Numerical Modeling of Anode Baking Furnace with COMSOL Multiphysics®

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Figure 1. Anode baking furnace at Aluchemie, Rotterdam

INTRODUCTION:

- Anodes account for 15% of costs in Aluminium industries
- Anode baking process is important to obtain the necessary properties of Anodes
- Optimization is needed to have balance of different process goals

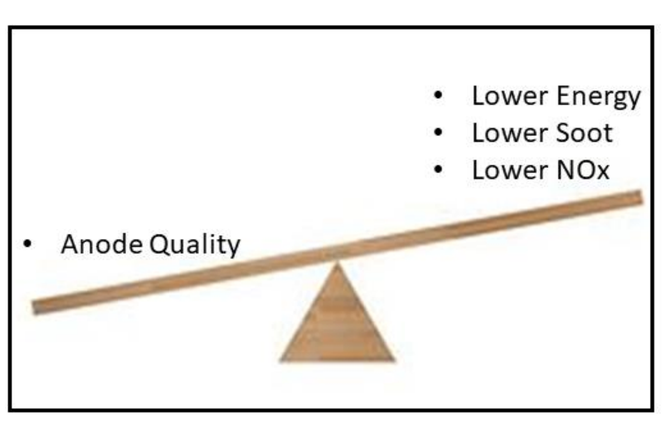

Figure 2. Balance of different process goals

COMPUTATIONAL METHODS:

Governing differential equations are:

- Continuity equation for fluid flow
- Navier-Stokes equation
- Equations for turbulence
  - k-ε turbulence model
  - Spalart-Allmaras model
- Transport equation for 5 chemical species
  - Eddy dissipation algebraic equation for modeling combustion
- P1 radiation model

GEOMETRY OF MODEL:

