

# Ceramic Castable Cement Tanks and Piping for Molten Salt

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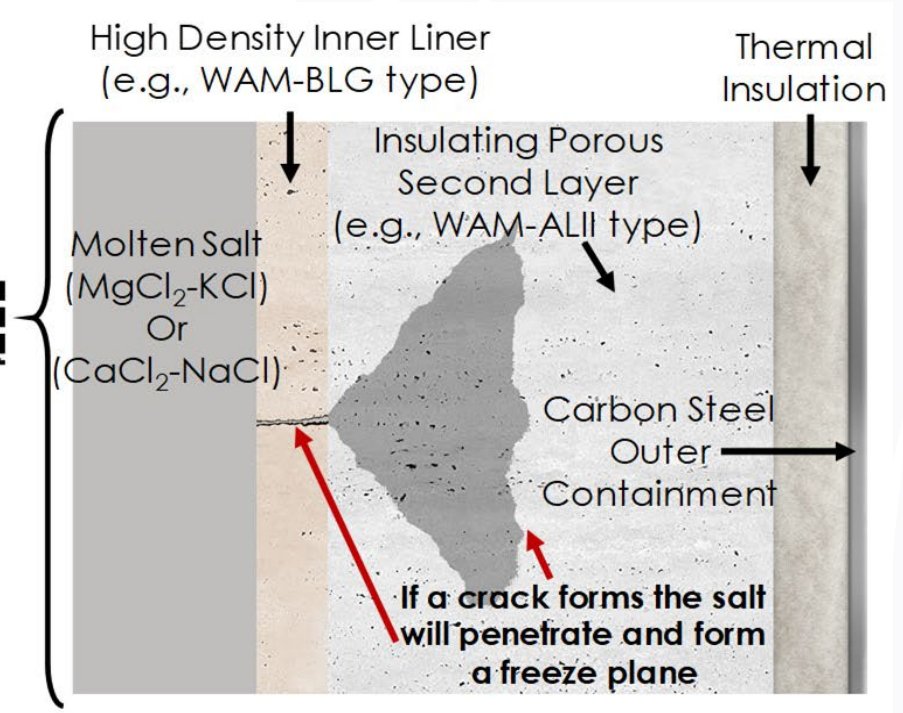
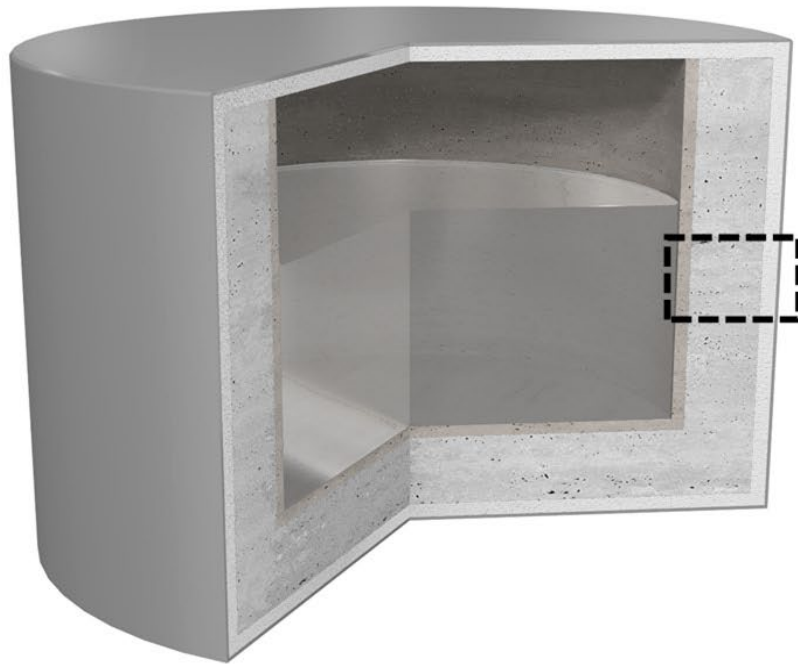
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# Overall Goals of the Project

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- **Objective (1):** Demonstrate through controlled tests with small samples that an optimized castable cement composition can sufficiently resist corrosion and penetration by  $\text{MgCl}_2\text{-KCl}$  at 750C. We also plan to show the material works under flowing condition, by demonstrating a lab scale tank that can hold 2 gallons of molten salt at > 750C, in a pumped closed loop configuration.
- **Objective (2):** Demonstrate that an optimized cement composition can be used for the piping infrastructure, demonstrating liquid tight seals between pipe sections under applied pressure.
- **Objective (3):** Develop techno-economic models for both the tank and piping to show that after all installation and manufacturing/processing related costs are accounted for, the two innovations proposed herein are much less expensive than the base case option of using Ni alloys for the entire infrastructure.

