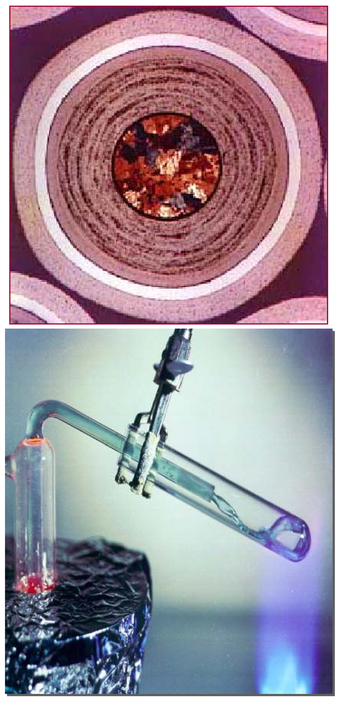
MIT High-Temperature (700°C) Salt-Coolant Power Projects

Salt-Cooled High-Temperature Reactor Project

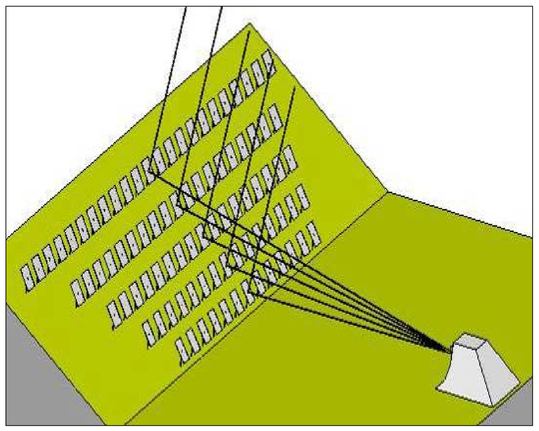


High-Temperature Fuel (Fail >1650°C)

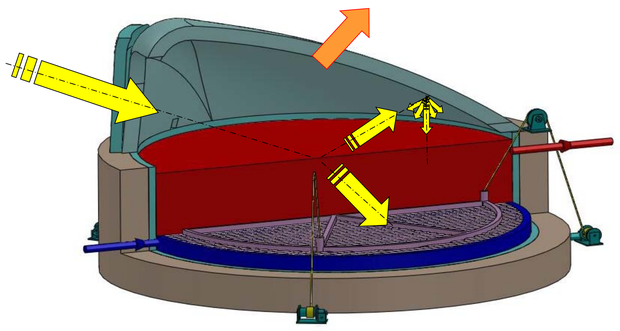
High-Temperature, Low-Pressure Transparent Liquid-Salt Coolant

- Goal: Develop new nuclear reactor concept to decision point to build test reactor.
- Potential reactor advantages:
  - No potential for core melt accident
  - Economic
  - High-Temperature (Efficient)
- MIT lead with U. of California (Berkeley) and U. of Wisconsin partners
- 7.5×10^6 3-year project

Concentrated Solar Power On Demand (CSPonD)

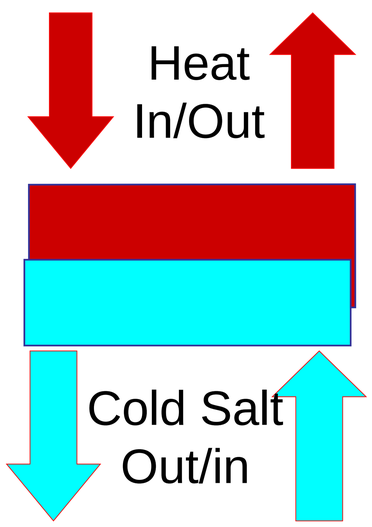


Mirrors Focus Light on Collector



Light Absorbed in Liquid Salt Bath

- Goal: High efficiency (>40%) solar collector with dry power-cycle cooling and heat storage
- Sunlight tightly focused with very high flux through open window in insulated building
- Sunlight absorbed going through transparent liquid salt



High-Temperature Heat Storage

- Goal: Efficient high-temperature heat storage to match energy production and demand. Three single-tank options:
  - Hot fluid on top of cold fluid
  - Floating insulated separator plate between hot and cold fluid
  - Internal low-cost fill

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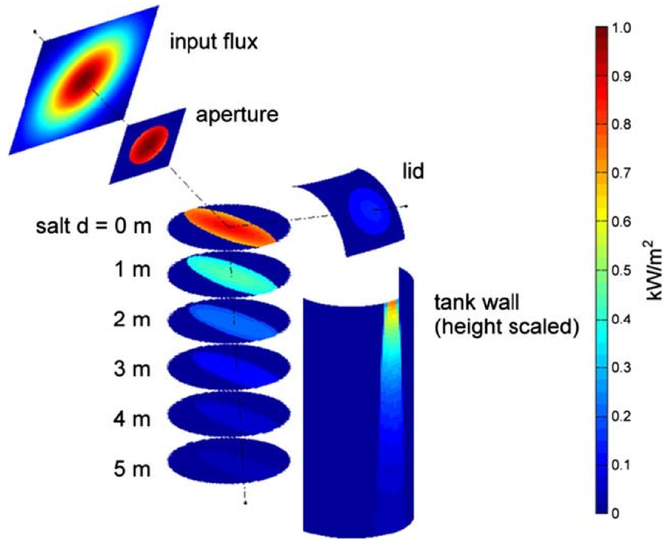
High-Temperature Salts for Solar Thermal Electricity Production and High-Temperature Nuclear Heat Storage