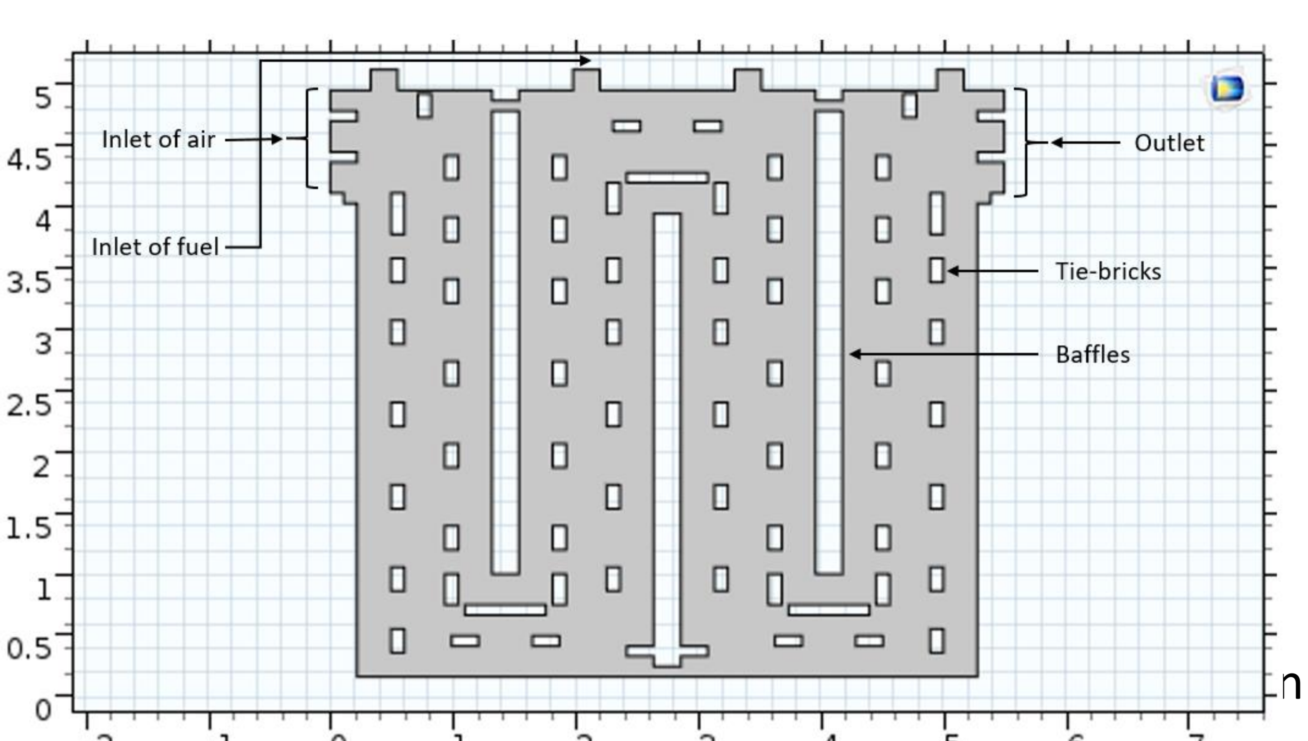

Figure 3. Geometry of model

RESULTS:

