BoilerMax
Optimize power plant start up
OPTIMAX® BoilerMax Challenge

- Boilers fire up using expensive fuels like natural gas or light fuel oil. At higher loads operators change to main fuel like coal or heavy fuel oil.
- During boiler warming up, the generated steam doesn’t fulfill turbine inlet parameters and is directed to the condenser.
- Boiler start ups induce significant thermal stress upon the thick-walled components of the boiler, such as headers and spherical fittings. Frequent boiler starts will increase thick-walled components lifetime consumption.
- Thus, the challenge is to reduce fuel costs, dumped steam and thermal stress.
OPTIMAX® BoilerMax Solution features

- Nonlinear Model Predictive Control (NMPC)
- The boiler model can be identified using measured data during start up
- Parallel calculation of set points for fuel, main steam pressure and temperature
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Functional principle

Nonlinear Model Predictive Control with cyclic tracking to the real process

Optimization Goals

Optimized setpoint and inputs

Cost function = Minimum!
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Nonlinear modelling

- Consideration of the following components in modeling process:
  - Economizer, evaporator, recirculation circle, steam drum
  - Superheater
  - HP turbine bypass for reheater
  - Thick-walled components like headers
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Determination of thermal stresses

Principle:
- Temperature difference $\Delta T$ is indicator for thermal stresses
- Measurement of $\Delta T$ between inner surface and the mean diameter of the annular cross section of thick-walled components
- Alternative 1: determination on non-heated surface
- Alternative 2: indirect determination from steam temperature

$\Delta T \approx T_m - T_i$

$\Delta T$ live steam header in °C
$\Delta T$ limit

dT_H4 [K]
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Enhanced start up phase

- Traditional start up to comply with design limits
- BoilerMax start up allows exploitation of design limits for more efficient process control:
  - Based on process model
  - NMPC technology
  - Predictive coordination of multiple variables
  - Online optimization in real-time
- Up to 15% savings due to fast and low-stress boiler start up
Donaukurier 24.8.2007
(translation)

“It shortens and optimizes the start up phase of the unit“ says Wolfgang Kleinsteuber, director of the power plant. “We will now produce 2000 tons of carbon dioxide (CO$_2$) less than last year.“

That is the average CO$_2$ emission of 1000 mid-size cars, according to E.ON’s press release.
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Benefits

- Shorter start up and shut down time reduces fuel consumption
- Faster load response to load dispatcher, advantages in energy trading
- Explicit consideration of thermal stresses in thick-walled components, control of temperature variances during start up
- Earlier warm up and speed up of the steam turbine and therefore earlier grid synchronization possible
- Reproducible starts allow precise scheduling of unit start up time