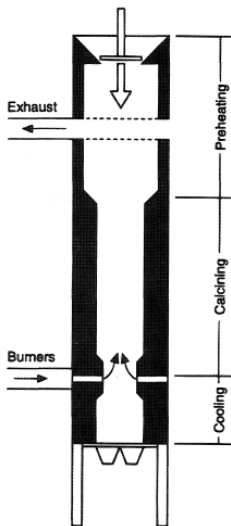# Modeling of Turbulent Combustion in Comsol Multiphysics

Domenico Lahaye (TU Delft)
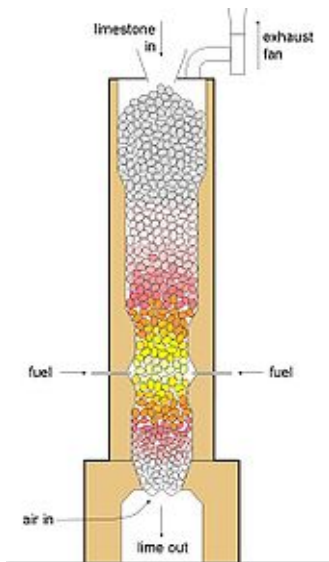ta.twi.tudelft.nl/nw/users/domenico

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

combustion = flow + chemistry

- turbulent flow of non-isothermal gas through the furnace

- chemistry of fuel and oxidizer producing heat

Modeling Turbulent Combustion

combustion = flow + chemistry

- 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)

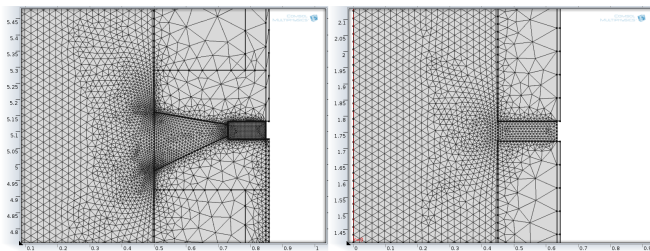# Modeling Combustion in Comsol Multiphysics

In the Comsol Multiphysics CFD Module

- implementing eddy break-up reaction rates

- implementing the energy source terms

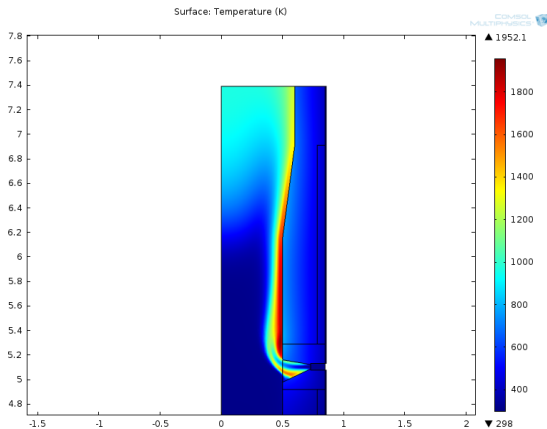# Numerical Results
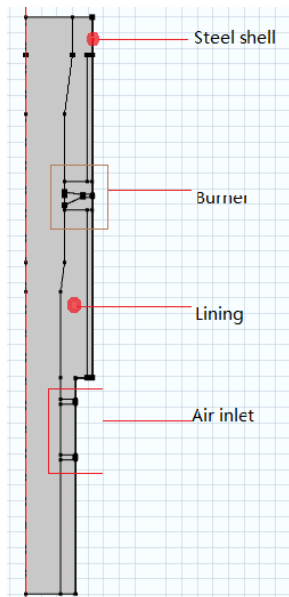
Numerical Results

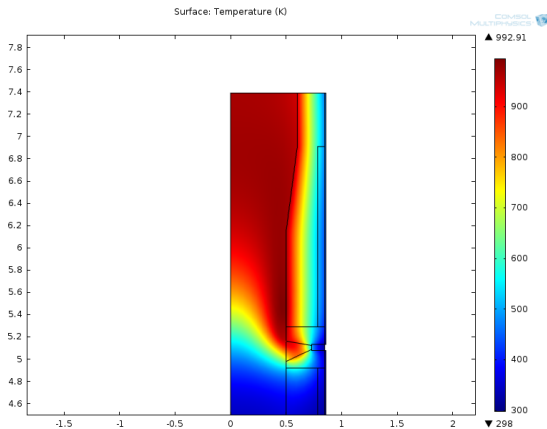Mesh around burner (left) and air inlet (right)

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