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Conjugate heat transfer simulations of a bypass valve for the next generation of highest-efficient power plants

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Increasing the efficiency for future steam cycle power plants is of significant importance for the reduction of their CO2 emissions.

Today?s best steam cycle power plants have a net plant efficiency of 46% while the average efficiency value for such power plants worldwide is still around 30%. Consequently, there exists a great potential for a reduction in CO2 emissions by replacing old power stations with new ones. Yet, a greater potential can be achieved if even higher efficiencies are obtained. In order to push the efficiency of stem power plants significantly over the 50% mark, further increases in live steam temperatures to more than 700° Celsius have to be achieved. However, new materials have to be applied for the hot path components and experiences in operation have to be obtained.

A collaborative research project, funded by the German government, deals with the challenges associated with such future power plants. Within one sub-project, an experimental set up in a real power station of a high temperature bypass-valve is supplied by steam with over 700° Celsius and investigated in long-term operation.

The transient thermal behaviour of that valve is of major interest and concern during the tests because of the thermal fatigue of the applied Ni-base material.

Full conjugate heat transfer calculations through application of STAR-CCM+ are an essential and high value contribution to the understanding of the heat transfer conditions during the valve operation. The comparison with thermal probe measurements shows that in conjugate heat transfer application the thermal behaviour of the valve can be calculated with highest accuracy by the STAR-CCM+ code.

Such detailed knowledge of the three-dimensional temperature distribution is of significant importance for the improved life cycle calculations during the design process of such valves and other thermally high loaded components in power plants.

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