

Bio- Chemo- Thermo- Hydro- Mechanical modeling of a municipal waste disposal

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Abstract:

This study considers the Municipal Solid Waste (MSW) as a multi-physics porous medium, where Bio-Chemo-Thermo-Hydro-Mechanical phenomena have a dominant effect on the long term behavior. Considering MSW in a bioreactor landfill provides a perfect application for coupled and multiphysics phenomena. A two-stage anaerobic biochemical model based on McDougall's formulation [1] is considered accounting for the progressive degradation of the organic matter. In presence of water, this latter decomposition is an exothermic reaction leading to an increase of the temperature, a generation of by-products as gases and chemical species, and finally compaction of the waste. The proposed model couples McDougall's formulation with an unsaturated flow model, a thermal model including a source term for heat generation from the biodegradation of organic matter and finally a mechanical model [2]. As proposed by [3], the constitutive law is a modified Camclay model allowing biochemical hardening/softening. The fully coupled model is implemented into the LAGAMINE multi-physics finite element code [4]. Numerical simulations are performed to study the couplings between all the phenomena and to propose a prediction for the long-term settlement of a bioreactor landfill. The first part of this paper introduces the main features of the BCHTM model. The second part deals with its application to the fully coupled modelling of a 1D column of waste. Each physical phenomenon is introduced sequentially in order to understand its effect on the evolution of the waste column. Analytical solutions are provided for each simplified physical problem in order to validate the numerical results and to isolate the influence of the main parameters.

References:

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