环境科学学报
ACTA SCIENTIAE CIRCUMSTANTIAE

污染控制技术及原理

谢海建,柯瀚,陈云敏.浓度变化时复合衬层中有机污染物的一维扩散分析[J].环境科学学报,2006,(6):930-935

浓度变化时复合衬层中有机污染物的一维扩散分析

Analysis of one-dimensional organic contaminants diffusion through composite liner under time-dependent concentration conditions

关键词： 复合衬层 扩散 解析解 压实粘土衬层 填埋场 有机污染物 土工聚合粘土衬层

基金项目： 国家杰出青年科学基金项目(No.50425825);国家自然科学基金重点资助项目(No.50538080)

作　者　单位

谢海建　浙江大学岩土工程研究所, 杭州 310027

柯　瀚　浙江大学岩土工程研究所, 杭州 310027

陈云敏　浙江大学岩土工程研究所, 杭州 310027

摘要： 在考虑填埋场有机污染物浓度随时间变化的基础上,对有机污染物在复合衬层中的一维扩散问题进行了解析求解.计算模型考虑了2种常见的下边界条件,即零浓度下边界及零通量下边界.计算模型亦考虑了污染物在各介质中的背景浓度.利用该解析解得到的结果和已有的试验结果较为接近.对于美国规范规定的标准复合衬层,当污染物在膜中的扩散系数达到$1.0\times10^{-13}m^2\cdot s^{-1}$且膜的分配系数达到50时,基本上可以忽略土工膜作为有机污染物扩散屏障的作用;对于同样的复合衬层,若膜的扩散系数达到$1.0\times10^{-12}m^2\cdot s^{-1}$,则膜分配系数只需达到5即可忽略土工膜作为有机污染物扩散屏障的作用.对于标准复合衬层及GM+GCL复合衬层,膜分配系数的变化对有机污染物通量击穿曲线的影响较大,而膜扩散系数对其的影响则相对较小.

Abstract: An analytical solution for one dimensional organic contaminant diffusion through composite liner is derived regarding the change of the concentration of organic contaminant in the landfill with time. The model accounts for the arbitrary initial condition and the conditions of zero concentration and zero mass flux on the bottom boundary. The background contaminant concentration of the media is also considered in the model.The results obtained by the presented analytical solutions agree well with the experimental results presented in literature papers. When the diffusion coefficient of the geomembrane is 1.0×10^{-13} $m^2\cdot s^{-1}$ and the partition coefficient of the geomembrane is 50,the diffusion barrier of the geomembrane can be neglected for the composite liner recommended in the American standard. When the diffusion coefficient of the geomembrane is 1.0×10^{-12} $m^2\cdot s^{-1}$ and the partition coefficient of the geomembrane is 5,the diffusion barrier of the geomembrane can be neglected for the composite liner recommended in the American standard. The mass flux at the base of the composite liner is found to be sensitive to the partition coefficient and less sensitive to the diffusion coefficient of the geomembrane.

Key words: composite liner diffusion analytical solutions compacted clay liners landfill organic contaminants GCL