PID control of rotary lime kilns using decoupling control

26th Nordic Process Control Workshop

Technical University of Denmark, Kgs. Lyngby, Denmark,
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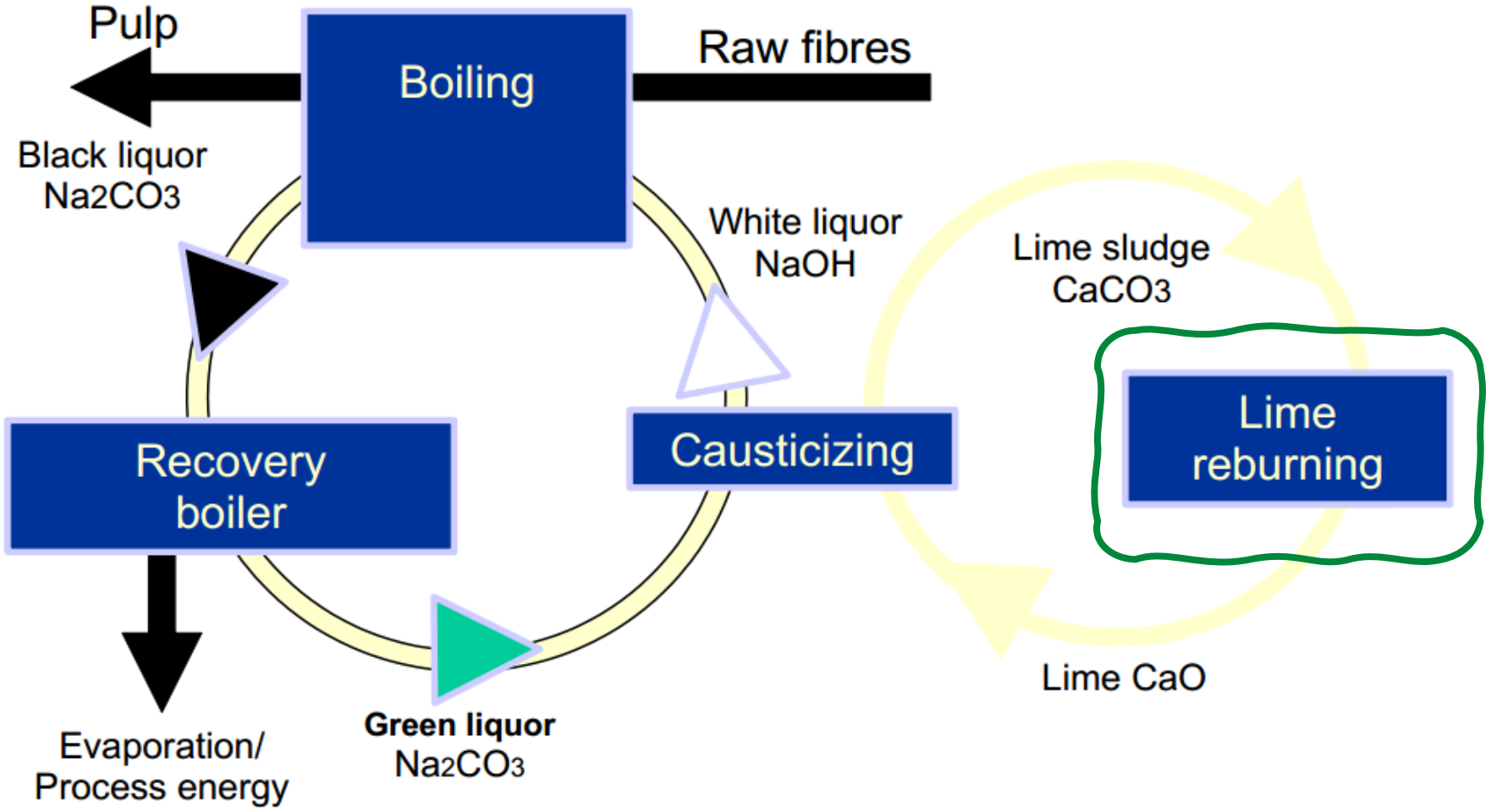
What is a Lime Kiln?

