Numerical simulation of quasi-steady-state gas flow in a landfill

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Introduction： Landfills, composed of large amounts of organic substances, undergo continuous microbial degradation, which generates lots of gas such as CH_4 and CO_2. Landfill gas will explode when CH_4 reaches a certain concentration, meanwhile it is also a promising source of renewable energy and needs to be utilized.

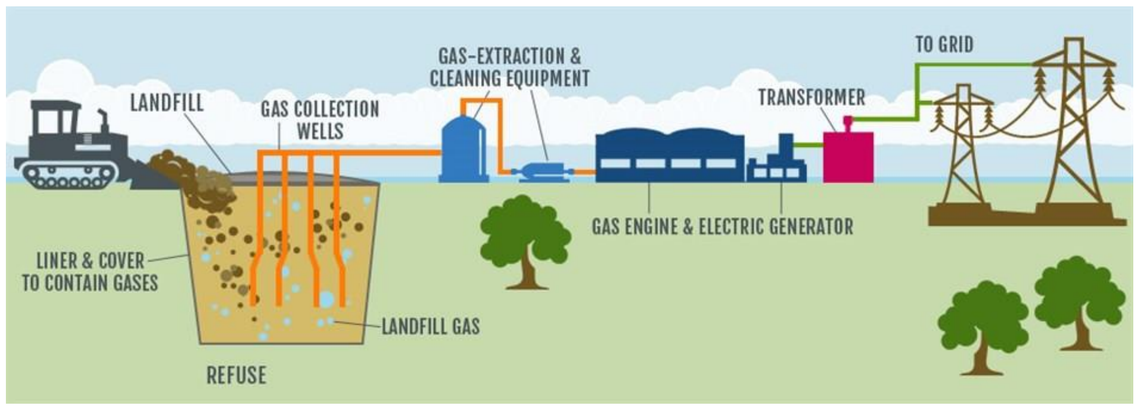

Fig 1. Landfill gas extracted for electricity generation

Calculation： Mass conservation equation and Darcy's law are coupled in this case. Gas production rate is contributed by three components and varies with time.

$$\frac{1}{r}\frac{\partial}{\partial r}(r\rho u_r) + \frac{\partial}{\partial z}(\rho u_z) = \alpha,$$

$$\alpha = C\sum_{i=1}^{3} A_i \lambda_i e^{-\lambda_i t},$$

$$t = t_0 + \frac{z}{h} t_f,$$

The geometry of landfill is followed.

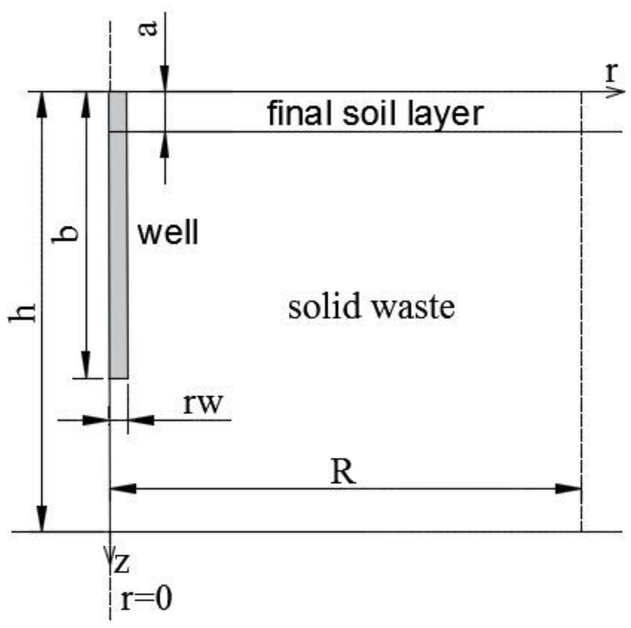

Fig 2. The landfill geometry

Results： The pressure contour in Fig 3 indicates that the gas moves almost horizontally and will be collected by the well. Furthermore, the flow rate increases with the decreasing cover permeability of and its increasing thickness because both of them can increase the resistance of gas emission from the final cover.

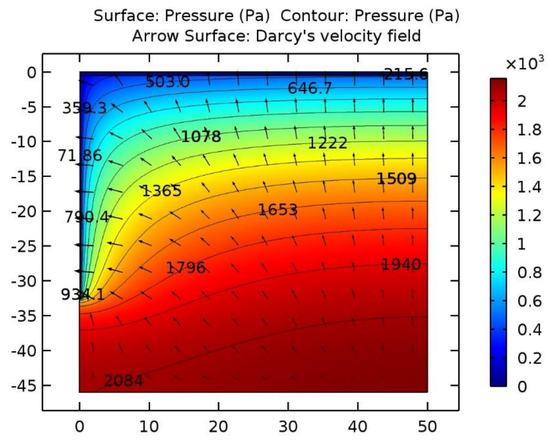

Fig 3. The pressure contour

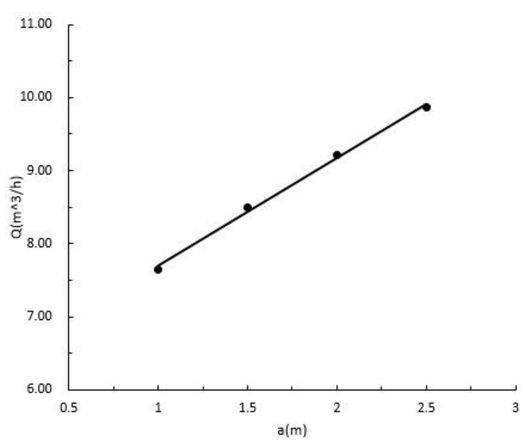

Fig 4. Flow rate varies with cover thickness

Variables	Values	Unit
Viscosity	1.54e-5	Pa*s
Permeability of cover	1.0e-13	m^2
Horizontal permeability of waste	3.0e-12	m^2
Vertical permeability of waste	1.0e-12	m^2

Tab 1. Viscosity and permeability values

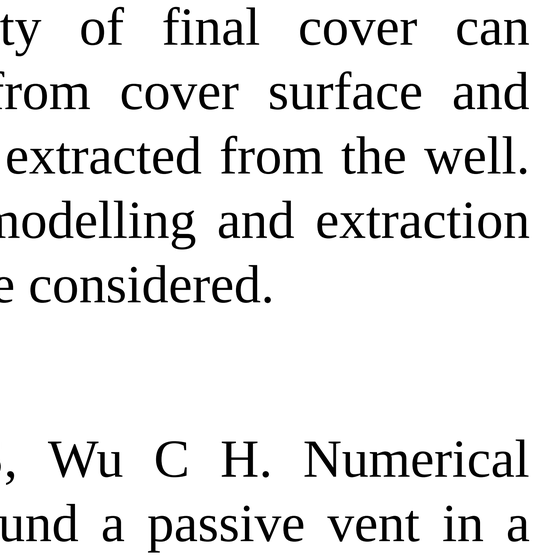

Fig 5. Flow rate varies with cover permeability

Conclusions： Both increasing the thickness and decreasing the permeability of final cover can reduce the gas emission from cover surface and increase the amount of gas extracted from the well. In the future, multi-wells modelling and extraction strategy optimization will be considered.

References：

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2. Mehrdad Hashemi H I K T. Computer simulation of gas generation and transport in landfills I: quasi-steady-state condition[J]. Chemical Engineering Science. 57:2475-2501(2002).