Detailed models for ignition and combustion of waste

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Introduction

- Introduction
- 2D front propagation
- Spontaneous ignition
- Conclusions

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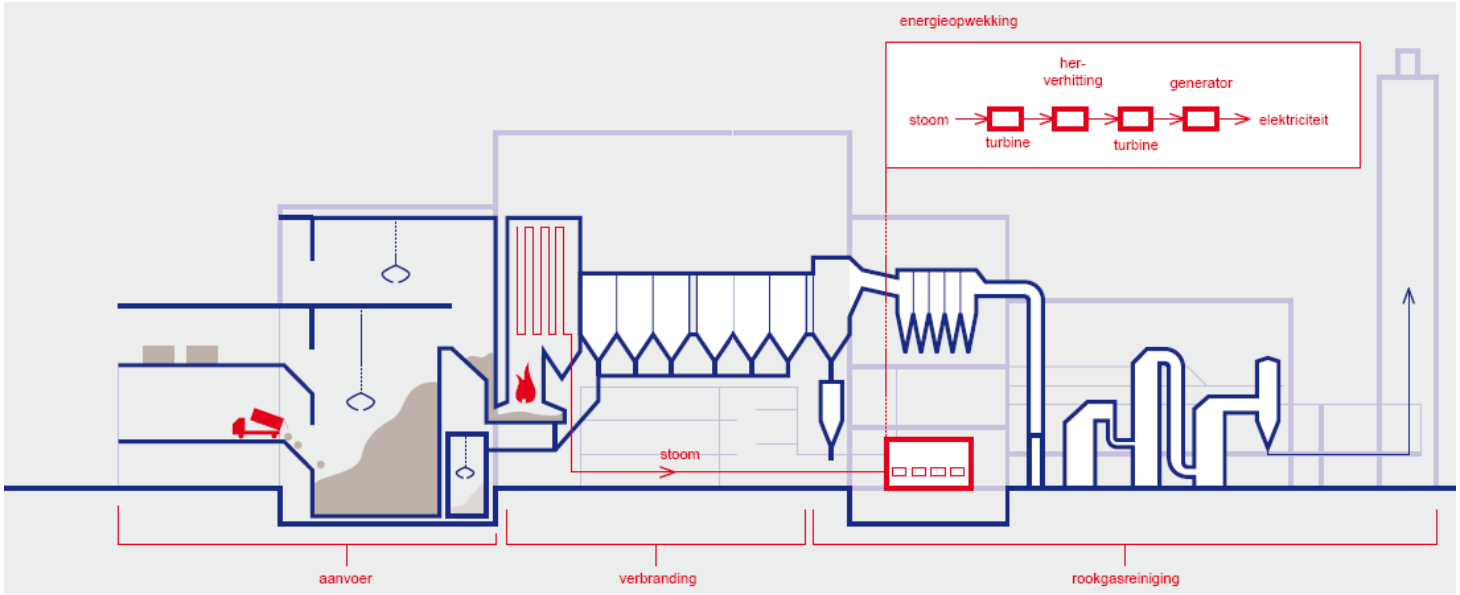
Introduction

- How to deal with this?



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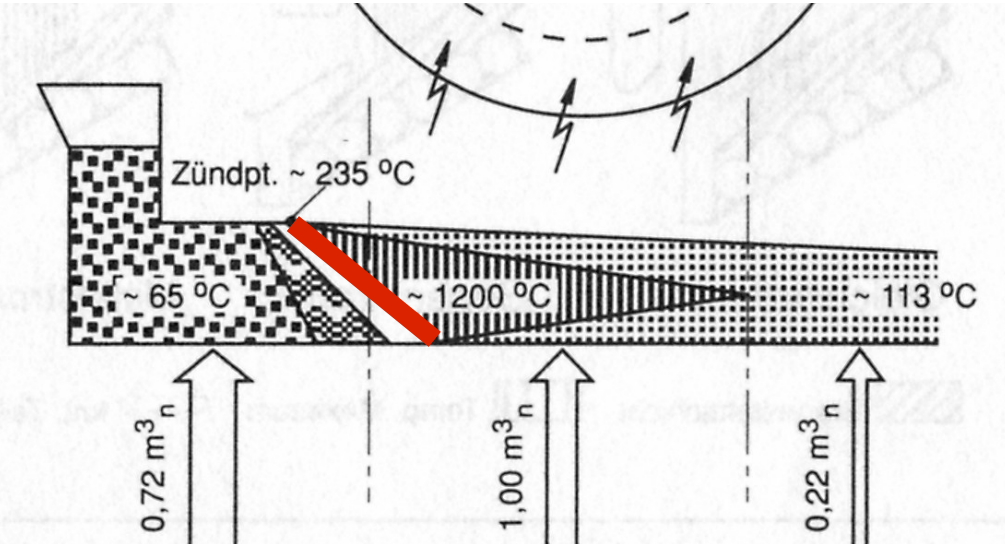
Research goal