General Process



Lime kiln

Feed of lime sludge
$CaCO_3+H_20$

Output of lime
CaO

- Rotating steel pipe with brick insulation
- Length 55-135m
- Diameter 2.5-5m
- A few degrees slope for material transport

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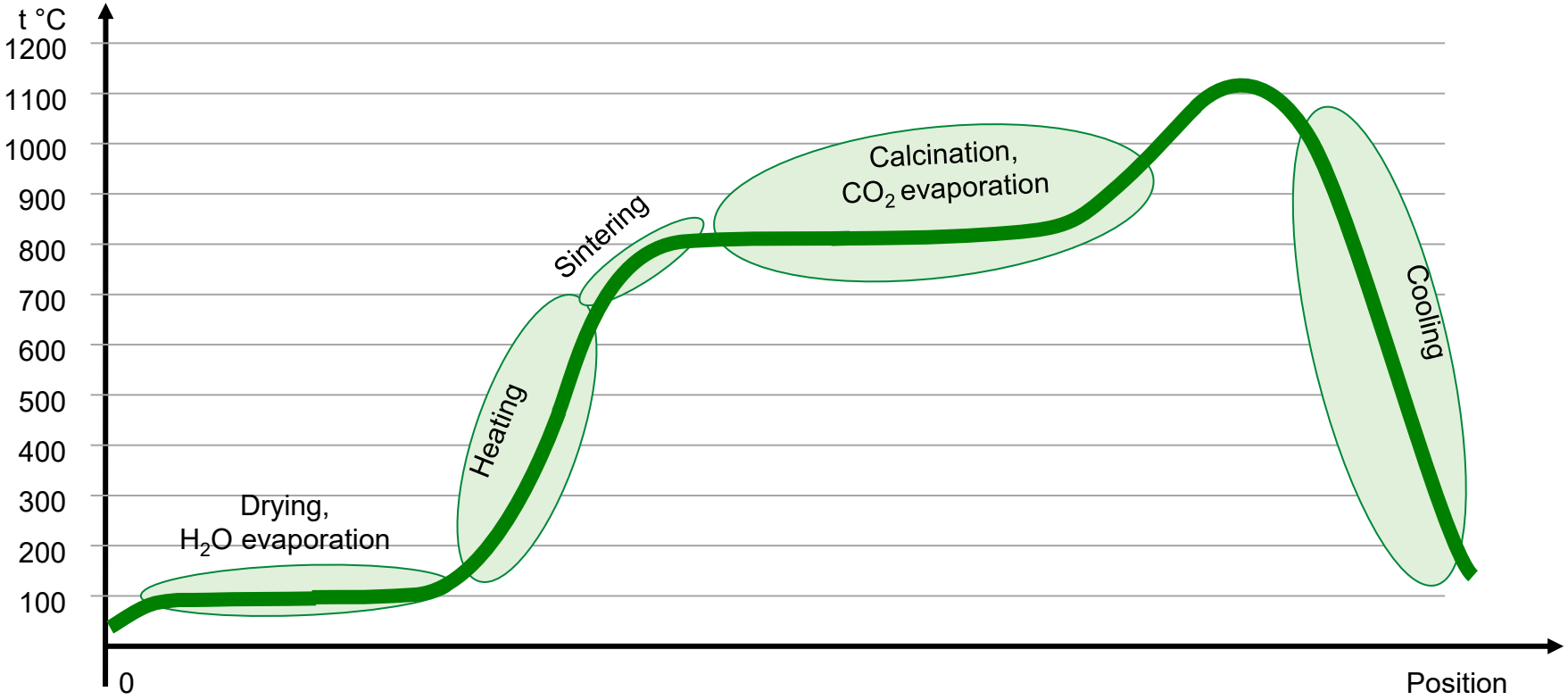
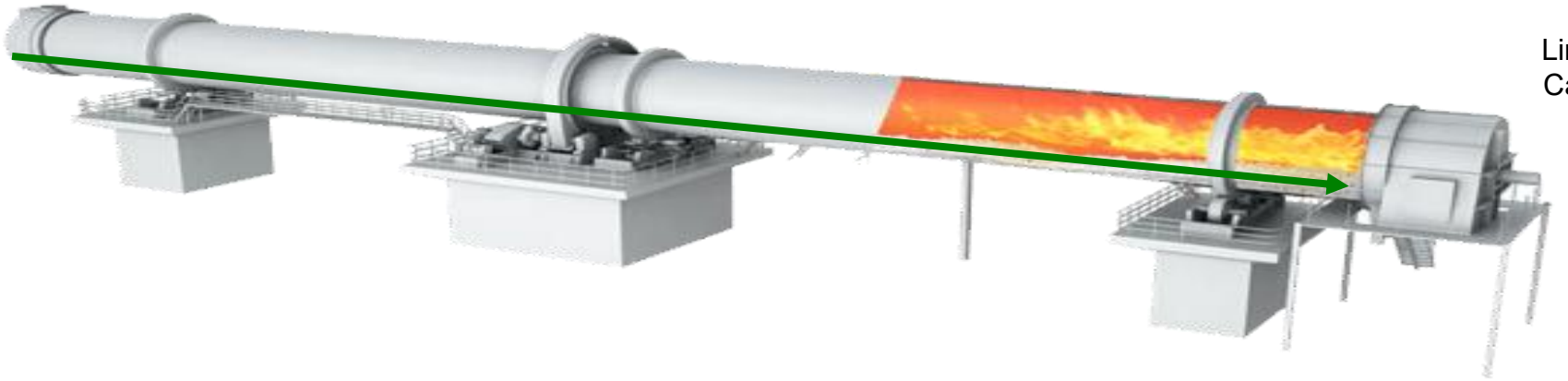
Lime Kiln Process



