Investigations on smoldering combustion at the RWTH Aachen

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OUTLINE

- Research interests at the IAM
- Experimental investigation on smoldering combustion of cork
- Numerical simulations of combustion processes in packed beds

Research interests at the Institut für Allgemeine Mechanik (IAM)

- Shock tube investigations
  - measurement of ignition delay times of gaseous fuels (and droplets)
  - self ignition phenomena
  - interaction of shock waves with obstacles
- Turbulent flame propagation
  - Single stroke engine
  - Influence of turbulence on partially confined gas explosions
  - Influence of turbulence on dust explosions
- Surface processes
  - Chemical vapor deposition (CVD)
  - Condensation and evaporation of Iodine
- Bulk combustion
  - Combustion of graphite and effects of particle release
  - Smoldering combustion of cork in stagnation point flow
  - Ignition of heterogenous and homogenous reactions in packed beds

Smoldering combustion of cork in stagnation point flow

Willi Braunschädel

- Principle idea of experiment
- Experimental setup and procedure
- Data of Cork
- Example of measured data
- Results
  - Thickness of reaction zone
  - Smoldering velocity and maximum temperature
  - self ignition of pyrolysis gases
  - spark ignition of pyrolysis gases
  - analysis of pyrolysis gases

Data of cork

Spark ignition of pyrolysis gases

Pyrolysis gases could ALWAYS be ignited

- analysis of pyrolysis gases gives concentrations which should not allow ignition
- presence of smoke particles

Ignition of heterogeneous and homogeneous reactions in packed beds

Dirk Reinelt
Eckhard Scheidemann

- Physical System
- Governing equations (sorry)
- Heterogeneous reactions
- Homogeneous and heterogeneous reactions

Simplifications for packed bed

- constant particle density
- constant particle radius
- constant pressure in packed bed
- thermal equilibrium of particles and gas
- same constant c_p and D for all species
- no homogeneous reaction

Summary

- Experimental results for smoldering combustion of cork in a well defined stagnation point flow were presented:
  - smoldering velocity
  - smoldering temperature
  - Ignition and composition of pyrolysis gases
- Essential features of the interaction of homogeneous and heterogeneous reactions in a similar system with well known chemistry were numerically simulated
  - Governing equations were derived
  - Different modes of the system were identified
  - Influence of relevant parameters was investigated

- **Lots of questions left for further investigations !**