DIGITIZED OPERATIONS for
SUSTAINABLE PROCESS INDUSTRIES

FUture DIrections of production Planning
and Optimized energy- and process
industries
(FUDIPO)

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At a glance

Learning System

- Compare process model expectations to on-line measurements.
- Feed signatures (deviations) to “learning system” for Continuous Knowledge Improvement

Normal degradation:
- Adapt process models
- Use for on-line control and optimization

Abnormal trends (faults):
- Use information for process and sensor diagnostics

Process Models:
- Oil and Gas
- Pulp and Paper
- Biological WWT
- CHP

Concurrent Engineering:
Design process modifications coupled to control

Maintenance on Demand and Production Planning

Plant-wide Model-based Predictive Control (MPC)

sorting “good data” used for tuning from “bad data” used for fault detection
1. Demonstrator Background: Mälarenergi AB, Block 6

High temp corrosion sensor
Results BN at CFB boiler 5

Diagnostics and decision support

Tp-Tm

Temp 1

0.2

0.3

Temp in Cyclone

Corrosion

Sensor fault

Moisture NIR

MC in fuel

p=predict
m=measured
Learning system in a fiberline – updating models semi on-line

\[
\frac{dL}{dt} = C_L \cdot [OH]^a \cdot [HS]^b \cdot e^{A-B/T}
\]

Dissolution rate of lignin in time

NIR Measurement of lignin content

MODEL BASED CONTROL

Open Modelica model

Lignin content on wood chips (measured)

Lignin content on pulp (predicted)

\( \Delta \) Lignin content

Dissolved lignin

COMPARISON

OPTIMIZATION

Dissolution rate of lignin in time

Wood chips

Chemicals

Pulp

Residual alkali

Steam for P&P

Electricity

TURBOGENERATOR

Chemicals for recycling

RECOVERY BOILER

EVAPORATORS

Chemicals

Fiber line

Kappa number

Billerud-Korsnäs
Temperature was higher than predicted. Indicate channeling.

- Temperature in the extraction flow during channelling:
  - yellow curve = measured process value
  - violet line = predicted value from simulation
Oil refinery at Tupras - Connection of the Physical Models

Determine feed comp by NIR

Optimize use of feed
Overall scheme of the WWTP at Mälarenergi (Sweden)

Minimize electricity
Reduce: NO3, NH4, BOD, PO4
Maximize biogas prod

BN and MPC
Micro gas turbines, mCHP

Fleet management of mGT plants

- Decision support
- Physical and statistical models
- Data pretreatment
- Measurements

- Maintenance on demand
- Diagnostics
Conclusions

- Goal to integrate different functions from low level to high level
- Build learning systems, that are self adapting
- Develop data structures that can make this possible
- Make supervised AI systems for process industries
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