System level coupled with boiler operation and furnace processes

Energy system modeling

To find ways to cope with flexibility demands energy systems of different scales have been analyzed in FLEXe. The limitations posed by individual power plants for the system level are due to

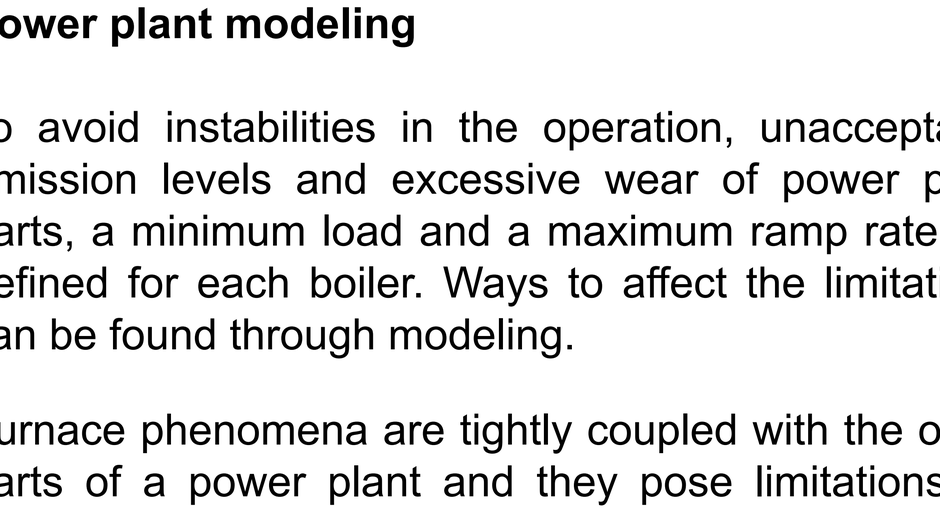
- Limitations due to boiler furnace phenomena
- Limitations posed by the water/steam cycle
- Limitations in turbine operation
- Limitations posed by process control

In Flexe, data on the limitations of boiler and engine based power plants were collected for system modelers for use in prediction of energy networks.

Power plant modeling

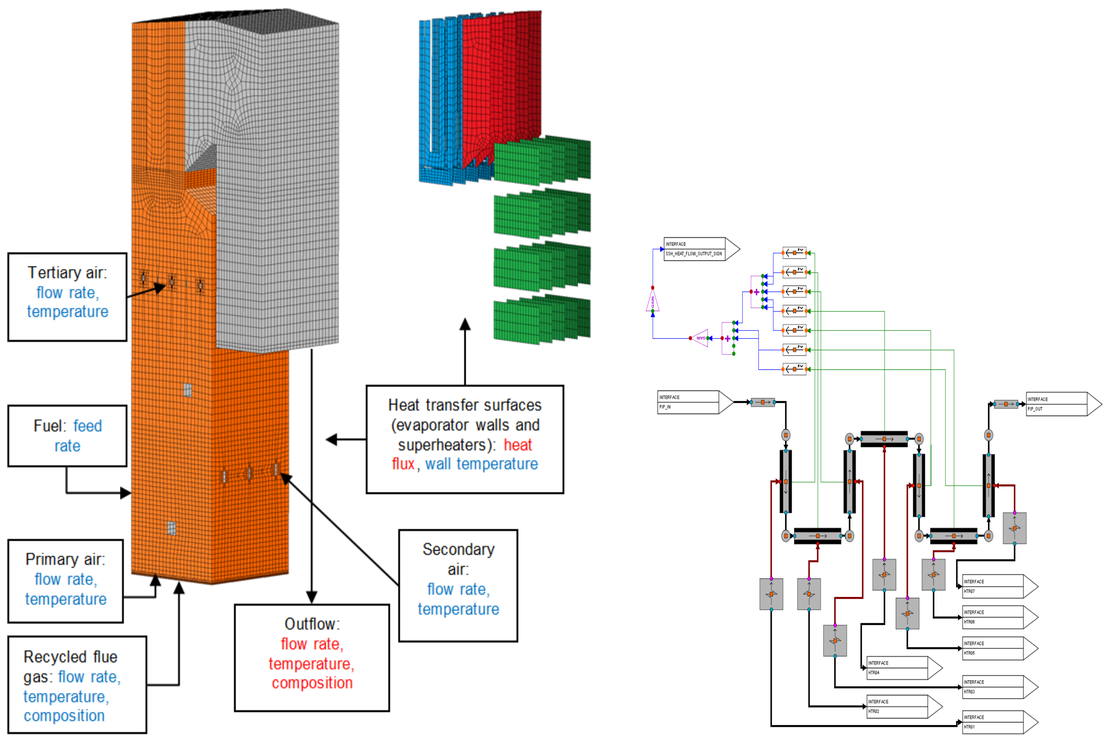
To avoid instabilities in the operation, unacceptable emission levels and excessive wear of power plant parts, a minimum load and a maximum ramp rate are defined for each boiler. Ways to affect the limitations can be found through modeling.

Furnace phenomena are tightly coupled with the other parts of a power plant and they pose limitations on allowed ramp rates and loads. In FLEXe, a coupled simulation method covering all parts of a power plant was developed. Computational fluid dynamic (CFD) modeling was used to describe the boiler furnace.

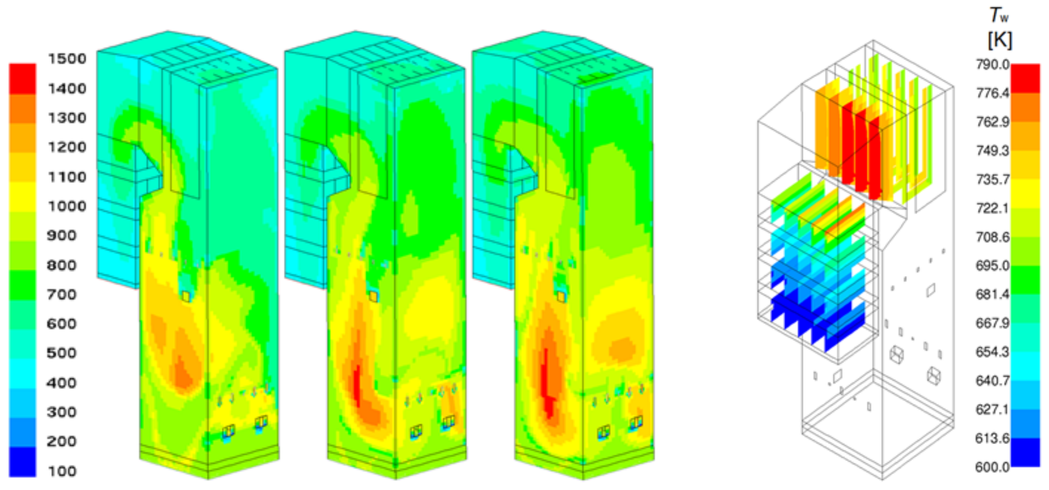


Gas temperature and O_2 distribution in a BFB furnace at 67%, 85% and 100% loads.

Dynamic system simulation with Apros was coupled with CFD modeling carried out with Ansys Fluent.



Left: Links between Fluent and Apros. Evaporator surfaces in orange, primary superheaters in green, secondary superheaters in blue and tertiary superheaters in red. Variables updated in Apros and transferred to Fluent are written in blue and the ones updated in Fluent and transferred to Apros are in red. Right: A suprheater panel in Apros.



Simulation results: Surface temperatures on boiler walls at 67%, 85% and 100% loads and on the superheater walls at 67% load.

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