- Ignition behaviour of waste



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2D front propagation

- Experimental

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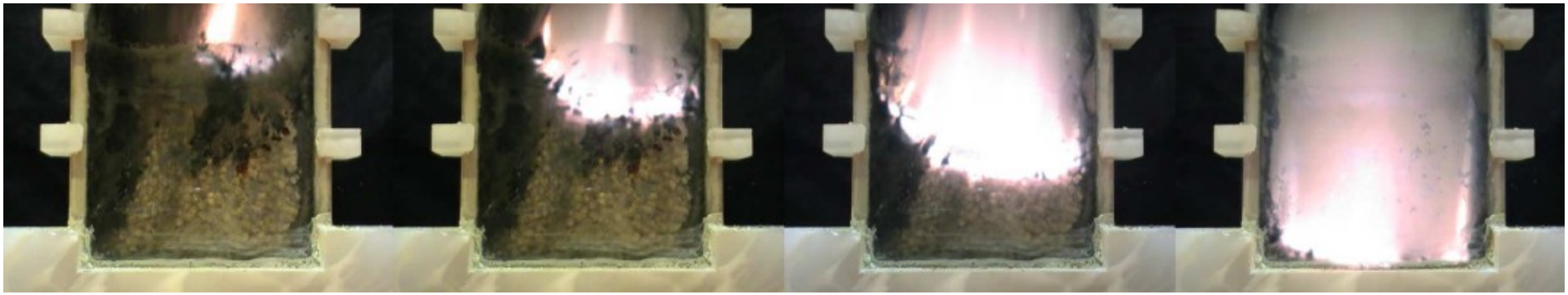
2D front propagation

- Results



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2D front propagation

- Results

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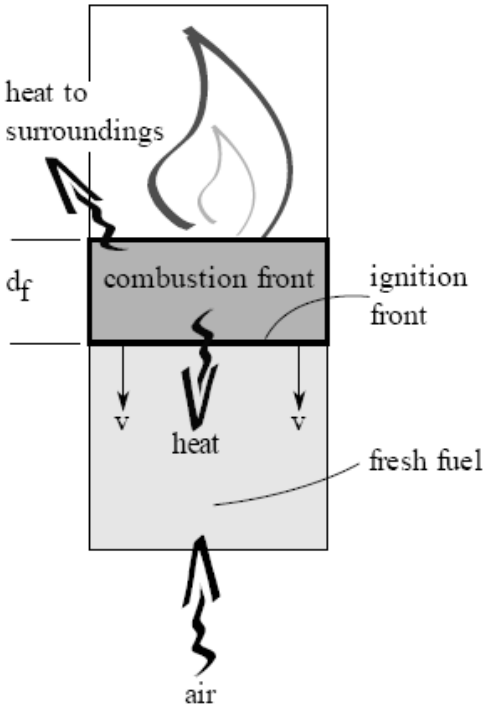
2D front propagation

- Modeling



Energy balance combustion front

$$\sigma e(T_f^4 - T_0^4) + hA_s d_f(T_f - T_0) = \dot{m}_c'' \Delta H - \dot{q}_0''$$

