Dynamic performance and stress analysis of the steam generator of parabolic trough solar power plants

The thermal stress on thick-walled components, such as tubesheets and steam drums, limits both the temperature ramp-up rates and the temperature differences between outer and inner walls. The cyclic operation of concentrating solar power plants may lead to fatigue damage. For these reasons, a stress analysis of the steam generator is required to assure its lifetime. A methodology is presented for the thermo-mechanical analysis of the steam generator for a parabolic trough power plant. This methodology consists of coupling transient thermodynamic and stress models of the heat exchangers in order to calculate the stress. Besides the heat exchanger models, a transient model for a TEMA H heat exchanger is proposed. Finite element simulations are carried out to calculate the deviations of the simplified analytical models. In this way, a powerful tool that allows the analysis and optimization of the steam generator operation is proposed. The results suggest that U-tube tubesheets are exposed to high thermal stresses on the no-tube-lane zone, especially in the reheater. The steam generator start-up can be accomplished in around 45 minutes using 36.4 MWhth. Furthermore, the TEMA X evaporator presents a thermal stress reduction of 35% compared to the kettle evaporator.