Heat Transfer Fluid and Thermal Storage Systems and Components

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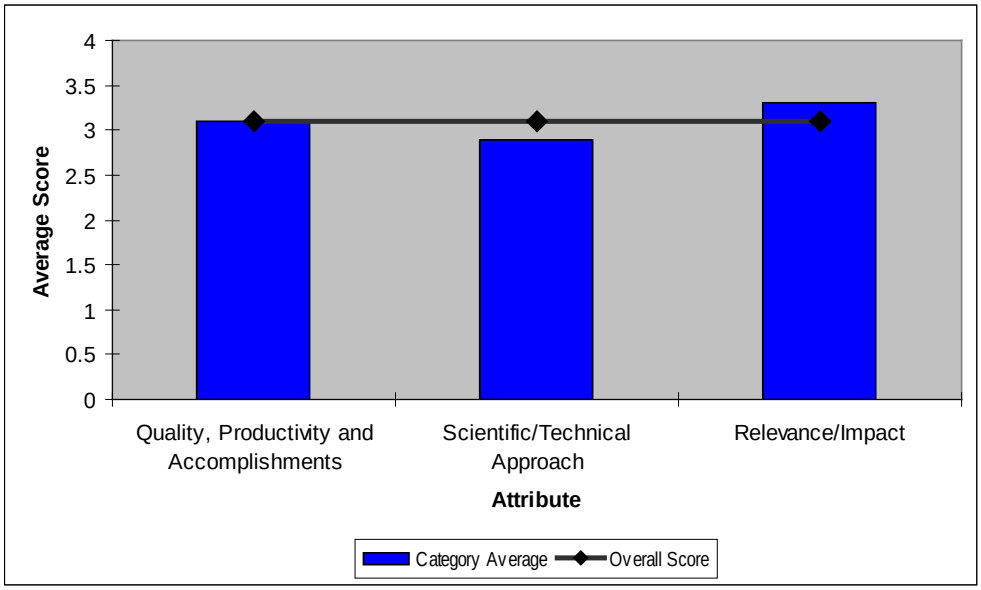

Details SNL's work in heat transfer-related CSP research. Activities include heat transfer fluid development, new molten salt formulations and qualification, freeze and thaw testing of trough components, research of advanced storage systems and components, and technical support of federally-funded industry partners such as Solar Millenium, Hamilton Sundstrand, and Symyx.

Quality, Productivity and Accomplishments (Average Rating 3.1)

Rating	Comments
3.0	The team is well qualified. The scientific productivity is excellent, and the project topic is of high interest to the CSP industry.
3.0	Insufficient information provided on team members' credentials, only the PI's CV is provided. However, the team members include many senior staff from SNL, which indicates a strong team. Significant accomplishments are indicated by the filing of two patents and publication of three technical papers in 2008. Good progress made in the development of low freezing point (<100 degC) and high temperature (~500 degC) salt formulation. However, it seems, for the storage system and component testing facility and the advanced 2x trough development, considerable amount of work still remains to be done. Expediting the proposed molten salt test facility would be beneficial. Based on the information provided, it is not clear what exactly was supposed to be completed during this reporting period, which makes it difficult to assess the reported accomplishments against what was expected.
3.0	An appropriate number of people, with well recognized technical credentials have been engaged in this project. The members of the team and collaborators clearly demonstrate their ability to contribute to the project. The facilities deployed on the project appear to be adequate, but limited, for the task at hand. The work under way is producing an appropriate level of accomplishment relative to the costs incurred. The project team appears to be on schedule, but the project is clearly still in progress and not yet complete. HTF development 2650k$ (1400 earmark carryover – 15 m long shafted pump testing for HS

3.5	Heat Transfer Fluid/Thermal Storage Systems and Components has focused on heat transfer fluid development, such as new molten salt formulations and qualification that will result in lower cost and higher performance parabolic trough systems; storage systems and components; parabolic trough modeling, and support to the private industry. Parabolic trough Heat transfer fluid development Salt service component testing interest Salt Freeze

Scientific/Technical Approach (Average Rating 2.9)