Lime mud
$CaCO_3+H_2O$



Lime
CaO

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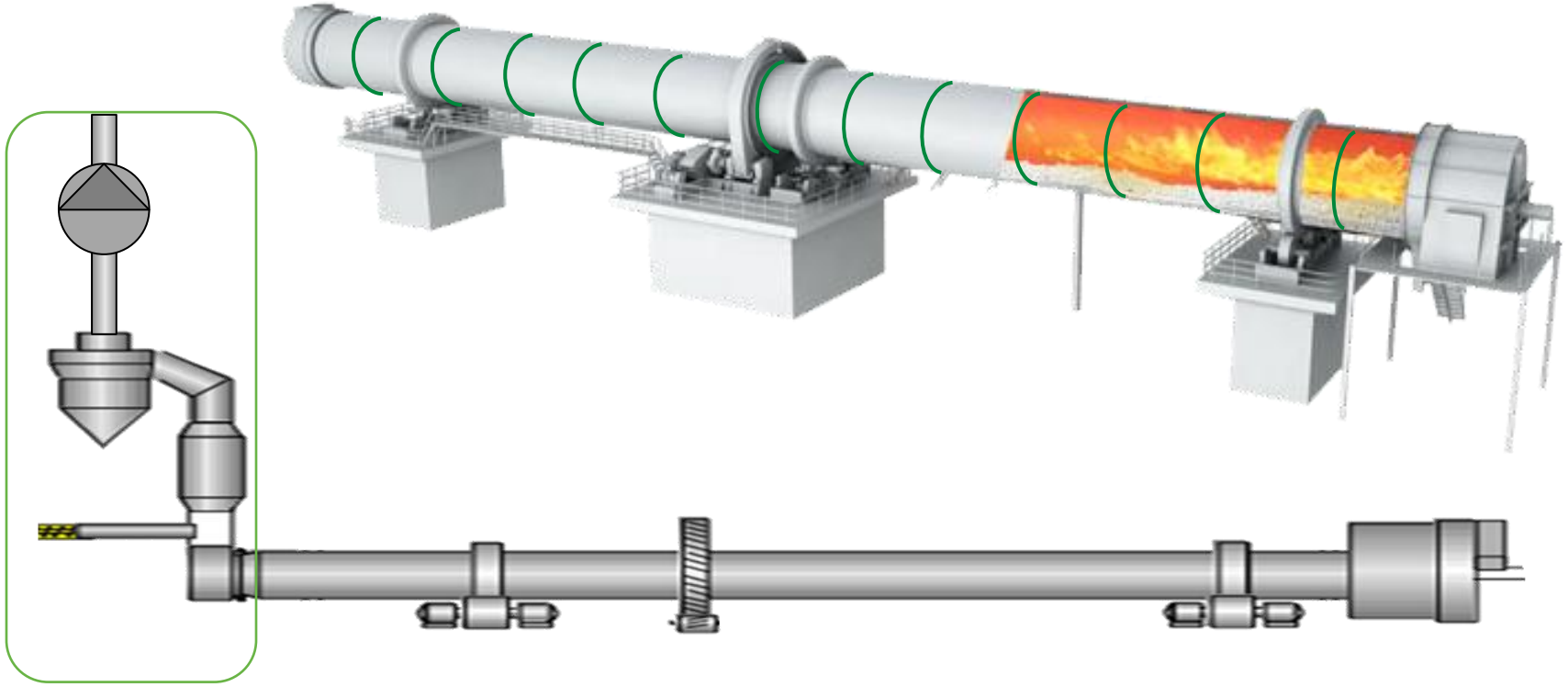
Lime Kiln Modeling