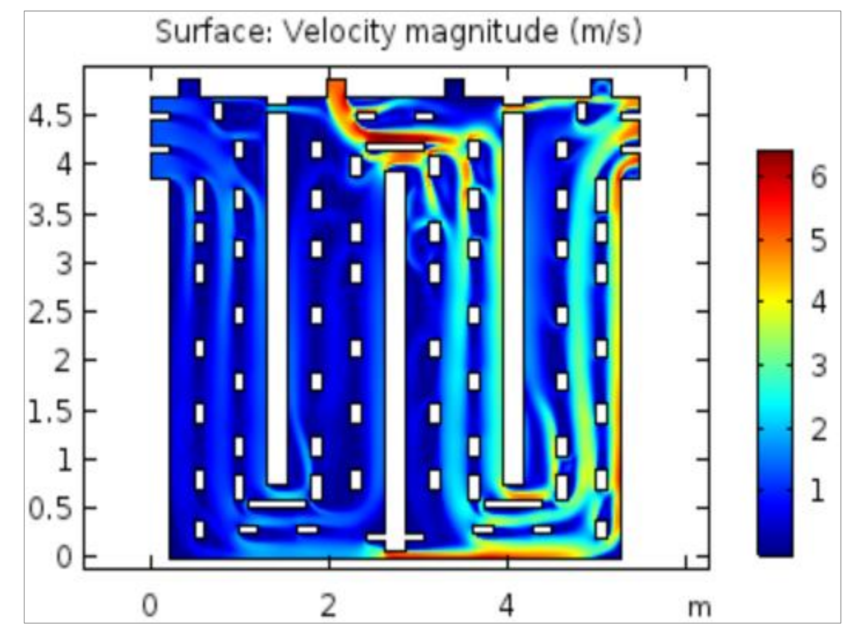

Figure 4. Velocity magnitude

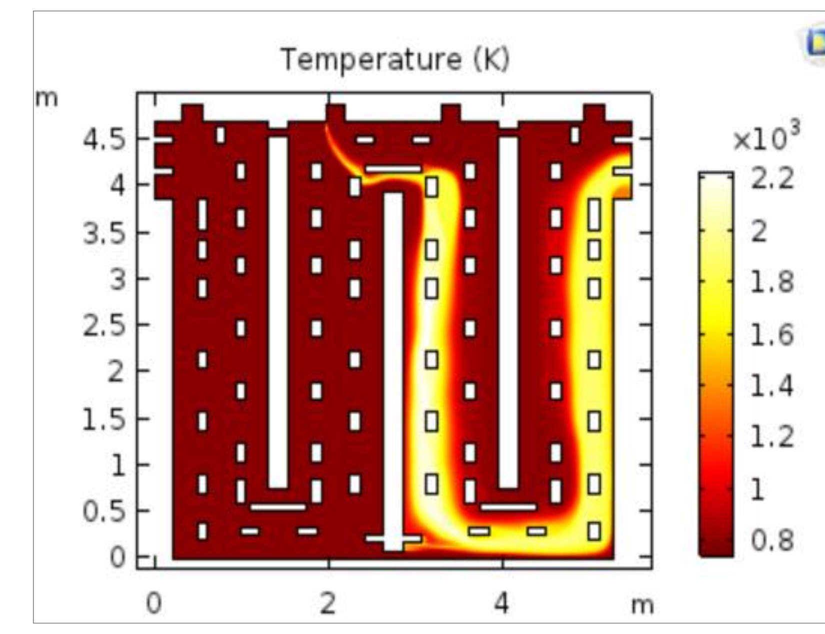

Figure 5. Temperature field

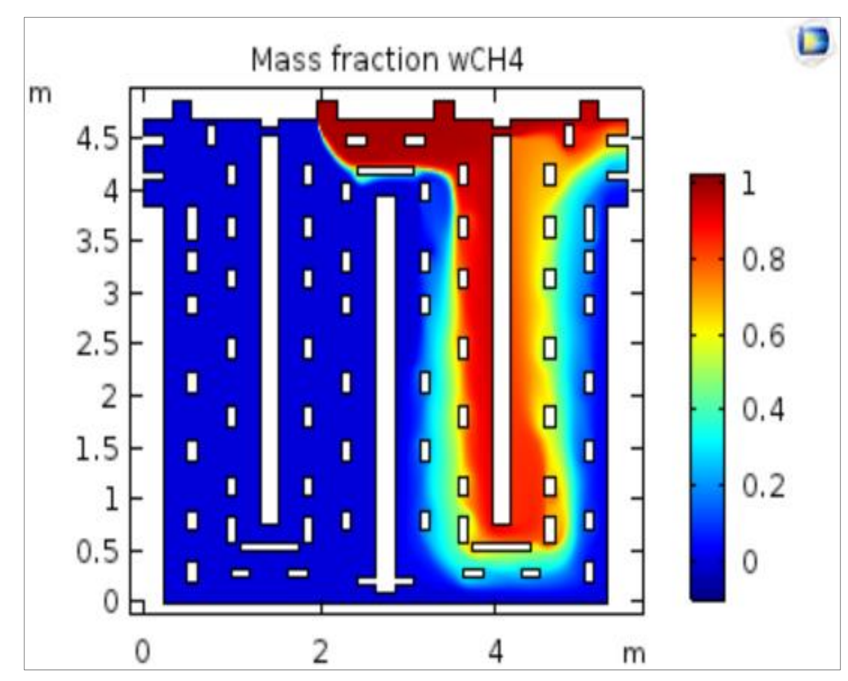

Figure 6. Mass fraction of CH_4

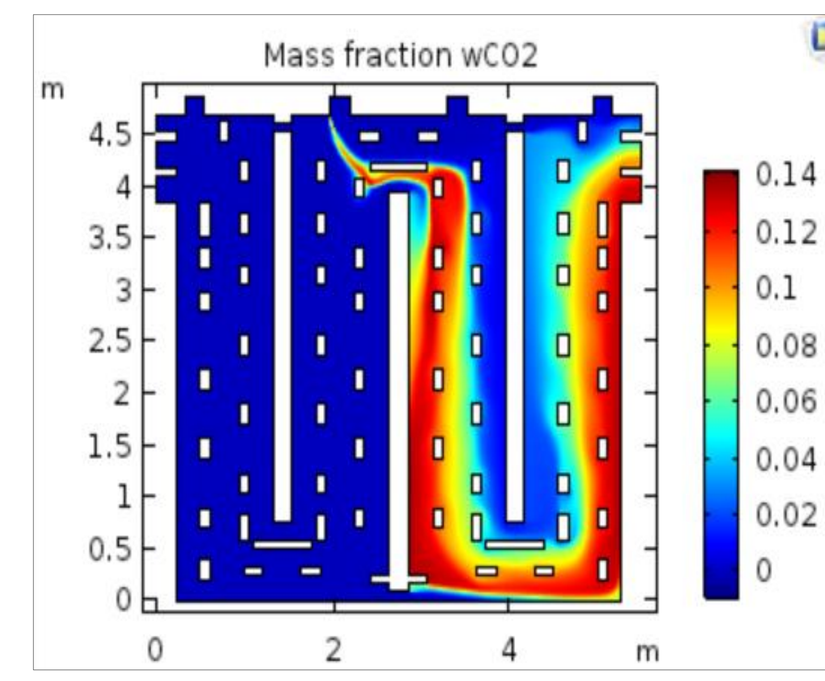

Figure 7. Mass fraction of CO_2

Validation of flow field:

