Some Advanced Ideas for Monitoring and Control of Small-Scale Combustion Appliances

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COMBUSTION CONTROL OF SMALL SCALE WOOD FIRED APPLIANCES
International workshop 17.6.2005
VTT Processes, Jyväskylä, Finland
Process Development and Automation in Small-Scale

• Process design issues are important
  – gasification
  – fuel feeding systems
  – heat storage, flue gas by-pass
  – combustion chambers, grates, air inlets
  – masonry, materials, dust removal
  → Controllability

• Automation is only part of the solution
Soft Sensors

- Inferential measurements

- Usually a mathematical model or models

- Utilisation of simple sensors, sensor fusion
  + fast response, inexpensive

- Also backup method for sensors and analysers?
CO-monitoring 1/2
Case: Batch Combustion of wood, 5 kW

SnO$_2$ -sensor
5mm x 5mm

+ Temperature +

Data-based model

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CO$_2$ [%, measured]

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CO$_2$ [%, model]
CO-monitoring 2/2
Case: a 300 kW boiler, fuel: wood chips

RMSE = 0.018 vol.-%
Monitoring of Heat Output, kW

Case: a 300 kW boiler, fuel: wood chips

RMSE = 37 kW

dt = 5min
Monitoring of flue gas $O_2$ vol.-%

Case: a 300 kW boiler, fuel: wood chips

RMSE_model = 1.6 vol.-%
RMSE_O2-sensor = 1.8 vol.-%
Extension of Control Horizon?

Knowledge extraction and Prediction

Extension

Control Environment

Fuel production
- Quality, w-%

Combustion system

Extension

Heat, electricity consumption
- Load changes
A Combustion Control Concept

Reconfigurability

User inputs

Change detection, Performance monitoring

Scheduling/Adaptation

Controller

Discrete event monitoring, Diagnostics

Models, Sensors

Combustion Process

User inputs

Change detection, Performance monitoring

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Discrete event monitoring, Diagnostics

Models, Sensors

Combustion Process
Conclusions

• Some ideas
  → Soft sensors for on-line combustion monitoring
  → Maximum information retrieval (data+environment)
  → Reconfigurable control

• Some potential consequences
  → Automatic maintenance of systems
  → Optimised energy production and consumption
References