- First principles model
- Material transport
- Heat and chemical reactions
- Discrete space model



Flue gas

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Lime kiln model principles

Lime transportation

Flue gas flow

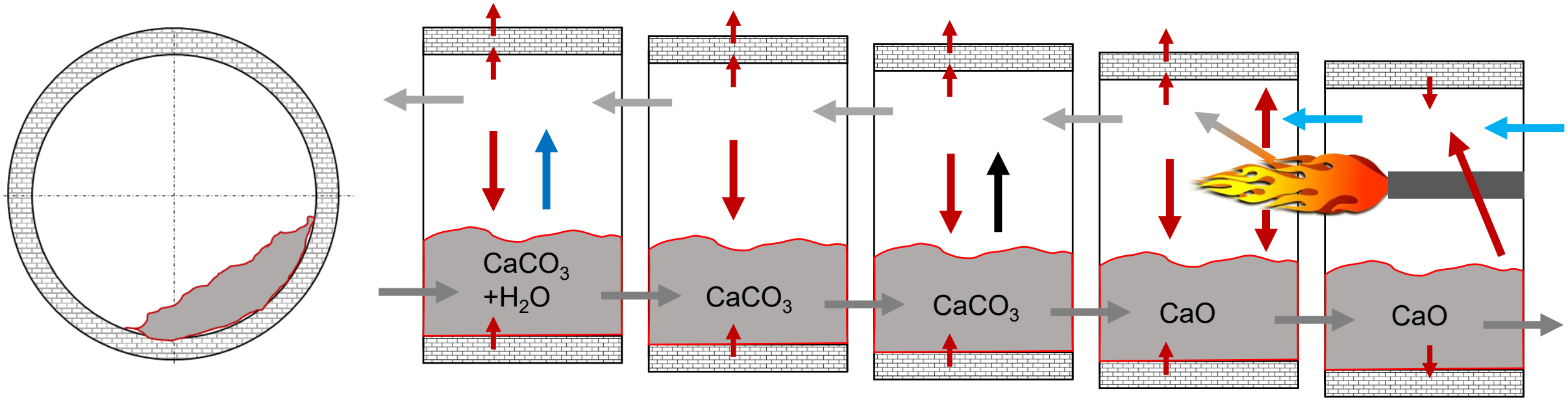
H_20 evaporation

CO_2 evaporation, calzination

Heat transportation

Burning of fuel to heat and flue gas

Combustion air



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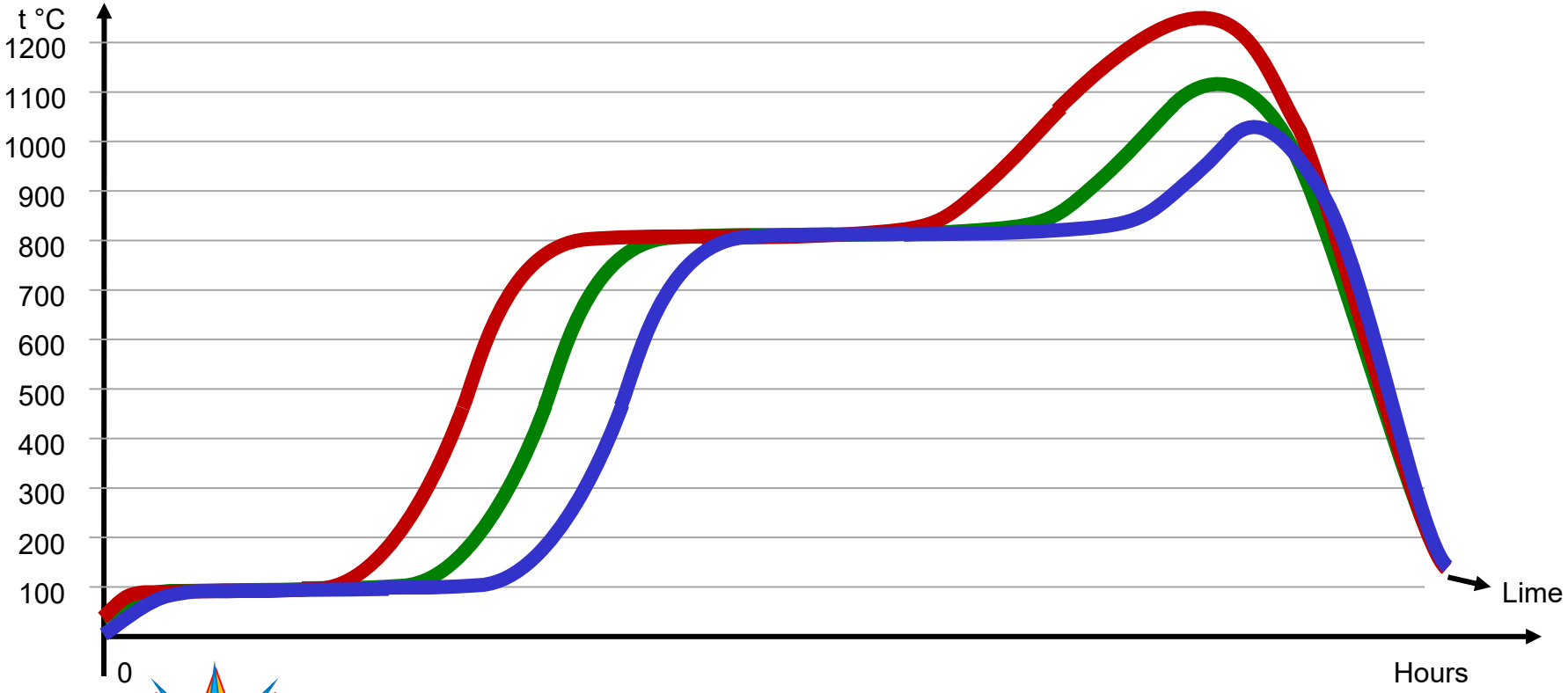
t °C
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Hours
Lime

