Optimax Plant Performance Monitoring
Key performance indicators, controllable losses, what-if
OPTIMAX® Plant Performance Monitoring Challenge

- Power plant operators are in charge to keep up efficiency under continuously changing loads.
- Power plant maintenance staff shall reduce both unplanned outages and maintenance costs.
- Power plant managers strive for meaningful figures for strategic decisions.
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Features

- Standard tool library (ISO, ASME, DIN) for easy calculation engineering
- Calculates deviations between actual and expected performance
- Converts performance deviation to short- and long-term degradation
- Interface to ABB’s Power Generation Information Management System (PGIM)
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Starting point: monitoring of process values in DCS

Process values alone usually give no information about the efficiency or the process quality of a plant.
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Determination of performance indicators

Performance indicators are determined by using multiple process values
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Key performance indicator example: condenser

\[ Q_{th} = F_{\text{CoolWater}} \times \text{spec.HeatCoeff}_{\text{Water}} \times (T_2 - T_1) \]

\[ A = \text{Condenser Surface} \]

\[ \Delta T_{\text{log}} = \frac{T_2 - T_1}{\ln \left( \frac{T_C - T_1}{T_C - T_2} \right)} \]

Heat Transfer Coefficient \( k_{\text{Actual}} = \frac{Q_{th}}{A \Delta T_{\text{log}}} \)
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Key performance indicators module library

- Steam Generators (fossil-fired, SG)
- Heat Recovery Steam Generators (HRSG)
- Combustion stoichiometry (for SG or HRSG)
- Gas turbines
- Steam turbines
- Feed water heaters
- Evaporators
- Super heaters
- Heat exchangers
- Desuperheaters
- Air preheaters
- Condensers
- Pumps, fans
- Generators
- Overall plant balance
- Auxiliary power and steam
- District heat
- Process steam
- Mathematical and statistical calculations
- Water/steam properties
- Gas properties
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Generation of reference values

- Online calculation of reference values depending on e.g.
  - Temperature
  - Air pressure
  - Load
  - Fuel sort
  - ...

- Reference characteristics extracted from heat balance sheets or fitted to archived process data from acceptance tests of new plant or after major retrofit
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Calculations configuration
Controllable losses include measured process values that can be controlled by the plant operator and having a known impact on plant energy losses when deviating from the design point, e.g.:

- Flue-gas temperature at boiler exit
- $O_2$ flue gas concentration at boiler exit
- Electrical auxiliary power
- Condenser pressure
- Condensate water temperature at feed water tank inlet
- Feed water temperature at boiler inlet
- Feed water temperature at economizer outlet
- Live steam temperature
- Live steam pressure

Process mimic presents for each controllable loss:

- Actual measurement value
- Design value (=expected value)
- Impact on plant efficiency / heat rate
- Additional plant fuel consumption due to actual deviation from design value
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What if calculations

- Replace controllable losses actual measurement values by manually defined “What-if” values.
- The calculation shows the impact of all deviations of controllable losses from their design values.
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Report of performance calculations

- Standard Reports e.g.:
  - Consumed and produced quantities
  - Components operating hours
  - Actuators number of switching cycles
  - Report of Performance Calculations e.g.:
    - Performance values averages, standard deviations
    - Performance values averages clustered into specific component/unit operation ranges/modes
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Report configuration

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Standard calculation of performance deviations

KPI = \frac{\eta_{act}}{\eta_{exp}}
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Identifying the origin of performance deviations
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Benefits

- Applicable for different plant types
- Increases overall plant efficiency by detecting sub-optimal operation modes
- Improves plant availability and predictive maintenance strategies by detecting material degradations
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Key performance indicators for steam power plants

- Steam generator
  - Thermal efficiency according to DIN or ASME PTC
  - Efficiency economizer
  - Efficiency feed water preheater
- Condenser
  - Expected condenser pressure
  - Cleanliness/heat rate
- Preheater
  - Logarithmic linear medium temperature difference
  - Heat rate impact
  - Efficiency
- Steam turbine
  - Thermal efficiency/heat rate impact
  - Isentropic heat power extractions
  - Shaft power
- Unit balances
  - Heat rate of unit
  - Auxiliary power consumption
  - Auxiliary steam consumption
  - Heat flow to district heating
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Key performance indicators for combined cycle power plants

- GT calculations acc. ISO2314, DIN4341, ASME-PTC22
  - Calculate actual efficiency and exhaust mass flow and enthalpy
  - Correct expected power and efficiency to ISO conditions based on correction curves for:
    - ambient air pressure, temperature, humidity
    - dp inlet and exhaust
    - grid frequency
  - Calculate expected power and efficiency from design curves

- HRSG calculations acc. ASME-PTC4.4
  - Calculate actual thermal efficiency according to either:
    - input / output method
    - thermal loss method
  - Calculate actual exergetic efficiency
  - Expected efficiency based on correction curves can be calculated by using the math and core tools