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Advanced Heat Exchanger Development for sCO2 Brayton Cycles

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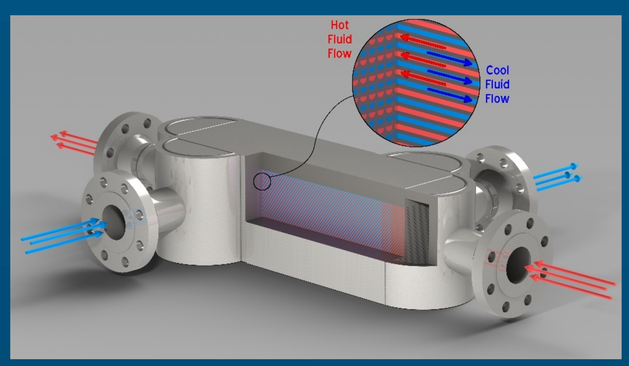
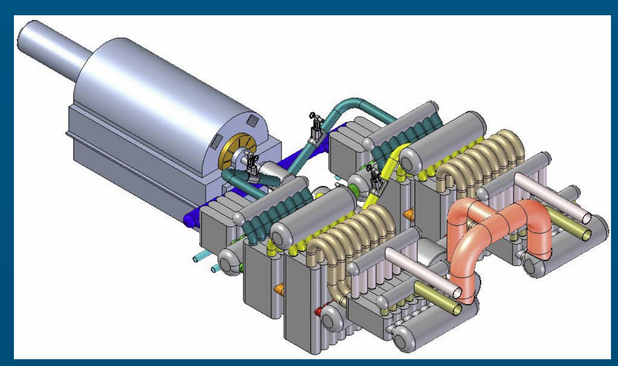
Problem Statement

- Reliable, cost effective, and high performance heat exchangers are required to achieve the promise of advanced power plants
- Research needs exist to understand aspects of heat exchangers from the level of fundamental science to prototype validation
- Numerous research programs at various institutions require coordination to ensure results can be leveraged by vendors

Printed Circuit Heat Exchanger

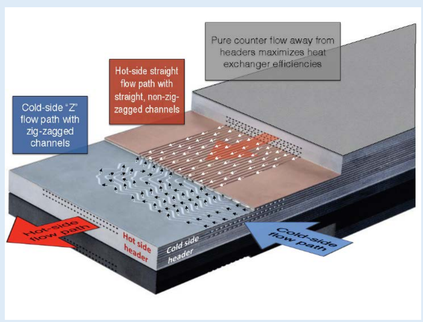


300 MW^{e} sCO2 Brayton Cycle



Fundamental Science

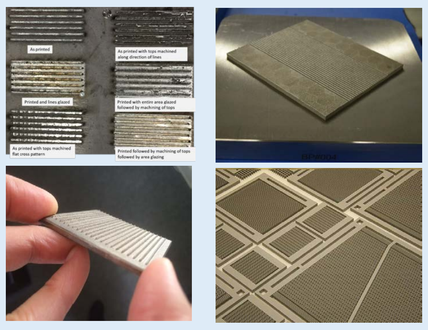
1. Design Optimization (STEP R&D, HPC4Manufacturing)



- Novel channel patterns
- Distributor-channel transition
- Nozzle/header flow considerations
- Integrated into SEARCH

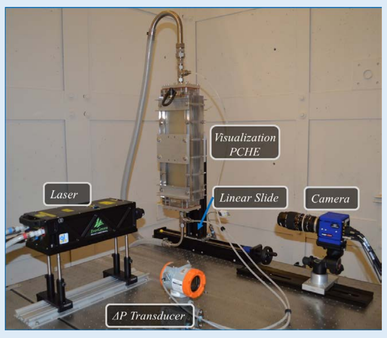
(Selection, Evaluation, and Ration of Compact Heat exchangers)

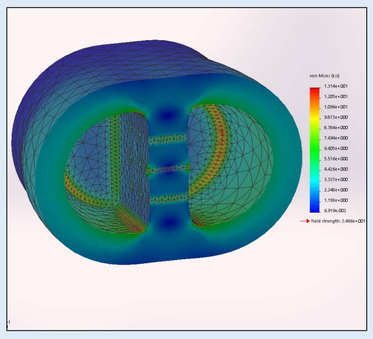
2. Shim Fabrication (STEP R&D, EERE-0999-1766)



- Hybrid additive manufacturing
  - Printed material on un-featured rolled sheet
- Improves lead-time, cost, and flexibility
- Exploring multiple additive techniques
  - LENS, DMLS, cold-spray, screen print

3. Alternative Headers (STEP R&D, TCF-17-13556)



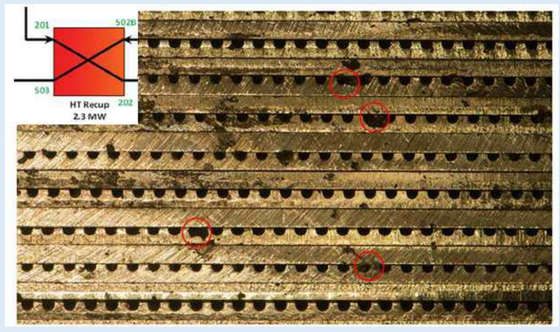


- Particle image velocimetry of flow
- Static pressure and fatigue lifetime
- Unconventional header geometries

