Condition and lifetime monitoring of boiler components and piping systems at high temperatures
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Abstract
Condition and lifetime monitoring of power plant components used in the boiler area as well as in high temperature piping plays an important role. The currently new power plants utilize significantly high steam parameters and thus a lower design reserve. At the same time, especially in Germany a higher flexibility due the modulation of the power grid is required so start-up and shutdown processes are expected more frequently associated with the energy turnaround. Because of the low creep strength of the used materials the high steam parameters cause high demands on the proper functioning of the pipeline system in order to guarantee even allowable creep rupture strength values and to limit the exhaustion due to fatigue. Monitoring of the degrees of exhaustion, relaxation of the piping system and functionality of the hanger system is thus an important precondition for maintaining the operation reliability, establishing maintenance and inspection intervals and the safe long-term operation.

In normal operation, two types of damage to pressurized components are possible and must therefore be taken into account. The mechanisms are creep damage which occurs as a result of mechanical loading at high temperature and low cycle fatigue caused by thermal stresses in the walls during start-up and shutdown processes. These damage effects can be quantified by the calculation of the degree of exhaustion. The calculation of lifetime is determined on the basis of the temperature and pressure loads according to the calculation rule DIN EN 12952. The lifetime calculation is conducted based on the Tresca equivalent stress (maximum shear stress hypothesis). It is assumed, that there is no influence by additional system loads. The verification of this boundary condition can be attained through the monitoring of the piping system.

Within the scope of the operating and lifetime monitoring systems implemented in conventional power plants, this long-term monitoring of the pipeline performance is carried out via force and displacement measurements at selected locations. The objectives of pipeline monitoring are identification of the scheduled behaviour of the piping system and acceptable stresses in the piping components and detection of inadmissible deviations from planned operation which can affect the lifetime. This makes it possible to react early to eliminate malfunctions. Representative examples from the lignite- and hard coal-fired power plants commissioned in the last few years will be presented.