Advanced control as a key to flexibility capabilities



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Hours per vea

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Background

Why automation and advanced controls are important part of future energy system?

Flexible production units ensure stable energy system.

Combustion based energy production plants will be a part of energy system for years ahead.

In changing environment, profitable operating models can be found from flexibility.

Production planning and optimization are in significant role.

Advanced control as a key to flexibility capabilities.

Wide range of knowledge is needed from market requirements to technical details to develop next generation control solutions.



Results 1

Combustion plant control strategies

Several combustion based boiler types exist, understanding of process specific restrictions and possibilities important

- Fluidized bed boilers (bubbling or circulating), grate boilers, pulverized coal fired boiler, gas boilers, industrial process specific units
- At first phase, the focus has been on biofuel and waste fired grate boilers

Research

- · Process challenges: long dead-time and time constant
- Research environment 1: MATLAB modelling
 - Results: Considering the water in the evaporation zone and the dry fuel in the thermal decomposition zone and the combustion power mass balances improve the loadfollowing capacity of the boiler. In addition, the amount of the fuel on the grate needs to be held very close the set point to avoid primary air and secondary air saturations and their unfavorable effects.
- Research environment 2: Simulations in control system virtual grate boiler model
 - Results: Model predictive controls (MPC) based control system to control steam flow with fuel feed and primary air flow gives good results.
- Improved process controllability stabilizes/increases the production and supports flexibility.





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Results 2

Concept of coordinated controls

Conventional coordination

 Matching fast turbine dynamics with slow boiler dynamics

New advanced coordination

- Dynamic matching
- Improved load change rate
 - Condensate stop
 - Overfiring
 - Adapting nonlinear characteristics
- Constraints
 - Load change rates
 - Stressing of structures
 - Emissions





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Results 3

Optimizing the district heating network supply temperature

Combined heat and power (CHP) plants as a link between district heating network (DHN) and electricity grid





Research Topic:

Optimizing the district heating network supply temperature

Results:

Optimization minimizes the heat delivery costs and the modelling of DHN also increases predictability and monitoring



Results 4

Combined heat and power plant grid balancing capabilities

Research Topic:

CHP plant grid balancing capabilities

Case examples: Coal firing CHP plant with DH accumulator

Picture 1:

Potential for fast changes in power production Note! Scaled y-axis, real variation +- 10 MW Picture 2:

Effect on DH Fluctuation in DH supply temperature occurs due to the fast changes

Result:

CHP plants can provide fast power level changes, but the changed heat production must be carefully considered in nearby DHN components





Conclusions

In the coming years, combustion plants will still be a part of energy system. Those plants will be more adaptive.

When structural restrictions and possibilities of plant components are known, functionalities are implemented by advanced controls.

Advanced control as a key to flexibility capabilities.

Economical benefits can be achieved by increasing the flexibility.

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