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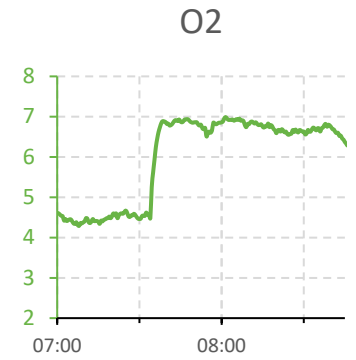
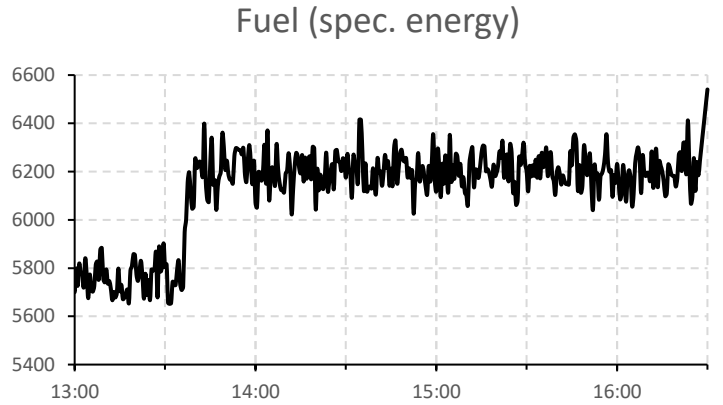
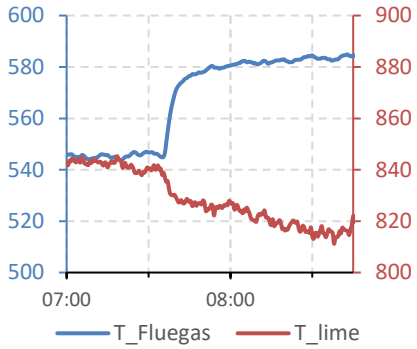
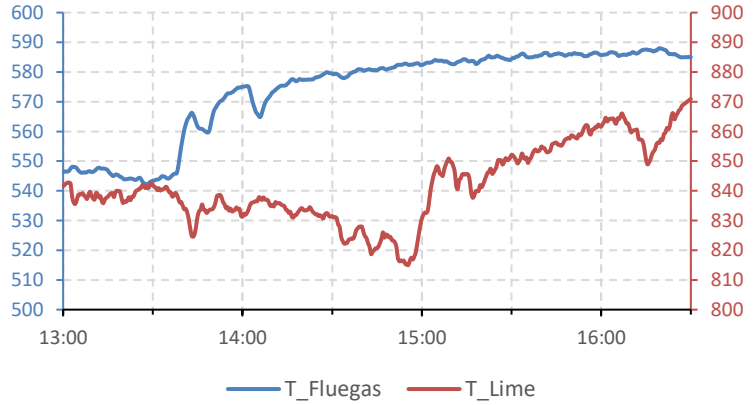
Traditional control