# Castable Cement Tank



Proposed concept for castable cement tank and tertiary protection mechanism

# Castable Cement Pipes

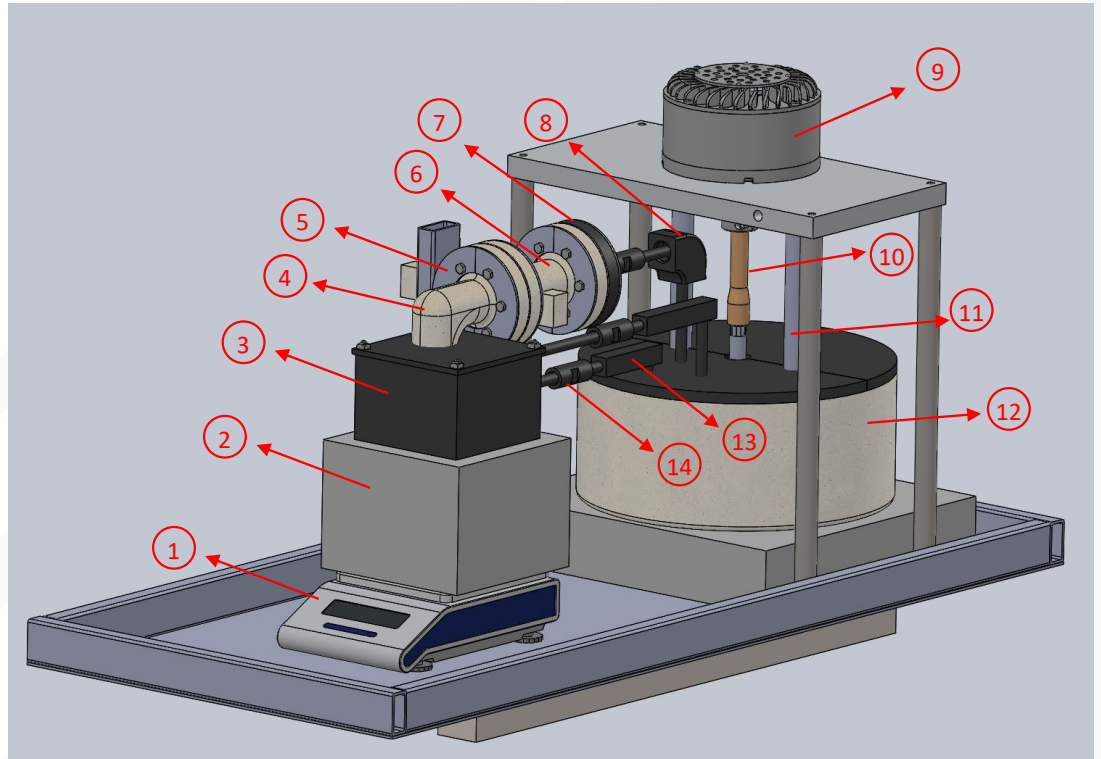
- Castable cement is an inexpensive route to a refractory and chemically compatible material for high temperature molten salts
- We are also proposing additional cost savings by employing castable cement to make piping as well as tank.
- The cements are generally composed of oxides, which have low thermal conductivities  $\sim 1\text{-}5 \text{ W m}^{-1} \text{ K}^{-1}$
- They are generally fabricated by adding water then pouring or forming a slurry into a mold, which is low cost, followed by a curing procedure at temperatures below 800C



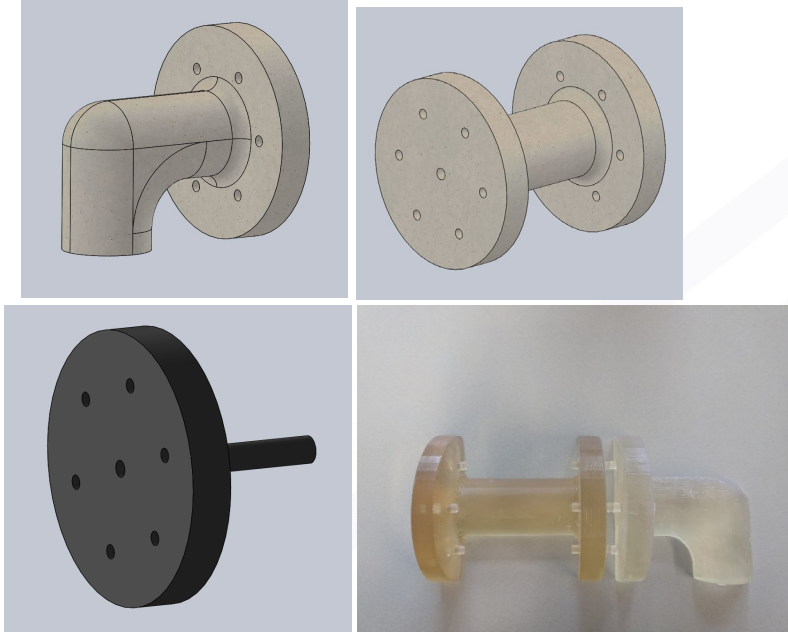
Proposed concept for castable cement piping with flanged connections and TZM bolts.

