Institute of Solar Research

# New Operating Strategies for Molten Salt in Line Focusing Solar Fields - Daily Drainage and Solar Preheating of Receivers

Martin Eickhoff, Mirko Meyer-Grünefeldt, Lothar Keller

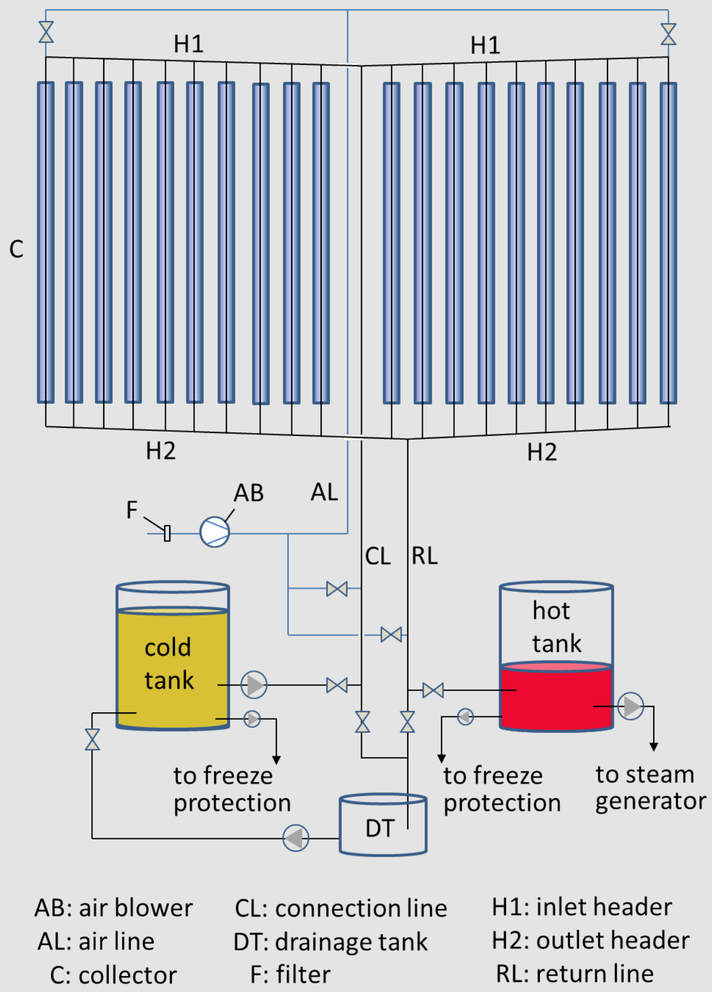


Figure 1: Schema of the new molten salt CSP plant

## Motivation

Molten salt is a promising heat transfer fluid for line focusing solar thermal power plants, since higher operating temperatures lead to higher process efficiency as well as higher storage efficiency. A significant drawback of liquid salt is the fact that when it remains in the absorber tubes in the evening after operation, there is the risk of solidification by freezing. For this reason, parabolic trough or Fresnel collectors are heated overnight with hot molten salt from the storage tanks to avoid solidification. A continuous nightly heating of large solar fields, however, is very costly especially in winter. In order to eliminate this drawback, DLR has developed a new operating strategy that avoids the nocturnal solar field heating.

## New Molten Salt CSP Plant

The new solar thermal power plant (see fig.1) uses the proven salt mixture "Solar Salt", which is stable in air up to 565 °C as heat transfer and storage medium. The plant consists of a solar field, storage tanks and a power block. An air blower (AB), a non-insulated airline (AL) and 1000m collectors (C) with continuous fix focus absorbers form the basis for the new operating concept. Actually only Linear-Fresnel collectors already reach such collector lengths. Nevertheless, DLR is developing a new 1000m parabolic trough collector that can be used for this kind of application.

## New Molten Salt Operating Strategy

The fundamental difference compared to state of the art molten salt CSP plants is a new operating strategy, which does not require overnight heating of the solar field since the absorber tubes of the 1000m collectors will be drained in the evening. The drainage of the solar field is realized by gravity and compressed air. Within minutes the molten salt flows from the absorber tubes to the underground drainage tank. During the night the tube walls of the solar field connection lines and the header lines are maintained hot by a thermal fluid heat tracing system that uses heat from the thermal storage tanks.

