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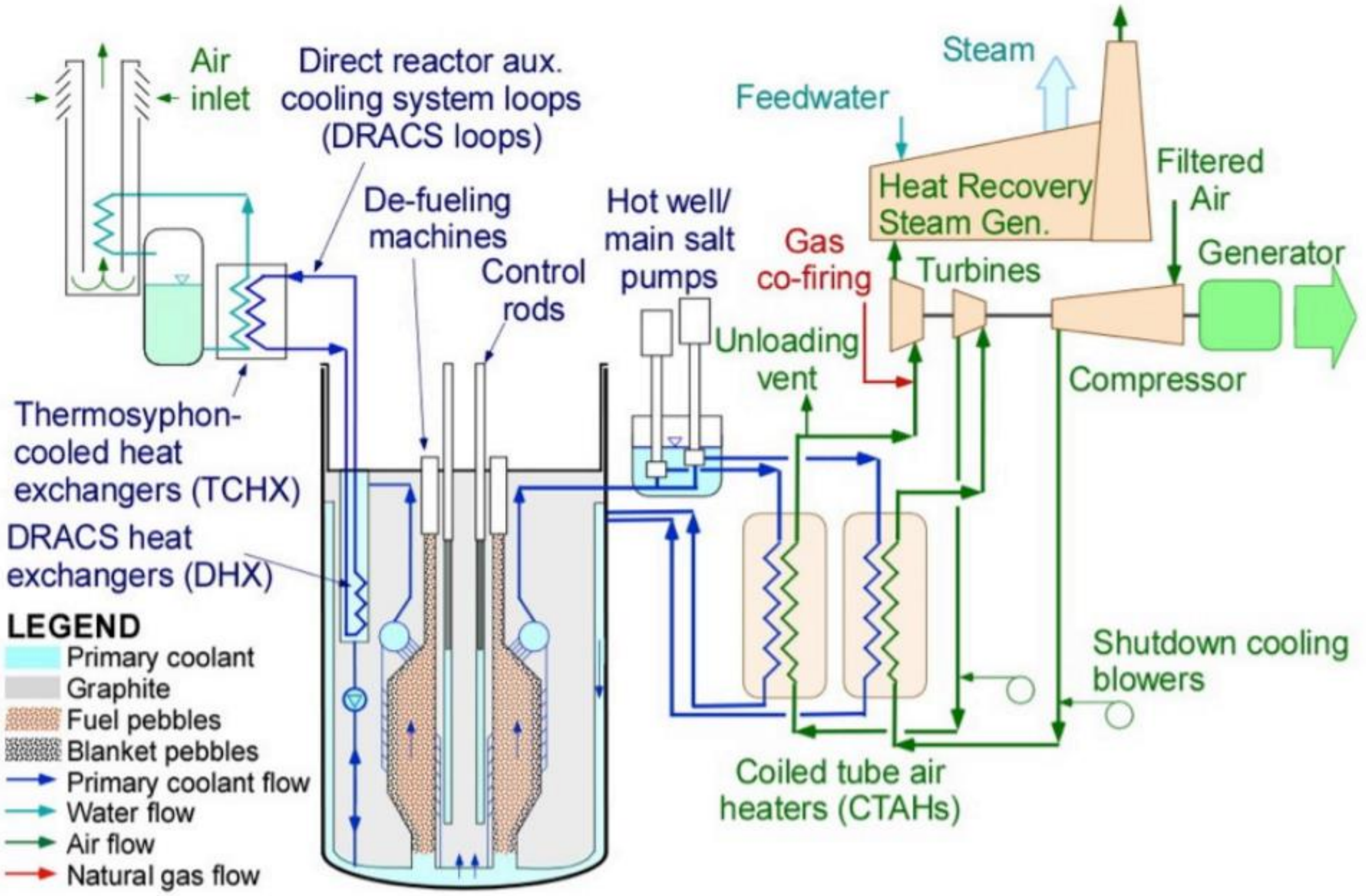
Research Project:
Study of Infrared Light Absorption by FLiNaK and FLiBe for Nuclear Reactor Applications

Radiative Heat Transfer in MSRs and FHRs

- Molten salt reactors (MSRs) and fluoride salt-cooled high temperature reactors (FHRs) are promising next generation nuclear reactor designs
- Expected temperature operating range is 450-700 ˚C
- Stefan-Boltzmann Law: $E = \sigma T^4$
- Higher temperatures mean that radiative heat transfer (RHT) must be accounted for
- Physical properties necessary to model RHT have not been well characterized at the operating temperatures and conditions
- Project objective is to fill this property value gap
  - Structural metal emissivity
  - Salt absorption coefficient