# Overall circulation setup

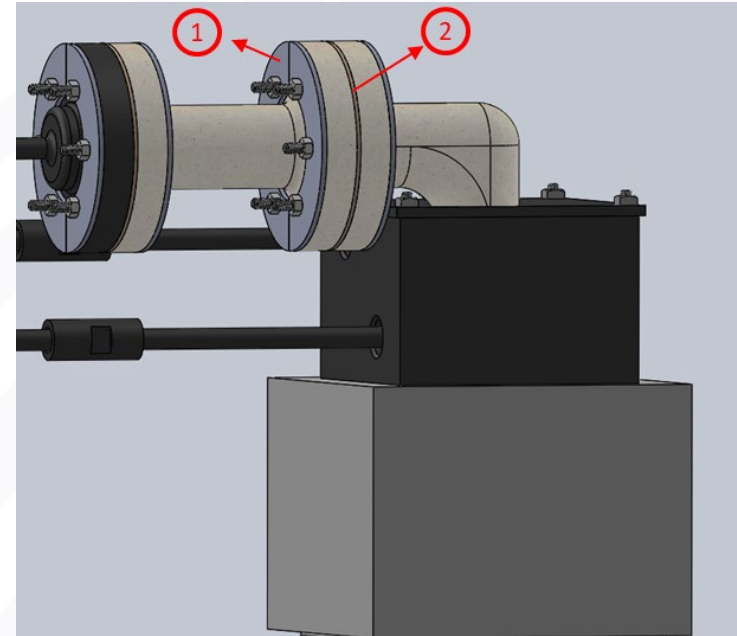
No.	Part name	Material
1	Scale	-
2	Insulation	-
3	Flowmeter	Graphite
4	Flanged adaptor	Castable ceramic
5	Flange	Inconel
6	Flanged pipe	Castable ceramic
7	Flanged adaptor	Graphite
8	Elbow	Graphite
9	Motor	-
10	insulator shaft	Zirconia
11	Pump support rods	Carbon fiber/alumina
12	Tank	Castable ceramic
13	Nub	Graphite
14	Union connector	Graphite



# Castable flanged connections piping



Custom designed, 3D printed flanged pipes for making the casting mold



Ceramic flange connection with metal washers and bolts

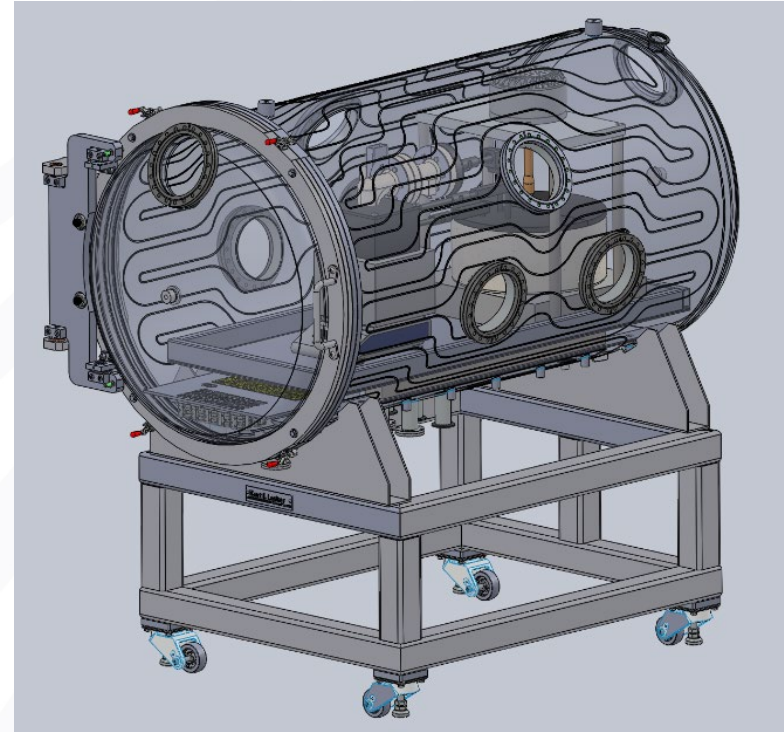
# Questions

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# Overall circulation setup

- The system is held inside a vacuum chamber
- The system provides the inert Ar environment.
- The Chamber's walls are water-cooled





# Castable chemistries under examination

- Three different castable calcium aluminate-based materials are being investigated:
  - **ALII** which is CaO:Al<sub>2</sub>O<sub>3</sub> molar ratio of 0.79:1
  - **ALII-HD** which is CaO:Al<sub>2</sub>O<sub>3</sub> molar ratio of 0.25:1
  - **ALII-HDF** which is CaO:Al<sub>2</sub>O<sub>3</sub> molar ratio of 0.73:1