Energy balance ignition front

$$v_f \rho_s c_{p,s}(T_f - T_0) = \sigma e(T_f^4 - T_0^4)$$

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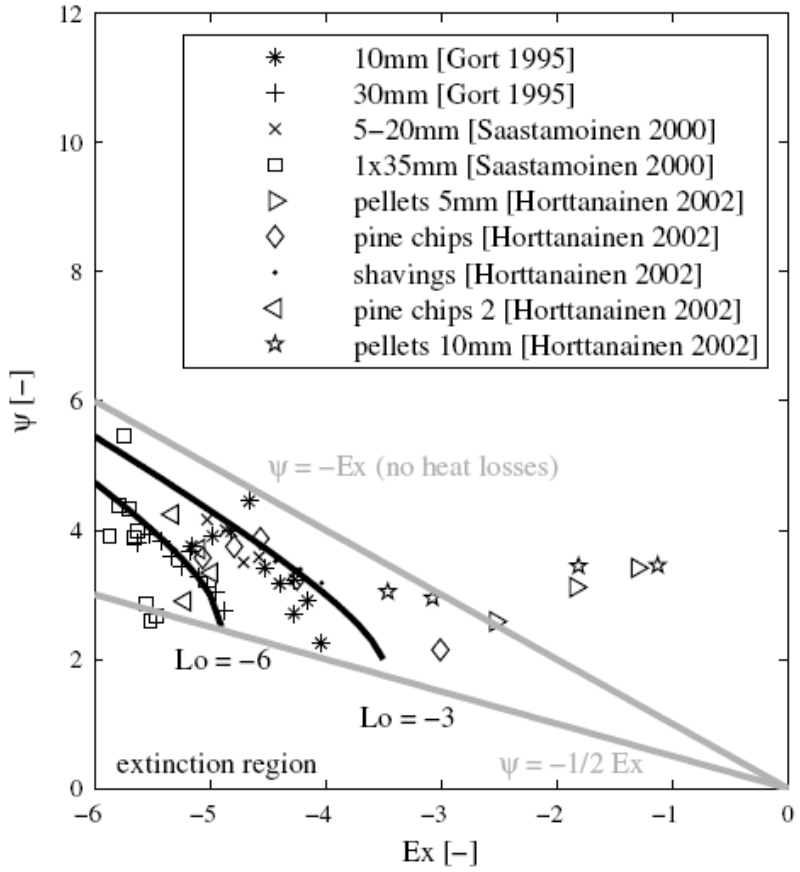
2D front propagation

- Results



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2D front propagation

- Conclusions
  - Char combustion is the mean heat source;
  - Trends are predicted well;
  - Upper and lower boundaries for the front velocity.

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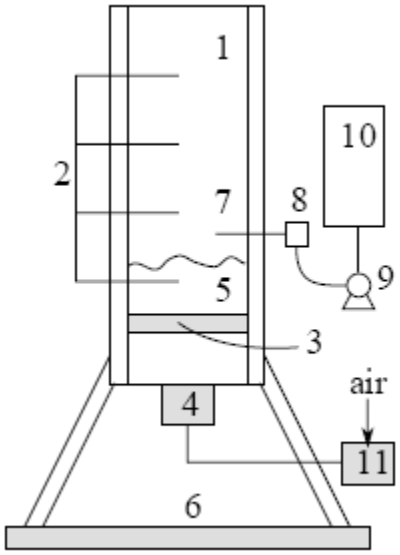
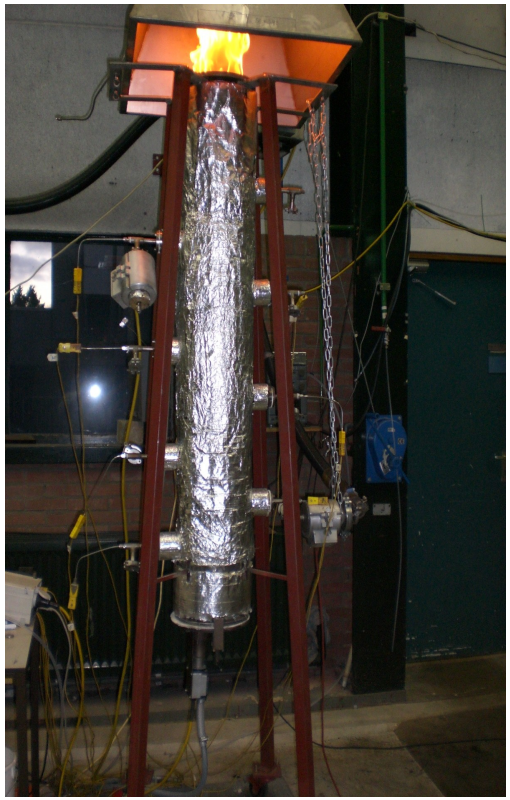
Spontaneous ignition

