Institute of
Engineering Thermodynamics

Concentrated Solar Tower Power Plant using Slag as Inventory Material for a Thermal Energy Storage (TES)

M. Krüger¹, J. Haunstetter¹, S. Zunft¹
¹German Aerospace Center (DLR), Institute of Engineering Thermodynamics, Stuttgart, Germany

Motivation & Approach
Slag from steel industry as an inventory material for thermal energy storage (TES) of CSP tower plants offers cost reduction potential, due to its classification as waste.

For a successful market introduction of this technology, efficient and up-scalable solutions for the TES are a prerequisite. Investigations to clarify open questions concerning the implementation in large installations in combination with slag-pebbles as inventory are needed. The European project REslag is dedicated to this.

Development activities
• Conception of TES design
• Thermal analysis of the TES
• Pilot scale tests of a set-up of slag pebbles and various insulation options
• Simulation of flow distribution using different distributors
• Thermo-mechanical calculations of the container wall and the slag pebbles

Results
• Max. temperature drop of 60°C of the hot end can be reached
• Steady state conditions can be reached after 8 days
• Highest pressure drop of 87 mbar occurs during solar noon
• Mean pressure drop is 50 mbar
• Several distributors with good uniformity of flow are identified; cylinder distributor of 1m height is most promising
• Increase of contact force with increasing temperature spread
• Higher forces for particle-wall contacts

Summary & Outlook
• Lead concept “Axial flow – vertical” could be identified by using thermal analysis as well as aptitude and risk analysis
• Distributor concept was identified
• Thermo-mechanical calculations with reduced degree of detail indicate larger forces than expected
• Mechanical and thermal slag analysis is promising
• The full scale lead design was adapted to the pilot scale test rig

Full scale CSP plant specifications:
- Net power output 150 MWel
- TES discharging duration 6.5 h
- TES charging duration 8 h
- TES inlet temperature 700 °C
- Mass flow discharging 780 kg/s
- Mean charging mass flow 706 kg/s

Acknowledgements:
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 642967.

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Knowledge for Tomorrow
Wissen für Morgen