36332 Design of Thermal Energy Storage Using Industrial Byproducts

An internal insulation material with closed-cell porosity could mitigate major salt permeation risk in TES design.

1. Impact

If successful, the project will provide (1) an alternative concrete-based TES design that could avoid certain thermomechanical failures of a metal-based TES design and (2) a safer internal insulation design that does not rely on a perfect hot-face to serve as the salt permeation barrier.

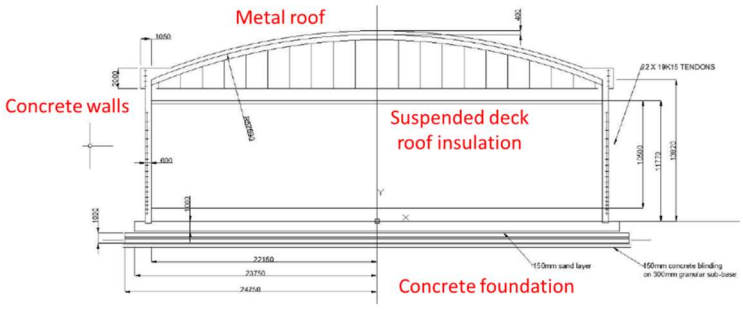
2. Project Goal

The project goals are (1) to reduce the overall TES cost and (2) to mitigate the major risk of salt permeation into internal insulation layer that could potentially cause TES structure failure.

3. Method(s)

(1) Detailed thermal and mechanical analysis of a commercial-scale concrete-based TES design using past design experience and experts from concrete-based liquified natural gas (LNG) tanks.

(2) Materials development of a matrix material, called geopolymer, for internal insulation with addition of closed-cell cenosphere particles and other additives to achieve the desired thermal and mechanical properties.



Current concrete molten salt TES design

4. Outcome(s)

(1) The team had conceptually designed and preliminarily costed a concrete-based TES for commercial scale application.

(2) The team had proved the concept of the geopolymer/cenosphere insulation material with ~30-40 vol.% closed-cell porosity by demonstrating its thermal and mechanical properties in the dry condition.

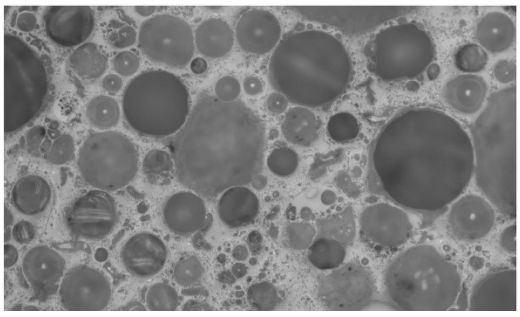
5. Conclusion/Risks

Geopolymer with cenosphere addition could be a viable alternative insulation design that can operate in a completely salt-wetted state without major compromise on thermal insulation performance. This can be one of the first fail-"safer" concepts for molten salt TES.

The team is currently investigating long-term stability of the internal insulation material and the impact of molten salt immersion on its chemical, thermal and mechanical properties.

6. Team

National Renewable Energy Laboratory, Massachusetts Institute of Technology, Morgan Advanced Materials, Worley, JT Thorpe & Son



Structure of the internal insulation material showing the geopolymer matrix, closed-cell porosities from cenospheres and other minor additives