- Experimental





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Spontaneous ignition

- Fuels





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Spontaneous ignition

- To be measured

- Critical air temperature
- Auto-ignition temperature
- Time to ignition
- Location of ignition

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Spontaneous ignition

- To be varied

- Fuel type (wood, char)
- Primary air velocity (0.1 – 0.5 m/s)
- Percentage inert (0 – 40 wt%)
- Moisture (10 – 50 wt%)
- Char particle size (1 – 4 cm)

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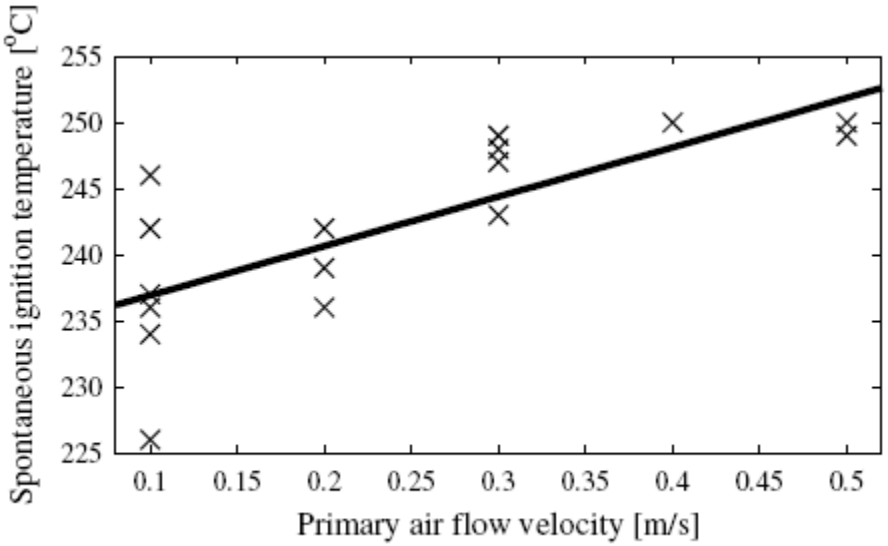
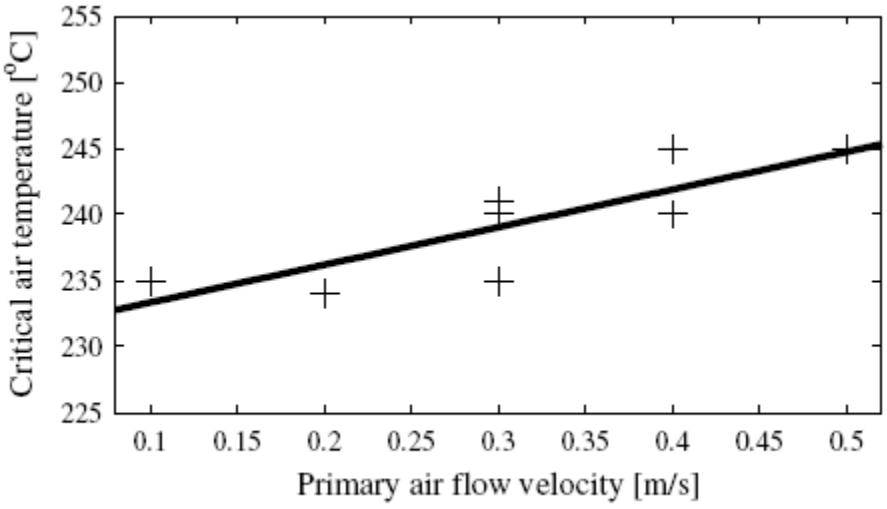
Spontaneous ignition