4. Thermo-mechanical Lifetime (STEP R&D, DOE-NE ART)

- Hydrostatic testing to 60000 psi
- Remotely operated in secondary containment for safety
- Planned expansion for pressure fatigue and thermal fatigue testing

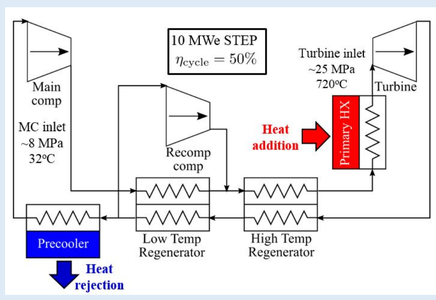
5. Fouling Prevention and Cleaning (UW-Madison, IRP-17-14227)

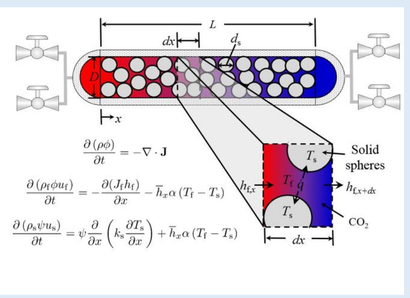


- Critical for nuclear applications
- sCO2 and reactor coolant fluids
- Validation of monitoring for fouling and cleaning techniques
  - High pressure water jetting, back puffing, and exploration of online techniques

Prototype Validation

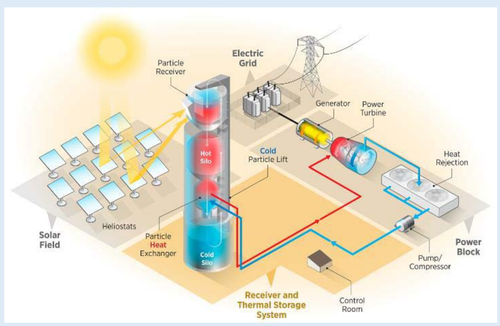
1. Switch-bed Regenerators (UW-Madison, DE-EE0001720)

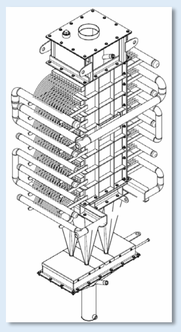




- Low-cost recupartor replacement
- High T, P, and cycle valves

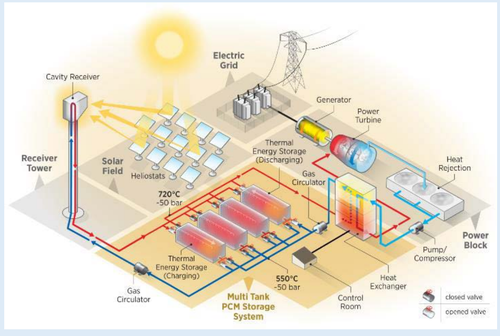
2. CSP Particle/sCO2 Heat Exchanger (SuNLaMP 1507)





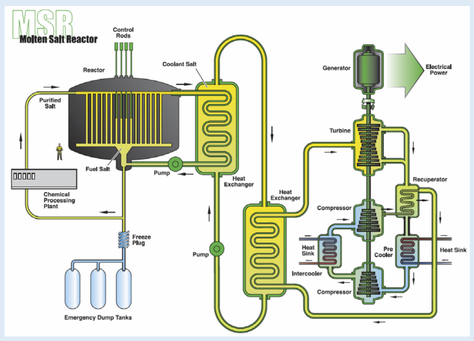
- First of a kind Hxer
- 700 °C and 20 Mpa
- In cooperation with Solex and Vacuum Process Engineering

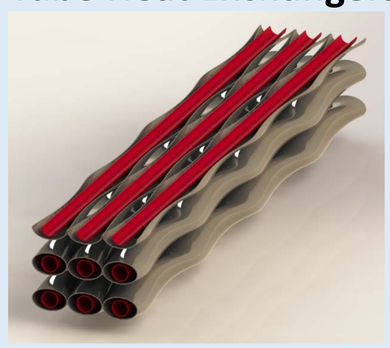
3. CSP Direct sCO2 Gas Receiver (OSU, DE-EE0007108)



- High heat flux to reduce heat loss
- Novel header/manifold to minimize pressure drop
- Optimized for low cost fabrication, numbering up

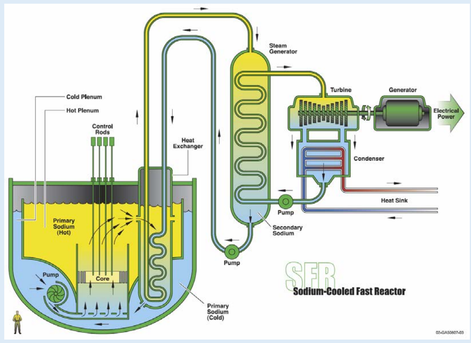
4. Double-Walled Twisted Tube Heat Exchangers (UNM, CFA-15-8667)





- Enhances salt heat transfer
- Contains high sCO2 pressure
- Enables tritium management

5. Nuclear Qualification of PCHEs (CFA-16-10578, IRP-17-14227)



- ASME BPV Code Section III Approval of Diffusion Bonding
- Volumetric Inspection Techniques
- Expanded qualification of materials (800H, 316H, etc.)

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