Rating	Comments
2.0	The empirical approach used to discover low melting point nitrate salts, seems slow to explore all potentially interesting salt mixtures. A feasibility study regarding the use of molten salt as heat transfer fluid (HTF) in large parabolic trough plants is much needed in order to determine the merits of such an option. It is hard to see how the energy losses associated with having to maintain the parabolic trough field at temperatures well above the freezing point of the molten salt, and the cost of the infrastructure needed to guarantee those operating conditions are not going to undermine the profitability of any project using molten salt as a HTF. The approaches followed to execute the remaining project tasks seem to be appropriate.
3.0	Technical approach is good. However it seems to lack end-user input and involvement. The current method (empirical) of salt formulation is slow. The robotic method mentioned in the presentation is better; likely to be more efficient and fast. However, a model that can simulate the characteristics of different salt formulation would be very valuable. Effort should be made to develop a model in which it is easy to vary the mixture composition and simulate or predict the properties and performance. Built in economic model would also assess the cost-benefit of different formulations. Expediting the work on developing molecular dynamics and continuum thermodynamics modeling to aid in material discovery would be very valuable.
3.0	The project team applied an appropriate technical approach in pursuit of project objectives. The design and execution of the approach are good. Computational molecular dynamics modeling to look for new nitrate salt mixtures that melt at lower temps. Additional modeling techniques will be valuable here.
3.6	Published technical papers Discovered several low melting point nitrate salts, which can result in reducing parabolic LCOE.. However, salt characterization still needs additional development, along with system development to recover from freeze event.

Relevance/Impact (Average Rating 3.3)

Rating	Comments
2.0	Some of the project results are of relevance to advance the state of the art of CSP parabolic trough plants. However, some of the lines of activity undertaken are not clearly justify, specially the one concerning the development of parabolic trough components for CSP plants using molten salt as HTF. It is not clear that the use of molten salt as a HTF makes economic and technological sense for large CSP parabolic trough plants.
4.0	Work is highly relevant. Storage is one of the most urgent requirements for CSP to be successful.
3.0	Hamilton Sunstrand - 6000 to 11000 gpm at 250 psi Focus on low melting point salts

Salt service components – need big facilities to test them
Some of the facilities are asking for support to do this testing
Freeze thaw testing of trough systems
Solar millennium, Hamilton sunstrand, symyx
Salts for direct replacement of the expensive oils in the trough fields
500C topout temperature in a parabolic trough
Strategy for putting salt in the field if it makes sense??

Do NOT recommend pursuit of molten salt in the field at this point in time. Too early, other more low-hanging fruit to be addressed first. Also, likelihood of problems too high. On the other hand, dealing with freeze recovery in other system components and subsystems is highly valuable.

4.0 Increase the aperture of the receiver when running at a higher temp
Higher heat transfer fluid
Impedance heating
Li nitrate – 3 times sodium nitrate
Tied to NG – fertilizers
Most work is empirical so far. Basic information is not available to develop computational model.

Overall (Average Rating 3.1)

Rating	Comments
2.0	The team is well qualified. The scientific productivity is excellent, and the project topic is of high interest to the CSP industry. However, The empirical approach used to discover low melting point nitrate salts, seems slow to explore all potentially interesting salt mixtures, and some of the lines of activity undertaken are not clearly justify, specially the one concerning the development of parabolic trough components for CSP plants using molten salt as HTF. It is not clear that the use of molten salt as a HTF makes economic and technological sense for large CSP parabolic trough plants.
3.5	Work on molten salt for parabolic trough field should be deferred, as that is not likely to be viable in the short term.
3.0	Analytical techniques must be used to complement empirical techniques.
3.7	The lab has developed multi-component molten nitrate salt mixture that solidify below 100 degrees C and thermal stability of these salts to 500 degrees C. Much higher focus is needed to development of higher temperature heat transfer fluid and storage options for power towers to achieve the goals, research direction and market timing and needs. Salt selection should be more than empirical work. Additional analysis should be done for selection of working fluid for the thermocline.