On the next morning initially before sunrise the collector inlet and outlet lines will be preheated by the air blower using heat from the hot tube walls of the headers and solar field connecting lines. At sunrise the absorber tubes of the solar field are being preheated using heat from the first solar irradiation. Then, the solar field is filled with molten salt from the storage tank for normal operation.

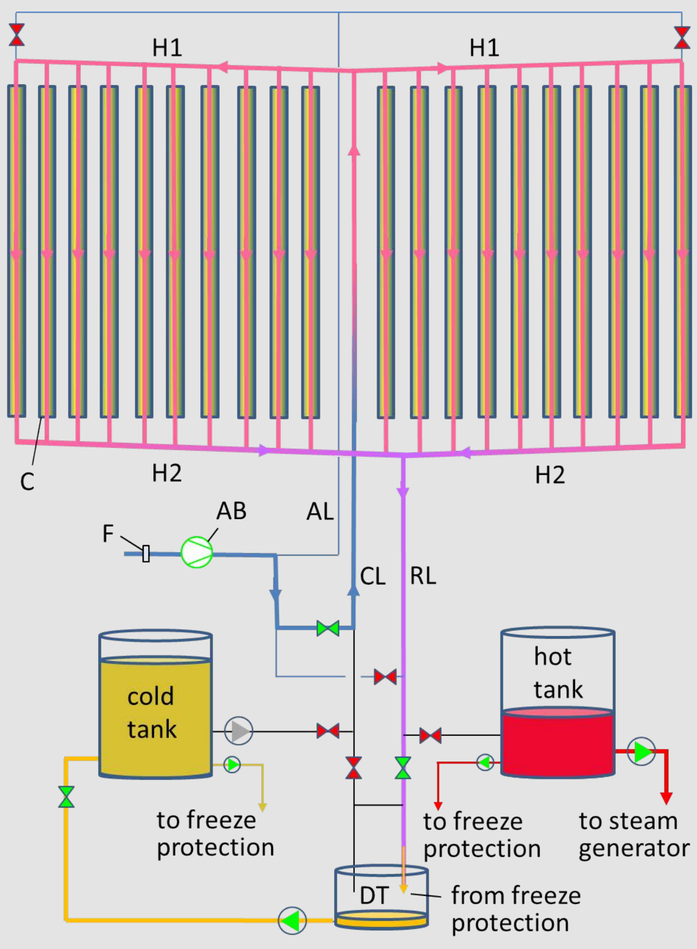


Figure 2: Solar Preheating of the Absorber Tubes

## Solar Preheating of Absorber Tubes

In this operating phase (see Fig. 2) the blower (AB) blows air through the solar field connection line (CL), inlet header pipe (H1) and collector inlet pipes to the collectors. Thereby the air is heated up by the hot tube walls and thus enters the absorber tubes of the collectors with elevated temperature. The collectors can now be focused. Due to low heat transfer coefficients and one-sided irradiation of the absorber tubes, critical temperature gradients can occur if the collectors are totally focused. Therefore, the collectors are only "partially focused", which means that the collectors are moved through the focus repeatedly respecting a certain waiting time. When moving through the focus a relatively high amount of energy is absorbed by the absorber tube wall. Slight temperature gradients over the tube circumference occur due to the one-sided heat input. During the waiting period the temperature gradients are reduced by heat conduction over the circumference and by heat exchange with the internal air flow. The higher the direct irradiation, the longer the waiting period before the next drive-through. First tests at Plataforma Solar de Almería (PSA) in Spain have shown that solar preheating without critical temperature gradients is feasible for parabolic trough collectors.

## Conclusion and Outlook

The novel power plant design and operating strategy create a line focusing power plant, which can be operated at high temperatures of 565 °C and which has almost no heat losses at night. First experimental results show that all technical challenges seem to be unproblematic and can be overcome. As a next step the realization of a prototype plant with solar salt should be aspired in order to demonstrate the practical feasibility of the new operating strategy.

Contact: **Institute of Solar Resesarch** | Line Focusing Systems | Plataforma Solar de Almería | Martin Eickhoff
Phone: +34 950/259 428 | E-Mail: martin.eickhoff@dlr.de

DLR Deutsches Zentrum für Luft- und Raumfahrt