- Wood



(a) Spontaneous ignition temperature



(b) Critical air temperature

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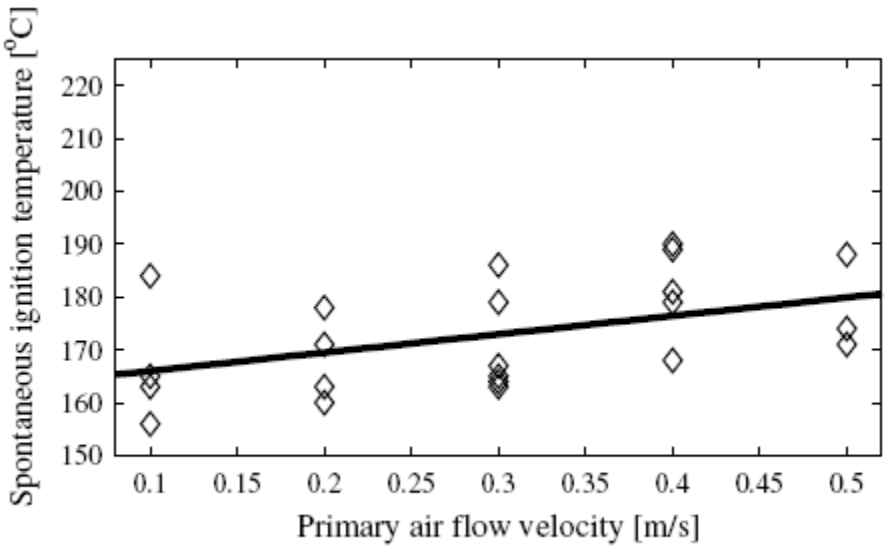
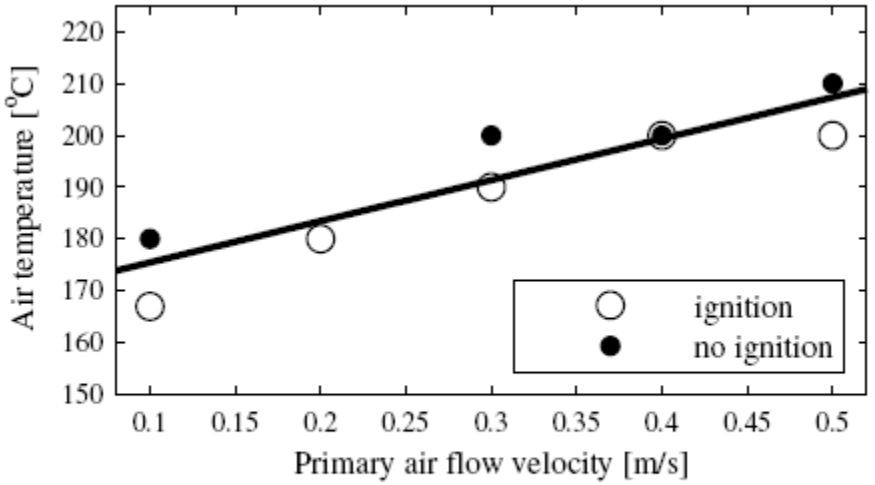
Spontaneous ignition

- Char



(a) Spontaneous ignition temperature



(b) Minimum measured air temperature at which ignition did occur (open symbols) and maximum measured air temperature at which ignition did not occur (closed symbols).

