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RESEARCH-TO-POWER: THE SCO_2 FUTURE ARGONNE'S VISION

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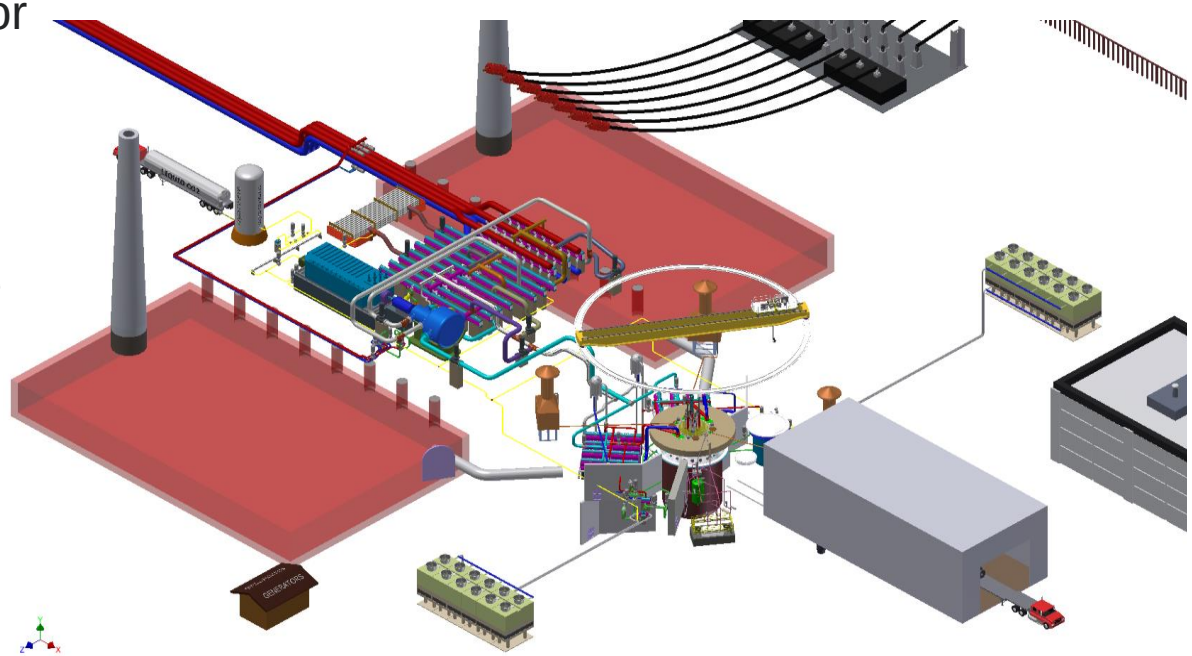
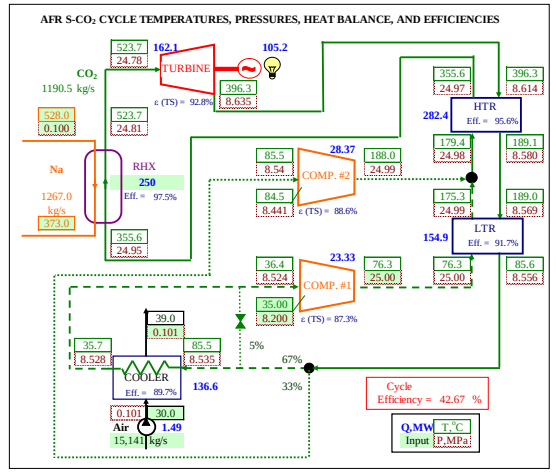
SCO_2 FUTURE: ARGONNE'S VISION

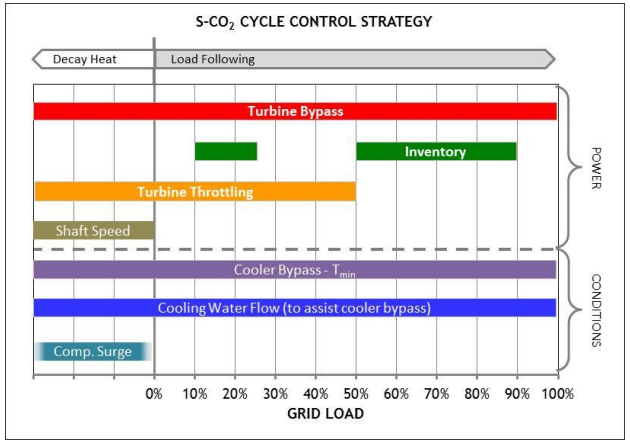
- sCO_2 cycle **<u>is</u> the best** power converter for ***advanced nuclear reactors***
  - Sodium Fast Reactors, Lead Fast Reactors, Molten Salt Reactors
  - **Benefits**: Eliminating water and sodium-water reaction, efficiency increase as temperature rises, reduction of plant capital cost
- sCO_2 cycle modeling – Needed for licensing
  - Interaction between sCO_2 cycle and nuclear reactor
    - Steady-state: optimization
    - Transient: load following and accidents
  - Dry air cooling
  - ANL Plant Dynamics Code
    - Coupled to SAS4A/SASSYS-1 reactor analysis code
- Sodium/lead/salt-to-CO_2 HX phenomena
  - Design and operation of coolant-to-CO_2 HXs
    - Channels size limitations
    - Efficient draining without holdup
  - Accidents
    - Sodium-CO_2 interaction
    - Freezing/thawing
    - Thermal stress/shock

