Hot Topics in Landfill Gas Recovery

Mark Milke
Department of Civil and Natural Resources Engineering
University of Canterbury
Christchurch, New Zealand

Overview

- Landfill Gas Production/Recovery
- Methane Emission Charging– theory and reality
- Difficulties in emission estimation
- Methane emission monitoring
- Future

Landfill Gas Production

- Methane production in landfills less efficient than in digesters, still roughly

  90 L/kg wet for food and garden waste

  200 L/kg for paper waste
- ~50% methane produced (CO_2 dissolution has significant impact on % gas recovered)
- First-order 'half-lives' from 1 to 25 years
- Carbon sequestration for non-digested waste

Landfill Gas Concerns

- Explosions
- Vegetation stress
- Odours/toxins
- Urban ozone precursors
- Greenhouse gas impacts

Gas Recovery

- Started early 80s
- Vertical wells
- Largest facility: 46 MW (net) Puente Hills, CA
- Design and operation highly empirical
- Tension between maximising recovery and minimising impacts

Influences on Gas Production

- Waste composition/degradability
- Moisture
- Particle size
- Toxins
- pH/Alkalinity
- Sulphate
- Temperature

Influences on Gas Recovery

- Density/location of wells
- Gas permeability of cover and liner
- Vacuum applied
- Atmospheric pressure, soil moisture

Influences on Methane Emitted

- Gas Production Rate
- Gas Recovery Efficiency
- Atm. Pressure, soil moisture
- Cracks in cover
- Microbial oxidation of methane
  - soil oxygen
  - soil carbon
  - soil moisture

Methane Emission Charging-- Theory

- Estimates of methane emissions exist
- Charge on emissions will give incentive for change
- Aust. estimate of A$1 - 16/tonne $\Rightarrow$

  over $NZ1million per year for regional landfills

Methane Emission Charging-- Reality

- Emission estimates exceptionally crude

  * poor estimate of degradation, rate, recovery, oxidation

  * highly variable site-to-site

- Expensive to measure methane emissions directly

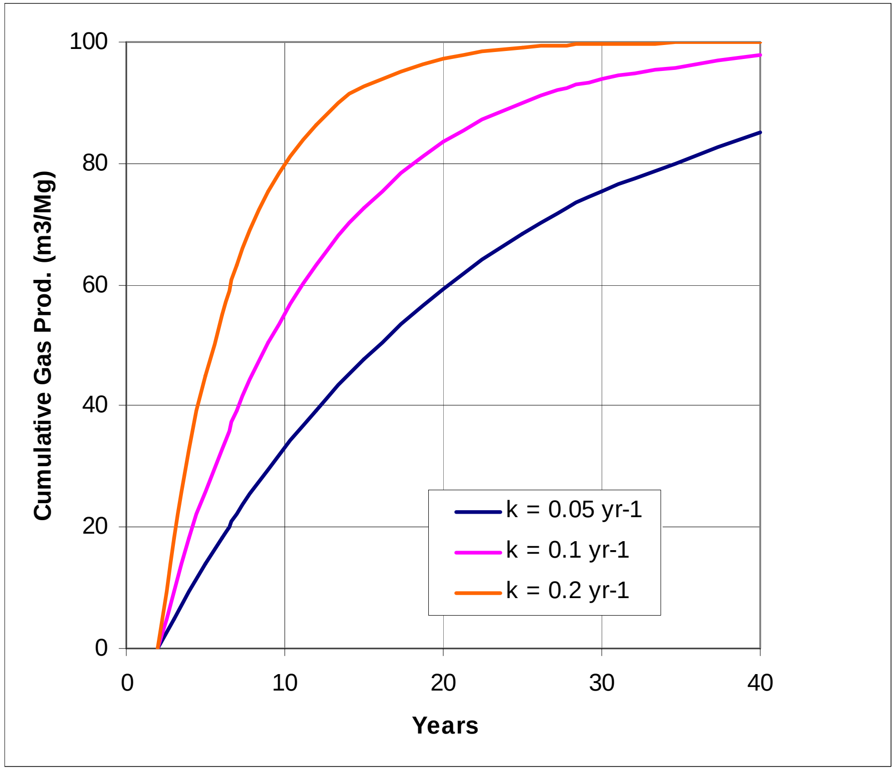
  * methods either labour or equipment intensive

