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Steam Turbine Start-up Optimization Tool based on Abaqus and Python Scripting

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Abstract: One key aspect for the design of fast and flexible steam turbine operation is thermal stresses arising during transient operation. If the stresses exceed the fatigue limits of the material, the lifetime of the steam turbine is shortened. Detailed finite element analysis is applied during design phase to assess the effect of transient temperature and stress profiles on the complex geometries. A significant amount of design effort is invested to determine the optimal process parameters for start-up (e.g. steam temperatures, run-up and loading gradients), in order to achieve the fastest possible starts without exceeding allowable material stress limits. The first step of the current practice is to derive the transient thermal boundary conditions for the whole start-up simulation, based on pre-defined process parameters. In a second step a finite element analysis is performed to verify these thermal boundary conditions. Using this sequential approach, a high number of iterations are required to arrive at the optimal process parameters.
An automation process in the form of a design tool was developed to determine the optimal process parameters, by means of a feedback control algorithm. Using Python scripting, the tool interlinks the finite element package Abaqus/CAE (Version 6.7 and above) with an Alstom in-house thermodynamic program, determining optimal transient thermal boundary conditions based on real time thermal stresses. Use of this tool eliminates the need for the high number of manual iterations previously required. This paper presents the concept of the optimization tool and how it interlinks the interdependent programs.

Keywords: Power Generation, Steam Turbine, Start-up, Thermal Stress, Optimization

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