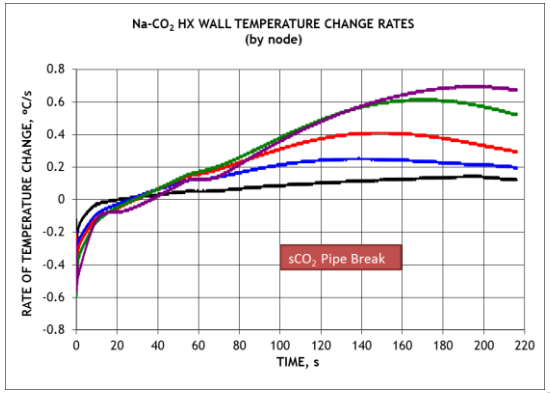


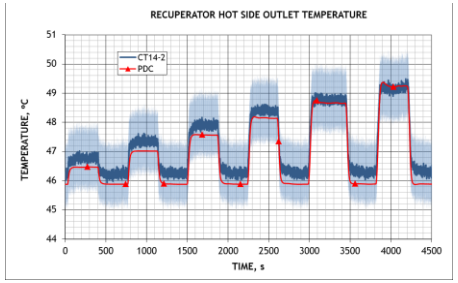
sCO_2 CYCLE DYNAMIC MODELING

- sCO_2 cycle development and analysis for advanced reactors
  - LFR, SFR, VHTR
- Cycle and component design and optimization
  - Cost-based optimization of HXs
- Investigation of cycle layouts and operating conditions
  - Cascading cycles, partial cooling, reheating/intercooling
  - Minimum/maximum cycle pressures and temperatures
- Cycle control strategy development
- Analysis of operational transients and accident conditions
  - CO_2 pipe break, Loss-of-load, Inadvertent valve closure
- Analysis and cycle optimization for dry air cooling
  - Optimization of cycle conditions
  - Optimal cycle operation under changing ambient conditions
- Ongoing: HX thermal transients
- Model Predictive Control
- Code validation
  - Small-scale integral tests thus far









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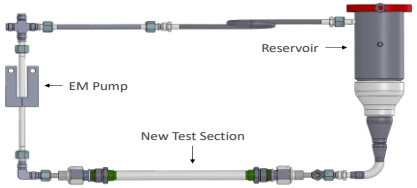
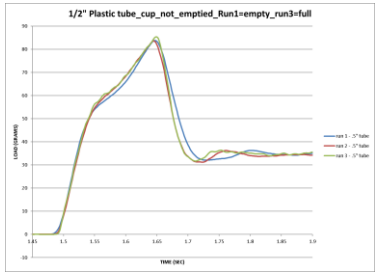
SOURCE FLUID-TO-CO_2 HX PHENOMENA

- Argonne is carrying out experiments on phenomena for which an understanding is crucial to the reliable design of compact diffusion-bonded HXs
  - Sodium-to-CO_2, can be extended to salt-to-CO_2, other fluids
- Need to drain reactor fluid from HX channels in 20 minutes following detection of pipe rupture accident and spillage
- Need to prevent reactor fluid from being retained inside the HX and bridging channels where it could oxidize forming oxide plugs that block channels and can't be readily removed preventing refilling of the HX
- Stresses from freezing of reactor fluid retained inside of HX or remelting of frozen fluid need to be understood to prevent accidental damage to HX
- Need to prevent rapid blockage of sodium channels at cold end of HX due to precipitation of sodium oxide (Na_2O) following air ingression from rupture of sodium circuit boundary
- Need to detect sodium-CO_2 interactions and understand sodium-CO_2 interaction phenomena following HX failure and CO_2 entry into sodium





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