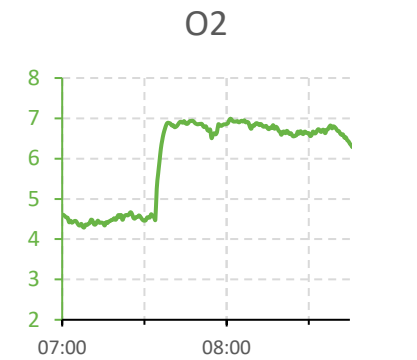


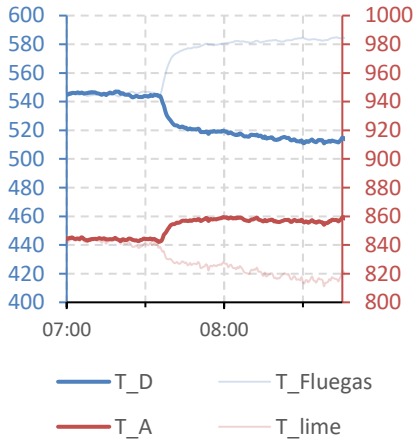


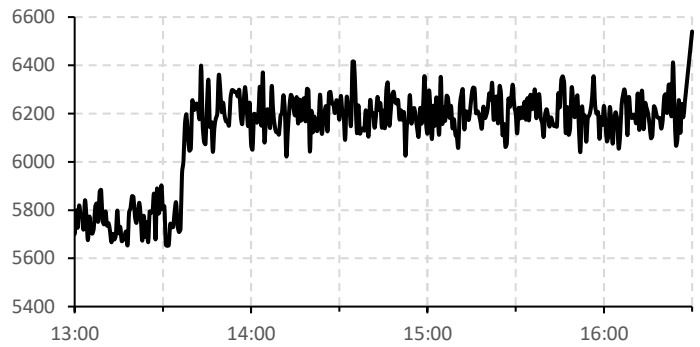


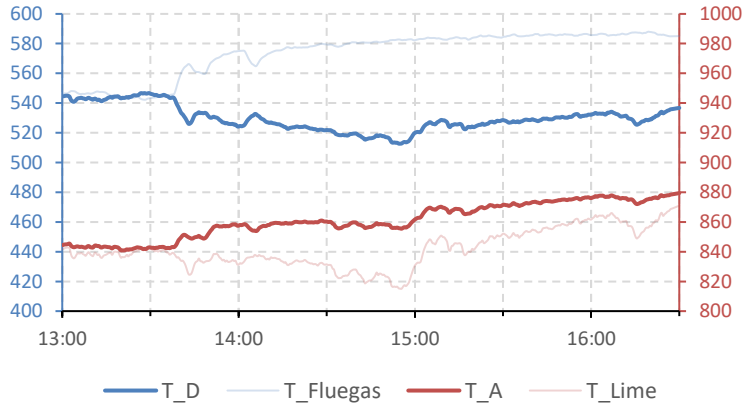


Decoupled control









Result

- Reduced energy consumption
  (typical 5-10%, 3-5 MSEK savings/year)
- Implemented in your DCS system
  (no extra equipment or black box)
- Handle production changes and multiple fuels
- Reduced maintenance costs due to less brick wear and ring formations in the kiln
- More stable process, both in the kiln and subsequent process steps
- Better product quality on the lime produced
- Releases valuable time for the operators
