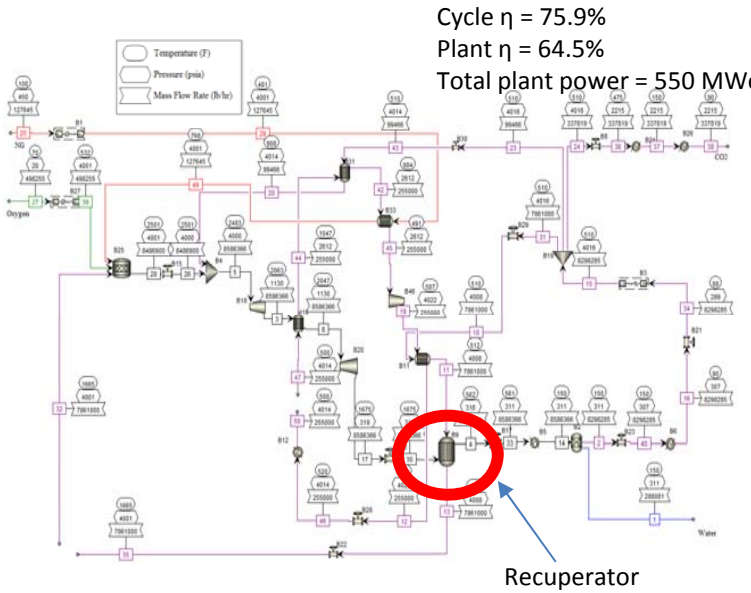
sCO2 Power Plant Modeling Defines Recuperator Needs



Recuperators



Indirect Cycle

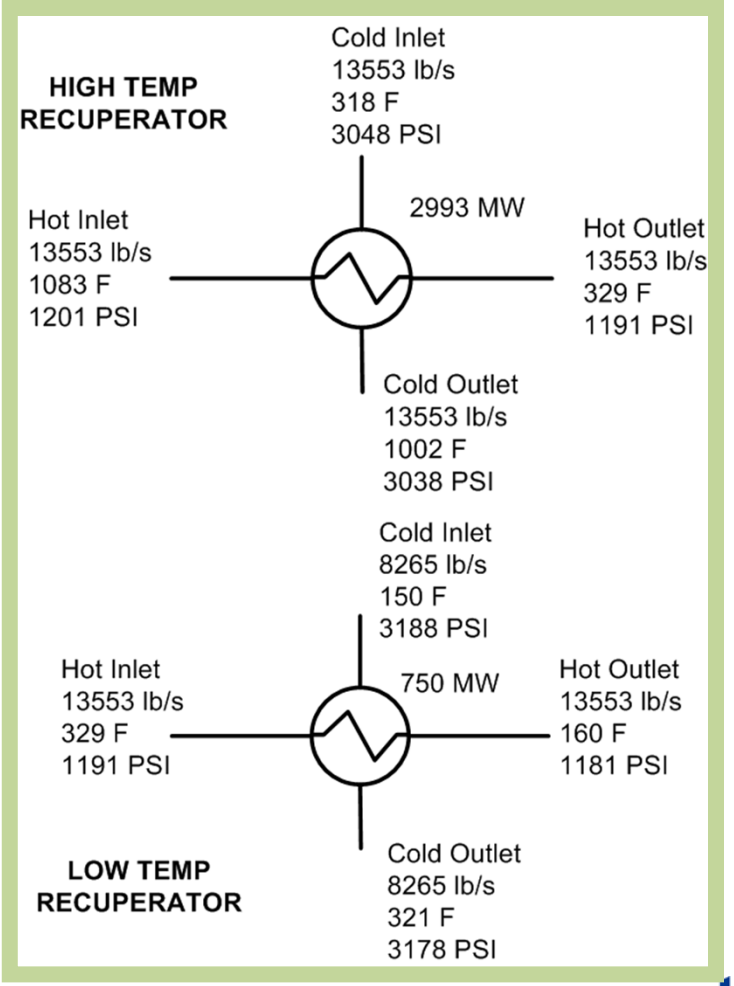
- Heat exchanger provides sCO2 to turbine
- Near term deployment
- Recently increased pressure to 4000psi to reduce equipment size & increase efficiency

Direct Cycle

- High pressure combustion gasses go directly into turbine
- Higher temperature, higher efficiency, slower deployment

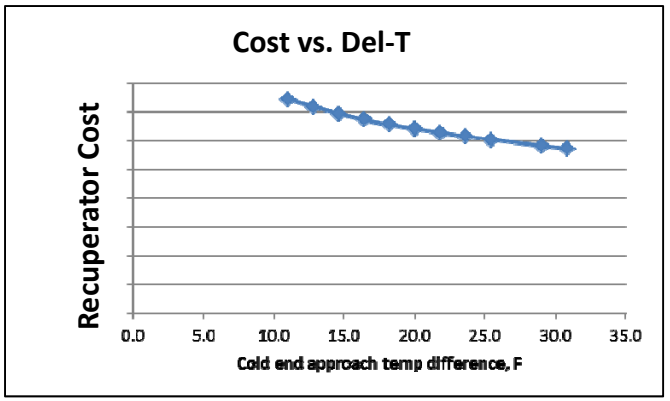
Recuperator Study Accomplishments

- Showed that the recuperator indirect cycle performance requirements can be met
  - Commercial scale sCO_2 power plant (550 MWe)
  - Defined a maturation roadmap
- Contracted with two heat exchanger vendors
  - One conventional (advanced shell and tube)
  - One advanced compact heat exchanger
- Prepared development plan & commercial system cost estimate

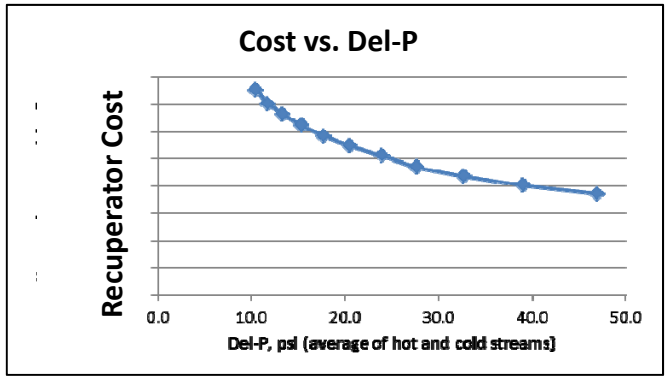


Recuperator Study Result: Dependence of Cost on System Criteria

- Lower recuperator cost with higher approach temperature
  - Less energy recuperated
  - Lower plant efficiency
  - Possible higher LCOE



- Lower recuperator cost by allowing higher pressure loss
  - Lower plant efficiency
  - Possible higher LCOE



Additionally: Almost a 4:1 difference in cost between two vendor concepts for the same criteria

Conclusion

- Recuperators are a large part of plant capital cost
  - Costs vary widely between vendors
- Adjusting criteria to reduce recuperator cost could increase plant LCOE
- Need Integrated system performance & cost model
  - Optimize component/recuperator criteria
  - Involve vendors for recuperator cost data
  - Consider physical integration issues
  - Optimize plant LCOE
- Model results needed to set cost & performance targets

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michael.mcdowell@gastechnology.org

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