NETL-EPRI Workshop on Heat Exchangers for Supercritical CO2 Power Cycles:

Panel Discussion on Laboratory Materials Research

Vito Cedro III

Project Manager, Crosscutting Research Division

October 12, 2015

Laboratory Materials Research Assumptions

- By end FY2020 sufficient materials data must be available to support the design of a demonstration scale sCO2 power plant – either direct or indirectly heated.
- sCO2 power plants will be designed for cycling operations
- FE based sCO2 power plants will operate at temperatures up to 760 C
- Design life for sCO2 heat exchangers and other major components will be for 20 years or higher
- The working fluid (sCO2) composition of indirectly heated cycles could be controlled to a limited extent if composition control would be beneficial to reduce oxidation/corrosion of materials.
- Existing mechanical properties data on structural alloys will be applicable to most components such as piping, valves, and standard thickness tubing. Ultra-thin heat exchanger surfaces and joints might exhibit unique mechanical properties which result in mechanical design challenges not found in conventional power cycles.

Laboratory Materials Research Questions for the Panel

- What is an acceptable thickness loss rate to oxidation/corrosion for the heat thin wall heat transfer surfaces being considered form high temperature sCO2 heat exchangers and recuperators?
- What are the key knowledge gaps on oxidation/corrosion behavior at T>500 deg C. What tests are needed to close these knowledge gaps?
- What affect will brazing alloys have on high temperature oxidation/corrosion and mechanical behavior of brazed joints in sCO2 heat exchangers?
- What are the key knowledge gaps on mechanical properties/behavior of ultra-thin materials? What tests are needed to close these knowledge gaps? Are there other unique aspects of high temperature sCO2 heat exchanger designs that will require investigation with respect to long term mechanical behavior?
- Is there an effect of sCO2 fluid environment on mechanical properties, aside from the obvious loss of metal thickness due to oxidation or corrosion? Is lab scale testing needed to answer the question and/or quantify this effect if it exists?

Laboratory Materials Research Questions for the Panel

- How can the existing knowledge (lab and plant data, mechanistic understanding) base on the oxidation of metals by ambient and high pressure steam be utilized to reduce the time needed to develop the knowledge base of oxidation of metals in sCO2 environments?
- What should be the strategic goals of round robin campaigns for lab scale sCO2 oxidation testing? What gaps exist that round robin testing would close? What variability in results would be considered acceptable for industrial use? How can previous round robin campaigns on lab scale steam oxidation testing be used to guide the objectives and details of robin testing in sCO2 environments?
- Does the potential exist to significantly reduce the cost of high temperature lab scale oxidation/corrosion testing for sCO2 applications by determining the effect of CO2 pressure on oxidation rates, and then conducting future oxidation/corrosion tests at much lower absolute pressure? What is the current state of knowledge on the effect of pressure on oxidation rates in sCO2?

END OF OVERVIEW on Laboratory Materials Research Panel