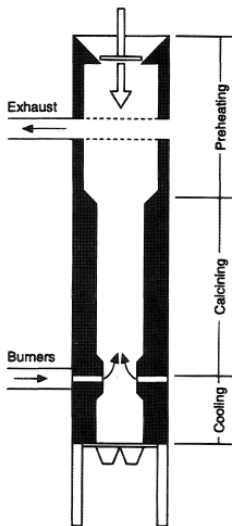COMSOL
CONFERENCE
ROTTERDAM*2013*

Modeling of Turbulent Combustion in Comsol Multiphysics

Domenico Lahaye (TU Delft)
ta.twi.tudelft.nl/nw/users/domenico
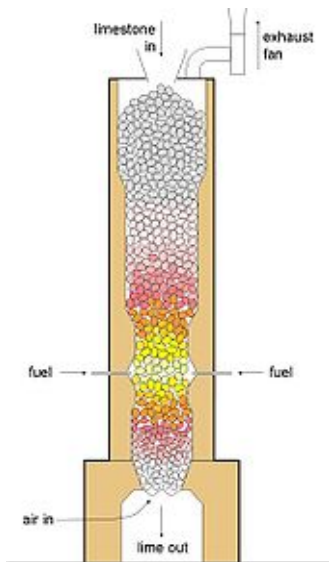
and Lu Cheng (Tsingua University)

COMSOL Users Conference - Rotterdam - 2013

Vertical Shaft Kiln

- downward flow of material undergoing calcination reactions

- upward flow of air feeding the combustion

- used e.g. in production of lime stone

Questions

- temperature and radiative heat in furnace?

- material heat up, mixing and reactions?

- here: empty furnace

Modeling Turbulent Combustion

<center>combustion = flow + chemistry</center>

- turbulent flow of non-isothermal gas through the furnace

- chemistry of fuel and oxidizer producing heat

Modeling Turbulent Combustion

<div style="text-align:center">

combustion = flow + chemistry

</div>

- turbulent flow of non-isothermal gas through the furnace
  - Reynolds-Averaged Navier-Stokes
  - k-ϵ turbulence model
  - convection-diffusion-reaction equation for hydrocarbons
  - conjugate heat transfer for the thermally insulating lining

- chemistry of fuel and oxidizer producing heat
  - mixing and reaction of fuel (methane) and oxidizer
  - resulting in combustion products and heat
  - eddy break-up model (mixed is burnt)

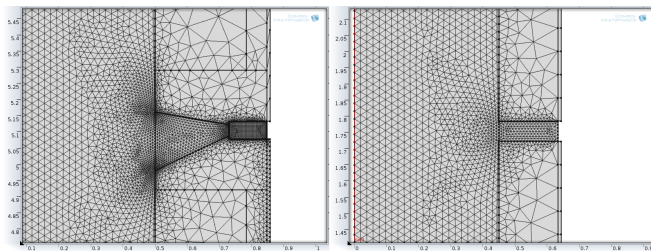# Modeling Combustion in Comsol Multiphysics

In the Comsol Multiphysics CFD Module

- implementing eddy break-up reaction rates

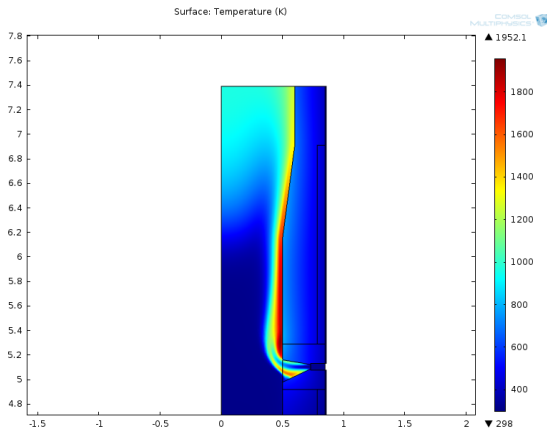- implementing the energy source terms

Numerical Results
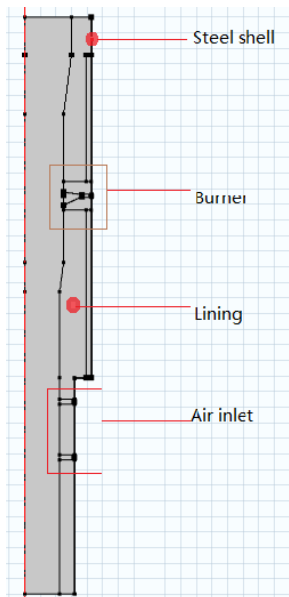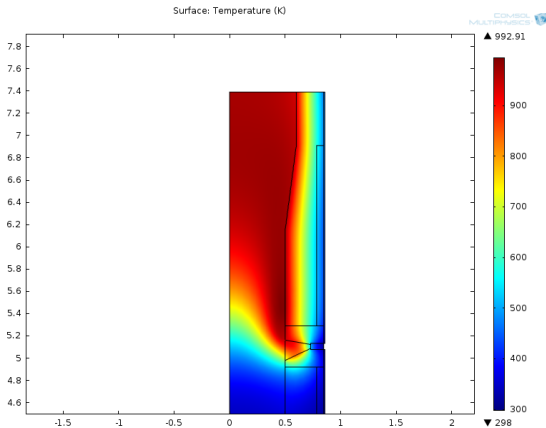
Numerical Results

Mesh around burner (left) and air inlet (right)

Numerical Results

Temperature around the burner

Numerical Results

Temperature around the burner assuming material in furnace

Conclusions

- eddy break-up model for turbulent combustion was implemented in Comsol Multiphysics

- empty furnaces model shows steep temperature gradients on the wall

- future work needed to extend to furnace including material