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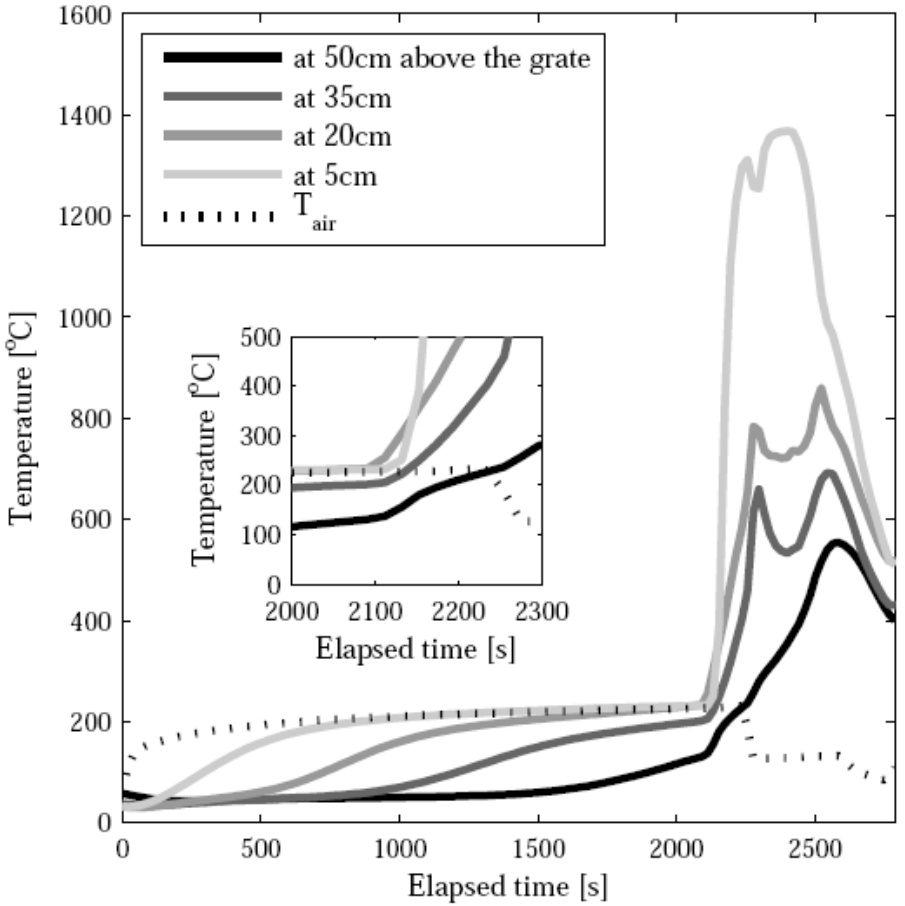
Spontaneous ignition

- Location of ignition
- 0.2 m/s
- Ignition 20cm above the grate



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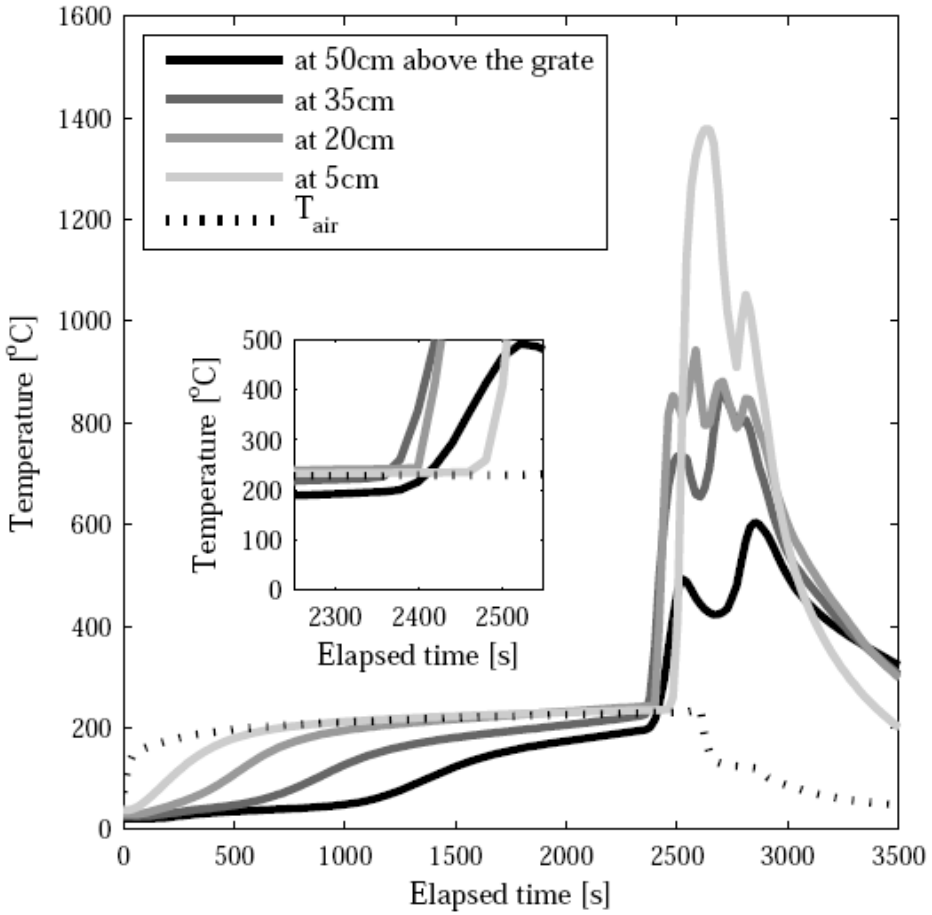
Spontaneous ignition

