11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

A COUPLED FE-MULTIPHASIC APPROACH FOR BACTERIAL METHANE OXIDATION IN LANDFILL COVER LAYERS

Andrea Sindern[1], Tim Ricken[1], Joachim Bluhm[2], Martin Denecke[3] and Tobias Gehrke[3]

[1] Institute of Mechanics Statics Dynamics, Faculty of Architecture and Civil Engineering, TU Dortmund, 44227 Dortmund, andrea.sindern@tu-dortmund.de,tim.ricken@tu-dortmund.de, http://www.bauwesen.tu-dortmund.de/ms

[2] Institute of Mechanics, Faculty of Engineering, Department of Civil Engineering, University Duisburg-Essen, Campus Essen, 45117 Essen, joachim.bluhm@uni-due.de, http://www.uni-due.de/mechanika

[3] Institute of Urban Water and Waste Management, Faculty of Engineering, Department of Civil Engineering, University Duisburg-Essen, Campus Essen, 45117 Essen, martin.denecke@uni-due.de, tobias.gehrke@uni-due.de, http://www.uni-due.de/abfall/essen

Key words: *Coupled Problems, Multiphysics Problems, Multiphase, TPM, Landfills*

Methane (CH_4), which has a 25 times higher global warming potential than carbon dioxide (CO_2), can be oxidated by methanotrophic bacteria into carbon dioxide and water. During this exothermic reaction an amount of heat of $\Delta G^0 = -883$kJ/mol is released. The biological oxidation of methane can be considered in the passive aftercare phase of landfills in order to reduce climate-damaging methane emissions, since methanotrophic bacteria are situated within the landfill cover layer and therefore can convert the harmful methane emissions arising from the degradation of organic waste to the less harmful carbon dioxide. Hence, the passive aftercare of landfills in terms of methane oxidation layers is an efficient method to reduce contributions to the greenhouse effect.
To model the coupled processes during phase transition from methane to carbon dioxide, the well-known Theory of Porous Media combined with a mixture approach for description of the solved components in a main phase has been used in order to develop a multiphasic FE calculation concept, see [1]. The thermodynamic consistent model analyzes the relevant gas productions of methane, carbon dioxide and oxygen. The model also accounts for the driving phenomena of production, diffusion and advection. A multiphasic continuum approach is presented, especially focussing on the constitutive modelling of the gas phase and gas concentrations, as well as the energy production during methane oxidation. For validation, selected numerical results are compared to experimental results.

Acknowledgement: This work is supported by the DFG (Grant No. RI 1202/3-1)

REFERENCES

[1] T. Ricken, A. Sindern, J. Bluhm, R. Widmann, M. Denecke, T. Gehrke, and T. C. Schmidt. Concentration driven phase transitions in multiphase porous media with application to methane oxidation in landfill cover layers. *Z. angew. Math. Mech.*, doi: 10.1002/zamm.201200198, 2013.