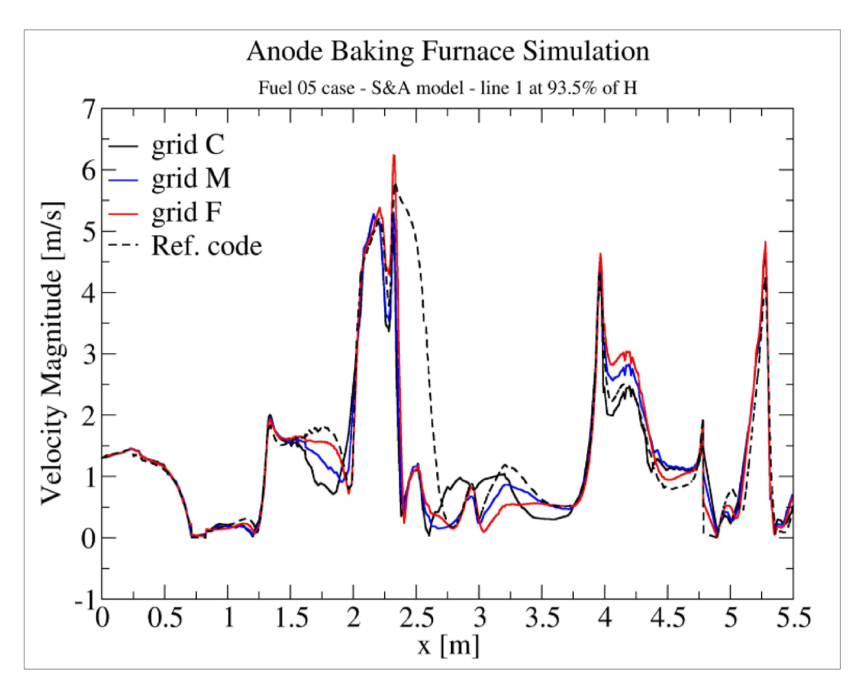

Figure 8. Comparison of velocity with IB-Raptor code

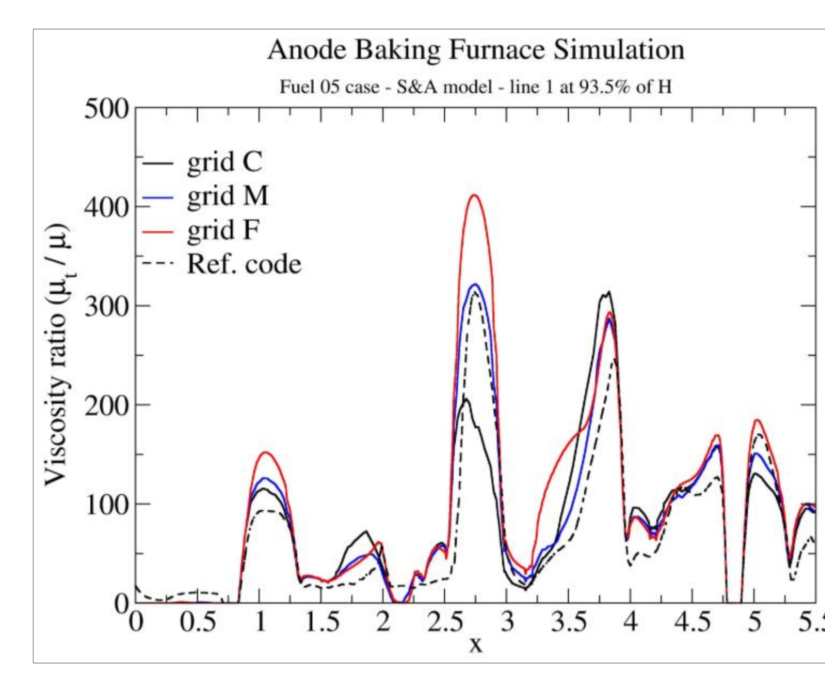

Figure 9. Comparison of viscosity ratio with IB-Raptor code

CONCLUSIONS:

- COMSOL Multiphysics® provide comparable results with another simulation environment
- Eddy dissipation module of COMSOL Multiphysics® provides realizable results for given air-fuel ratio

REFERENCES:

1. P. Nakate, 2017. "Mathematical Modeling of Combustion Reactions in Turbulent Flow of Anode Baking Process". DIAM report 17-10, Delft university of technology
2. P. Nakate, D. Lahaye, C. Vuik and M. Talice, "SYSTEMATIC DEVELOPMENT AND MESH SENSITIVITY ANALYSIS OF A MATHEMATICAL MODEL FOR AN ANODE BAKING FURNACE," in *Proceedings of the ASME 2018, 5th Joint US-European Fluids Engineering Division Summer Meeting*, Montreal, Canada, 2018

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