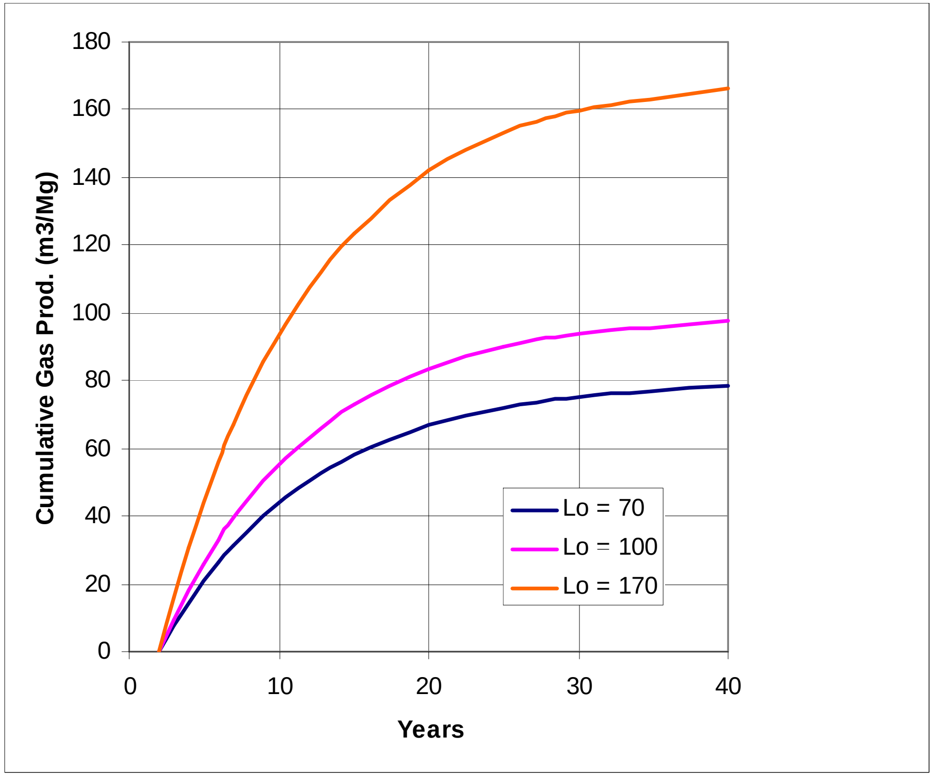
  * large spatial, temporal variability

- No easy, fair system for charging

First-order Decay Model

$$\text{Cumulative Gas (t)} = L_o\,(1 - \exp(-k[t - t_{lag}]))$$





All three parameters uncertain and of interest

Difficulties in using literature values

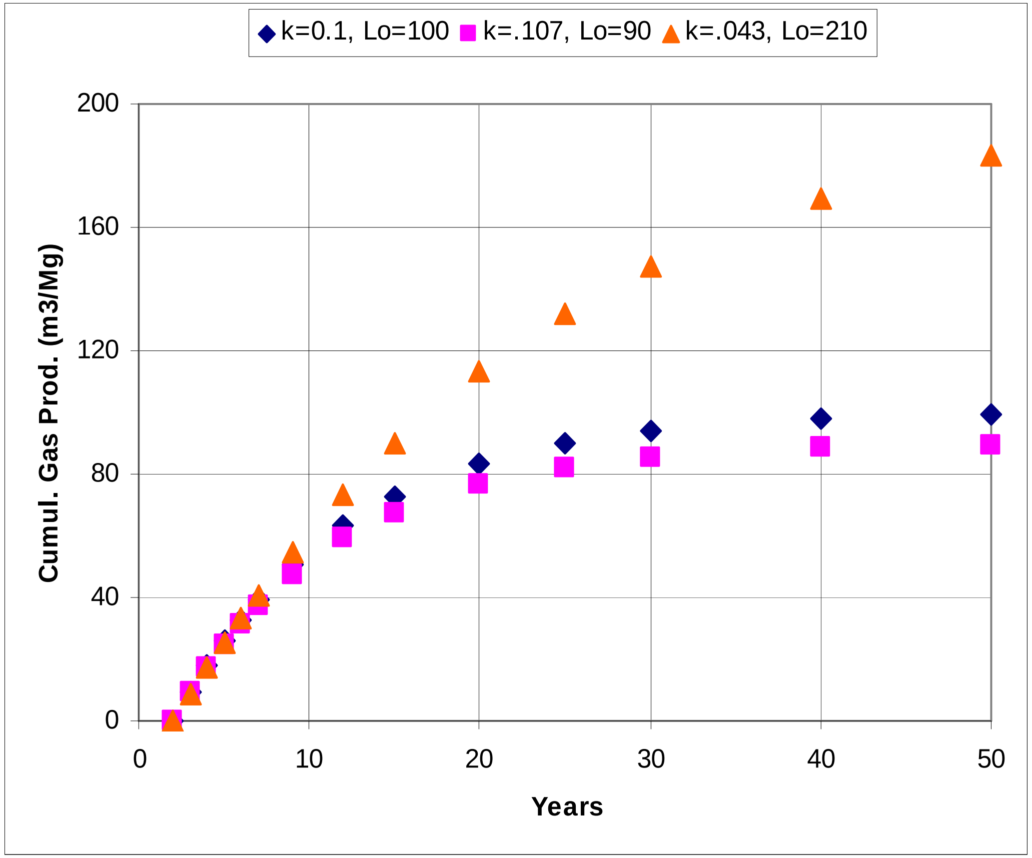
- Type of waste varies between sites

- Method of operation varies between sites (e.g., leachate recycled or not)

$\Rightarrow$ Use actual data and fit parameters?

Difficulties in parameter estimation

Difficult to independently estimate k and L_o when using only early data



Difficulties in parameter estimation

- Full-scale facilities have waste of different ages, gas recovery varies with time, cover
- First-order model crude and not representative of leach-bed degradation kinetics

Institutionalisation of Estimates

- Many previous estimates now accepted in charges, LCA, accounting
- Difficult to change, in spite of new information

Ex: untreated wood decomposition

- Often assume 50% landfill degradation (5%?)
- Often assume 50% gas emission (10%?)

Methane Emission Monitoring

- Avoid issues of poor estimates ⇒ unfair charges
- Rapid improvements in technologies
  - Flux boxes
  - Infrared detection
  - Trace gas and meteorological estimate
- Rapid improvement in engineered oxidation

Future

- Convergence of landfill and anaerobic digestion technologies to `batch biodigesters’
- High temperature (70° C) concerns
- Methane oxidation carpets
- Carbon-neutral landfills: high recovery, oxidation, sequestration
- Increased organics to new ‘batch biodigesters’

Questions??