- Location of ignition
- 0.3 m/s
- Ignition 35cm above the grate



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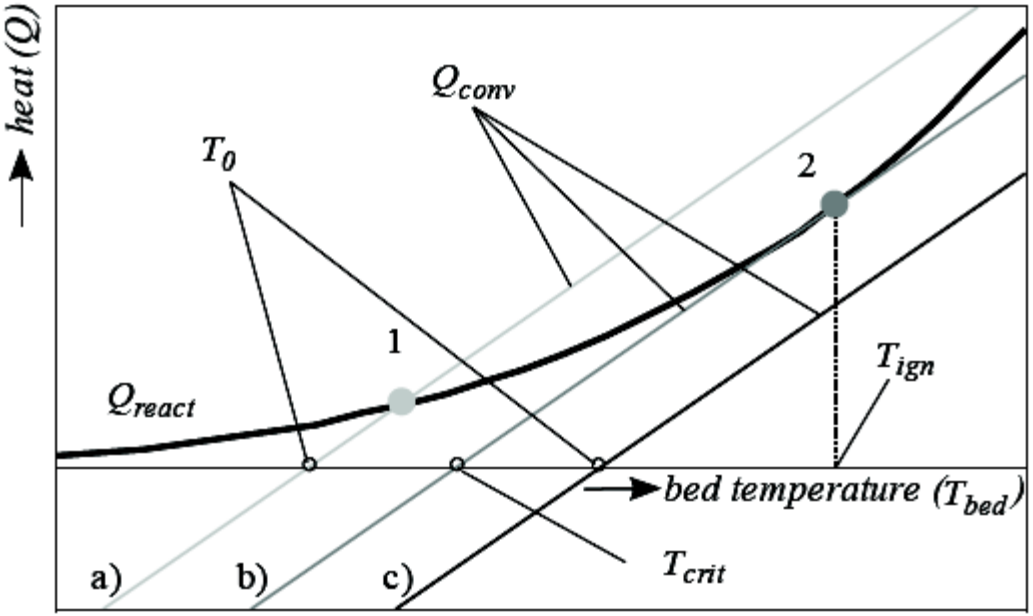
Spontaneous ignition

- Modeling



$$\dot{q}''_{conv} = h(T_a - T_{bed})A_s d_{bed}$$

$$\dot{q}''_{react} = K\Delta H d_{bed}$$

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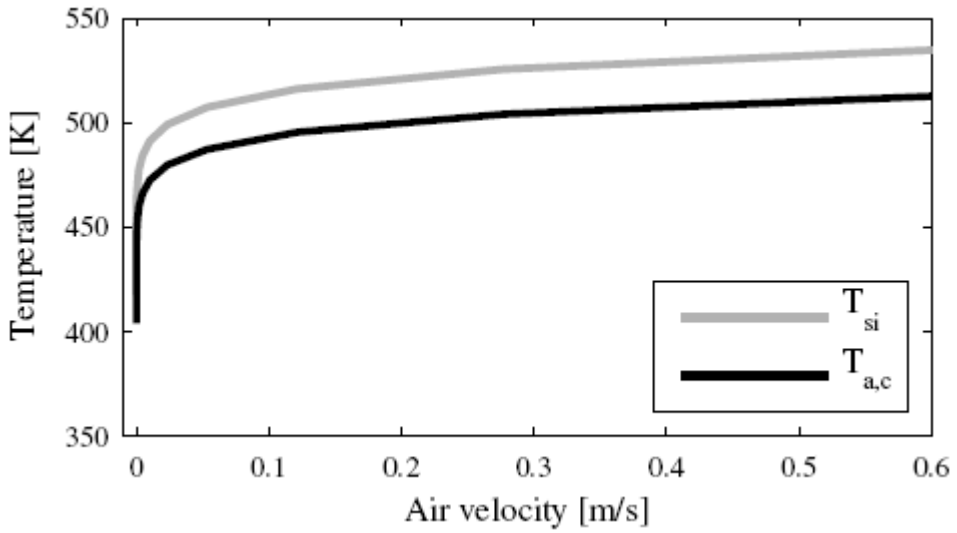
Spontaneous ignition