- Patented solution

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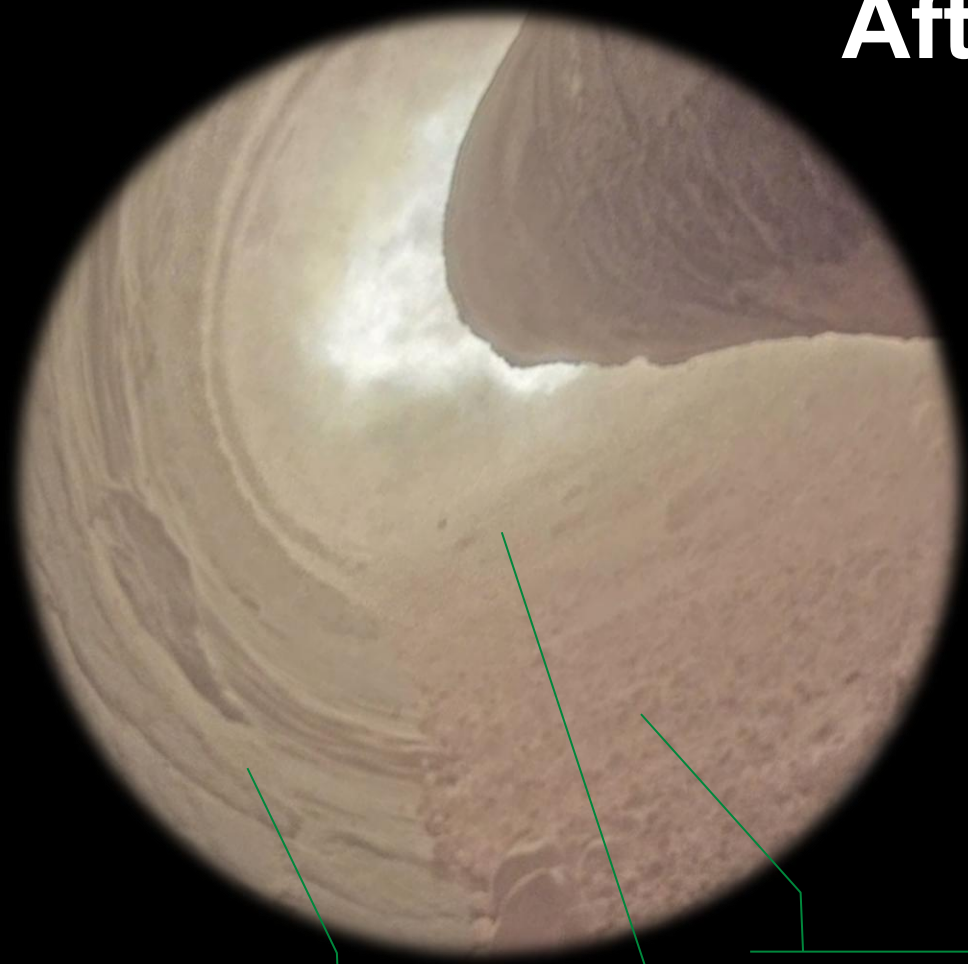
Before

A lot of lime built up on the walls of the kiln, which makes the formation of rings more likely

Fine materials in the lime is the base for dust in the kiln

Sight is limited due to dust, and dust reduces the efficiency of the kiln

After



Essentially no lime built up on the walls of the kiln

The lime is more granulated

The view is clearer, and you can se details much further in the kiln, which means that there is less dust

Thank you for listening

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