Numerical Simulation of Field-Scale Landfill Gas Emission through Intermediate Cover with Gas Collection System

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INTRODUCTION: Controlling the odiferous landfill gas (LFG) [e.g., Hydrogen sulfide (H_2S)] emission is an important environmental issue during operating a municipal solid waste (MSW) landfill. A combination of LFG collection system and landfill cover has been an adapted method to mitigate the issue nowadays. The distance of horizontal collection wells and gas emission need to be considered under the combination LFG controlling method. Meanwhile, the efficiency of the new type of EVOH geomembrane (GM) in reducing LFG emissions compared to the traditional LLDPE GM was also studied.

COMPUTATIONAL METHODS An intermediate cover system comprised of a waste material as contaminant resource, GM, and silty cover soil (0.3 m) modeled by finite element method (FEM) via the COMSOL Multiphysics. The gas collection system was modeled to evaluate the effectiveness of intermediate cover with GM associated with the LFG collection system (e.g., the distance for a horizontal well, total LFG production, the performance of LFG collection system) on odor gas emission (e.g., concentration and flux of H_2S). And the barrier effect of covers with different GM on LFG emission is also simulated. The gas collection system has a negative pressure, which induces the LFG flow from the waste to the collection system. Darcy's law and Fick's law coupled model was used in this study.

$$\frac{\partial}{\partial t}(\rho\varepsilon) + \nabla \cdot (\rho\mathbf{u}) = Q_m$$

$$\frac{\partial c}{\partial t} + \nabla \cdot (-D\nabla c) + \mathbf{u} \cdot \nabla c = R$$

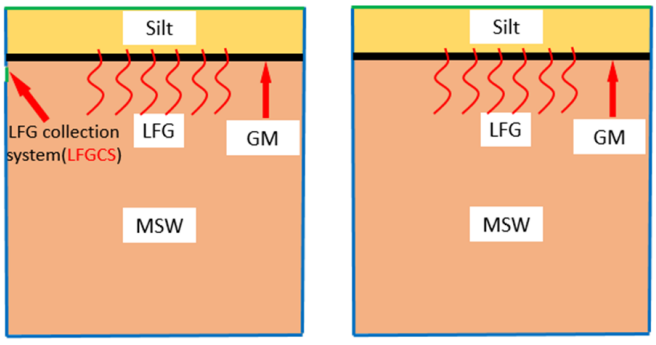

Figure 1. A Schematic of an Intermediate Cover for Numerical Simulation Using COMSOL: (a) With Gas Collection System and (b) Without the Gas Collection System

RESULTS: The simulation gives the pressure distribution and LFG flow inside the landfill, as well as the distribution of H_2S. The results shows the H_2S diffusion at the landfill surface and the efficiency range of the collections wells under the different distance of the horizontal wells.

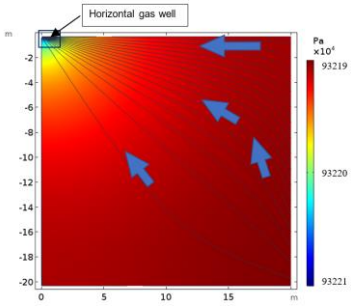

Figure 2. Pressure & LFG flow

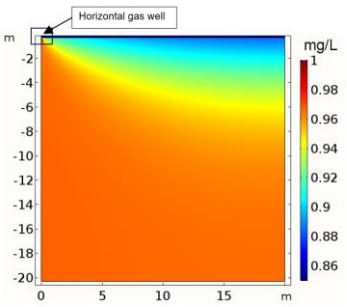

Figure 3. H_2S Concentration Distribution in Waste Mass

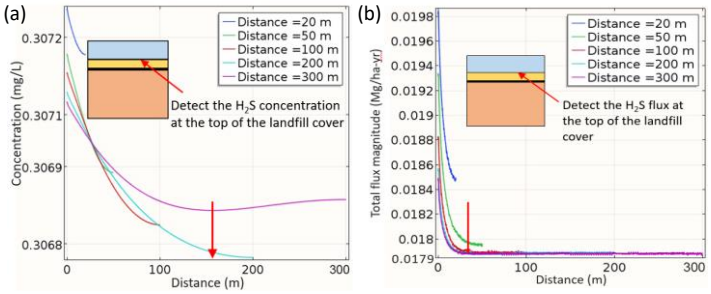

Figure 4 Effect of Distance for a Horizontal Well on a) H_2S Concentration in Cover Soil and b) the H_2S Emit Flux (Distance = 20 m, 50 m, 100 m, 200 m, and 300 m)

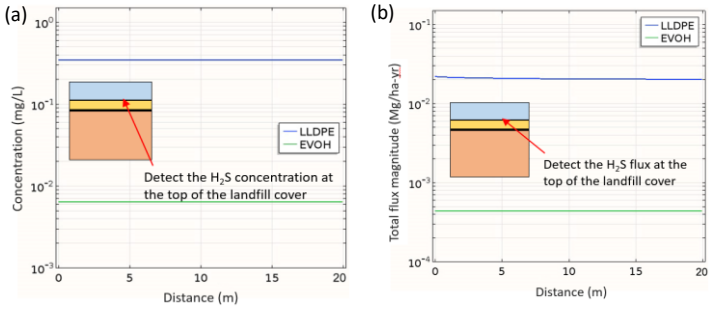

Figure 5 Effect of a Landfill Cover with EVOH GM and LLDPE GM on a) H_2S Concentration in the Cover Soil and b) H_2S Emit Flux

CONCLUSIONS: The LFG inside the waste is mainly transported in horizontal direction in the landfill when the landfill has the horizontal LFG collection wells and covered with intermediate GM. The H_2S emission flux through the intermediate cover with LLDPE/EVOH GM remains constant at a distance of 35 m from the horizontal well. Therefore, the proper interval of the horizontal gas well would be 70 m in this study. The landfill cover with EVOH GM can reduce the H2S concentration in the cover soil by 79% compared with the use of LLDPE GM.