- Results



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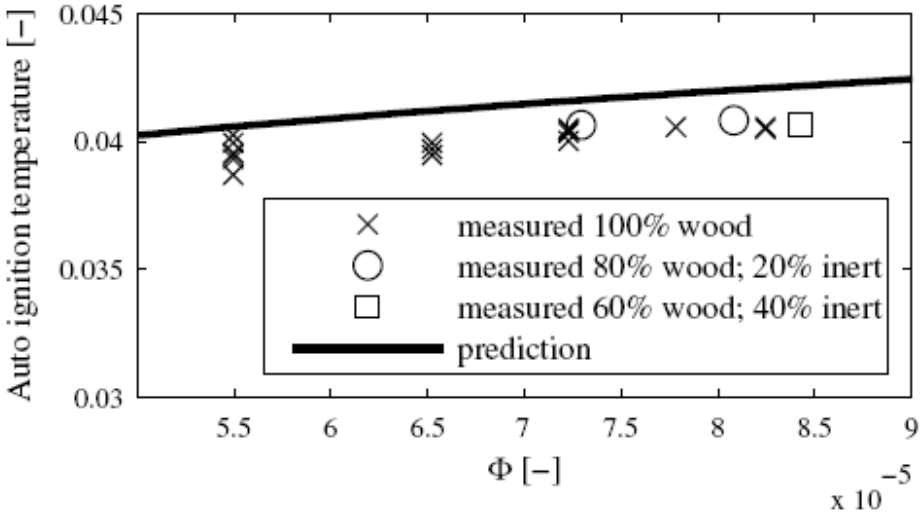
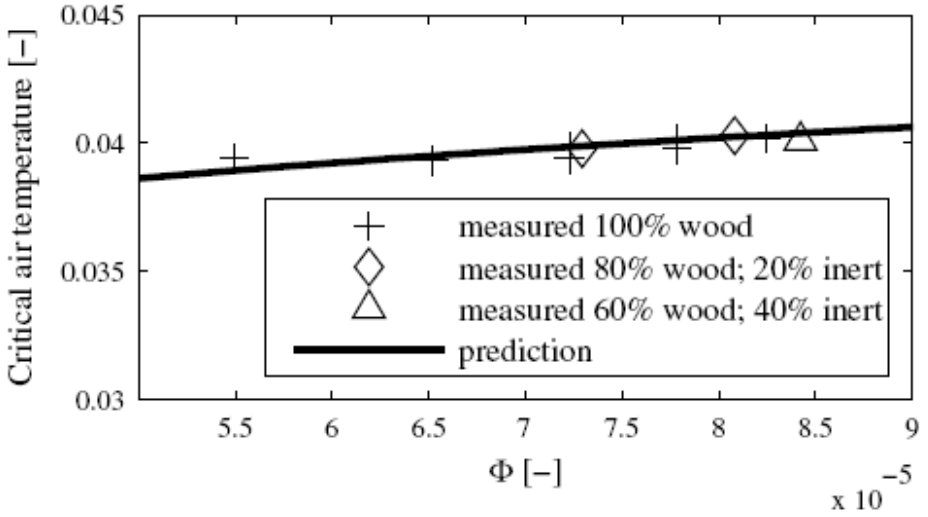
Spontaneous ignition

- Results





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Spontaneous ignition

- Conclusions
  - Critical air temperature for wood: 230-245°C
  - Critical air temperature for char: 170-200°C
  - More inert → higher air temperature needed
  - Ignition does not take place at the grate

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