Charles Forsberg, Tom McKrell, Jacopo Buongiorno, Jong Won Kim, and Stefano Passerini

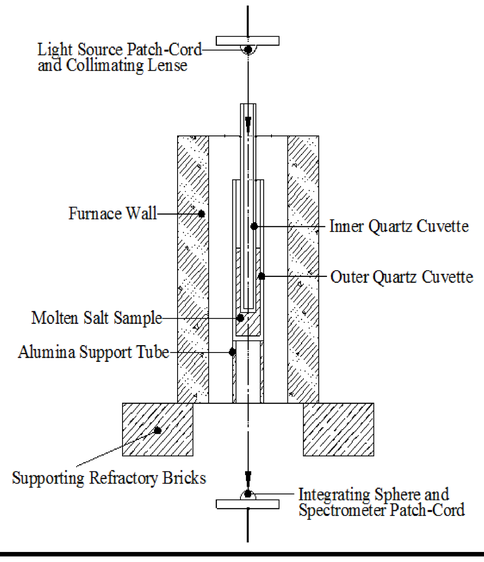
Optical Properties of Molten Salts are Central to All Applications

- *Optical properties (index of refraction and extinction coefficient) are largely unknown for molten salts*
- *For all applications radiative heat transfer can only be modelled if the optical properties are known.*
- *For the solar application the absorption of the sunlight with depth is required for the design of the receiver/pond.*



From: Concentrated Solar Power on Demand, Solar Energy 85 (2011) 1519–1529.

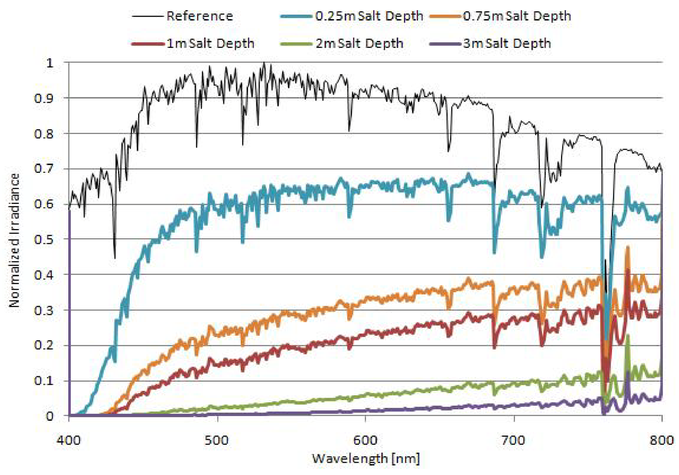
We are Experimentally Measuring the Attenuation of light with Salt Depth, Temperature, and Wavelength



Goal: Use a custom built experimental apparatus to measure absorption of light with temperature and wavelength.

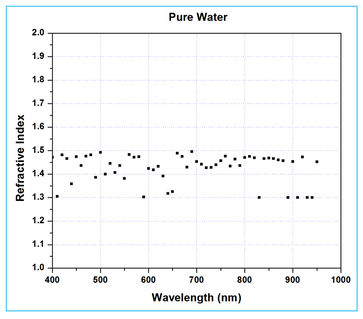
Initial candidates:

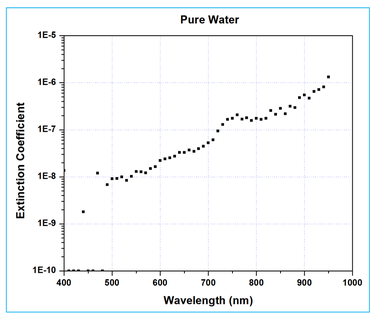
- *Ternary* chloride salt, NaCl-KCl-$MgCl_2$ (eutectic 30-20-50 mol %, melting point 396°C)
- Binary chloride salt, NaCl-KCl (eutectic 50-50 wt%, melting point 657°C)
- Ternary carbonate salt, Li_2CO_3-Na_2CO_3-K_2CO_3 “cartecsal” (eutectic 32-33-35 wt%, melting point 397°C)
- Binary nitrate mixture, KNO_3-$NaNO_3$, (eutectic 40-60 wt%, melting point 222°C);



Experimental Measurements Enable Models of Salt System Performance

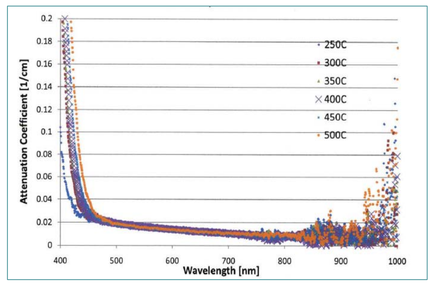
- Optical properties (Refractive index and Extinction coefficient) of liquid salt from transmittance from two different path lengths

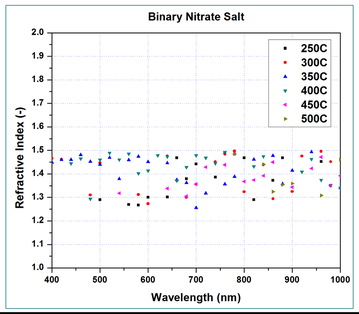


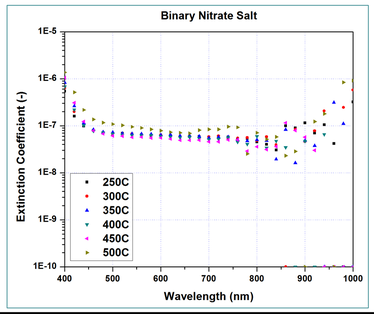


Pure water

Binary Nitrate Salt







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