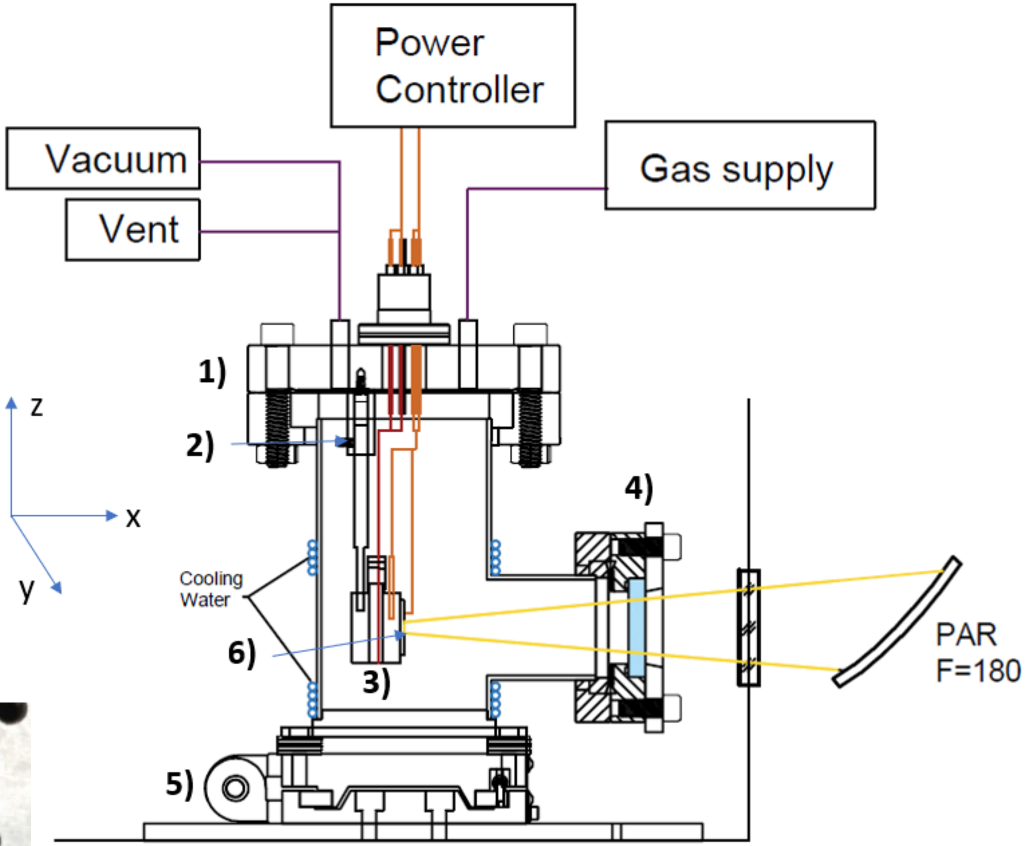


Schematic of FHR process flow diagram

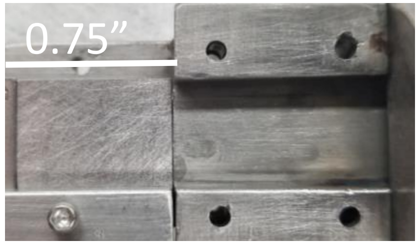
[1] C. Andreades, A. T. Cisneros, J. K. Choi, A. Y. K. Chong, M. Fratoni, S. Hong, L. R. Huddar, K. D. Huff, D. L. Krumwiede, M. R. Laufer, M. Munk, R. O. Scarlat, N. Zweibaum, E. Greenspan, and P. F. Peterson, "Technical Description of the 'Mark 1' Pebble-Bed Fluoride-Salt-Cooled High-Temperature Reactor (PB-FHR) Power Plant," University of California - Berkeley, UCBTH-14-002, 2014.

Structural Material Emissivity

- How does emissivity of structural materials change after exposure to FLiBe?
- 2 SS316 samples have been exposed to flowing FLiBe 1000 hours at 2 gpm
- After removal from loop, samples were not cleaned in order to avoid subsequent oxidation from aqueous cleaning methods
- Shown on right is setup designed to measure emissivity of samples at 700 ˚C in high vacuum. Carbon nano-tube (CNT) deposited on Si wafer to be used as blackbody

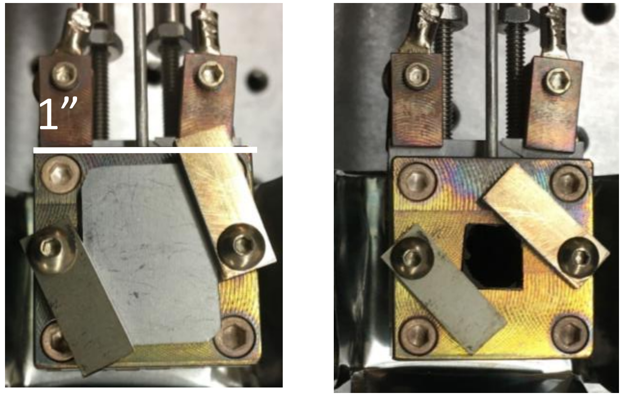


Schematic for emissivity measurement setup. **1**, top flange; **2**, heater support assembly; **3**, heater assembly; **4**, CaF_2 window flange assembly; **5**, optical mount assembly; **6**, focal point of collection optics.



