

Robust Calibration of Complex ThermoSysPro Models using Data Assimilation Techniques: Application on the Secondary Loop of a Pressurized Water Reactor

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Abstract

ThermoSysPro (TSP) is a library for the modeling and simulation of power plants and energy systems. It has been developed by EDF and it is released under open source license. When developing models with TSP it is necessary to ensure that they match reality. In practice, this operation is performed by adjusting the value of the parameters appearing in the model. This major step corresponds to model calibration.

Calibration can be performed through various methods. A classical way to do so with Modelica models is by model inversion. The major inconvenience of this method, in addition of potential convergence problems for complex models, is that it is necessary to have exactly the same number of measurements as parameters to be calibrated, which is not often the case in practice.

This paper shows how data assimilation techniques can robustly be used for calibration of complex TSP models avoiding the inconveniences associated to calibration by model inversion while ensuring an optimal use of the available measurements. A complex TSP model of the secondary loop of a Pressurized Water Reactor (PWR) is considered for this purpose.

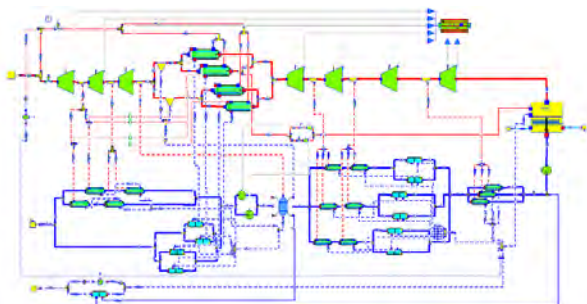


Figure 1. 1300 MW PWR model with ThermoSysPro

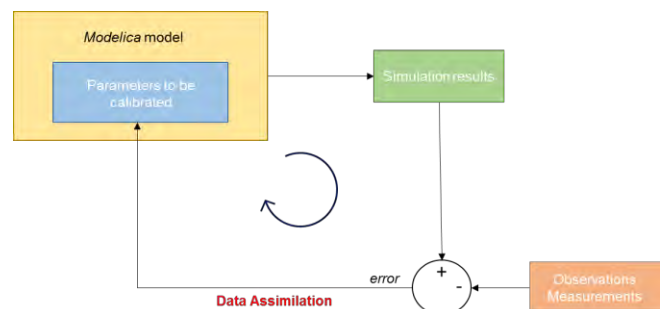


Figure 2. Illustration of the calibration procedure using data assimilation techniques

Keywords: Modelica, ThermoSysPro, data assimilation, model calibration, thermal-hydraulics, pressurized water reactor.

References

- Asch M., Bocquet M., Nodet M., *Data Assimilation - Methods, Algorithms and Applications*, SIAM, 2016.
- Bouttier B., Courtier P., *Data assimilation concepts and methods*, Meteorological Training Course Lecture Series, ECMWF, 1999.
- El Hefni B., Bouskela D., *Modeling and simulation of a complex ThermoSysPro model with OpenModelica – Dynamic Modeling of a combined power plant*, 12th International Modelica Conference, May 15-17, 2017, Prague, Czech Republic.
- Kalnay E., *Atmospheric Modeling, Data Assimilation and Predictability*, Cambridge University Press, 2003.
- Modelica, open-source modelling language, information available at: <https://www.modelica.org/>
- OpenModelica, open-source Modelica-based modeling and simulation environment, information available at: <https://openmodelica.org/>
- SALOME The Open Source Integration Platform for Numerical Simulation, information available at: <http://www.salome-platform.org/>