Hot leg: 700 ˚C

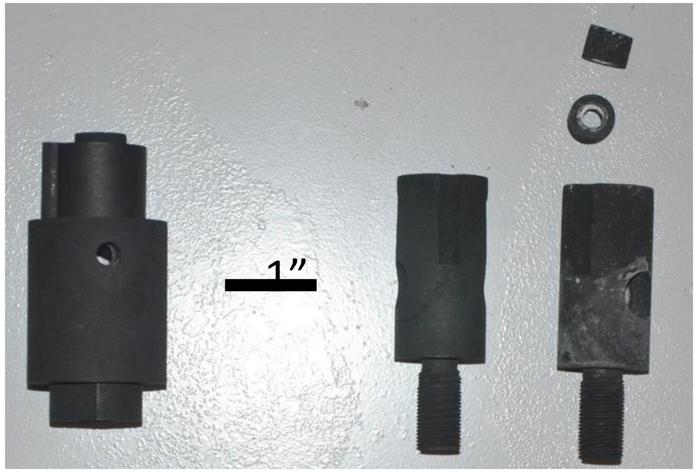
Cold leg: 650 ˚C

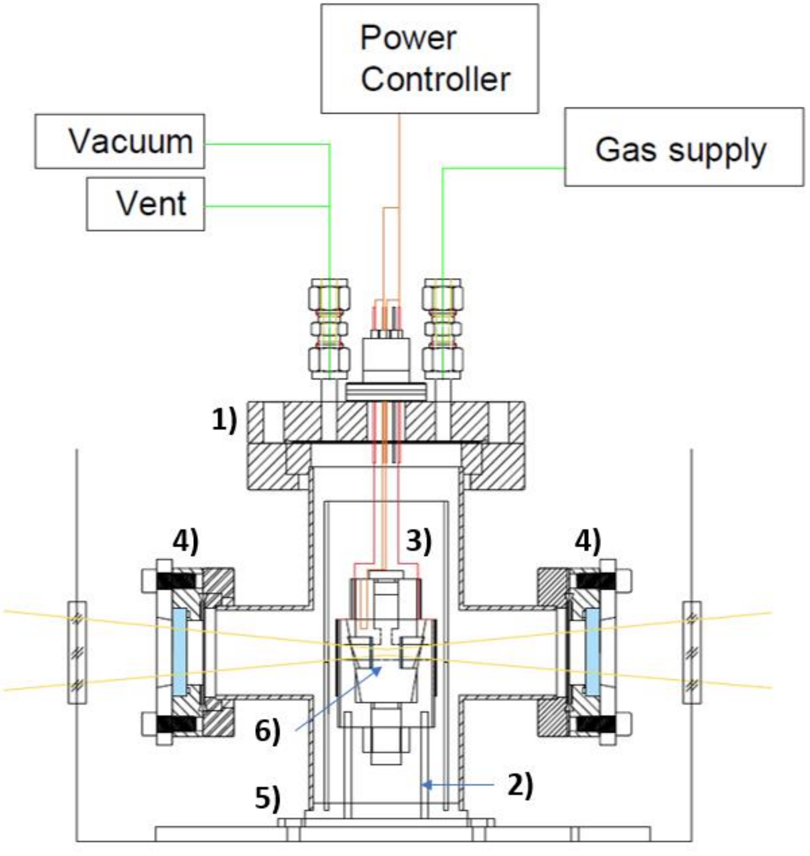


(left) Reference sample and (right) CNT mounted on heater

Salt Absorption Coefficient

- The linear absorption coefficient, κ_λ, determines the amount of attenuation per path length of light traveling through a medium
- In semi-transparent media at high temperature, κ_λ also governs the amount of light re-emitted by the medium. Depending on the geometry, re-emitted light can play a role in enhancing heat transfer
- A setup has been designed to perform transmission measurements to measure κ_λ in FLiNaK and FLiBe salt, using a previously constructed graphite cell with diamond windows (shown below)
- In addition to purified salt, additions of impurities such as Cr, Fe, and Ni will be made to investigate their effect on κ_λ





Schematic for absorption coefficient measurement setup. **1**, Top flange; **2**, Cell support rods; **3**, Graphite cell; **4**, CaF_2 window flange assembly; **5**, optical mount assembly; **6**, focal point of transmission optics