Methane Emission Mitigation in a Manitoban Landfill

By: Parvin Berenjkar, Ph.D.
Civil and Environmental Engineering
University of Manitoba

April 2022

Outline

- Introduction
- Overview of previous work
- Field-scale testing
- Supporting laboratory experiments
- Engineering significance
- Acknowledgement

Introduction- Landfills and Methane

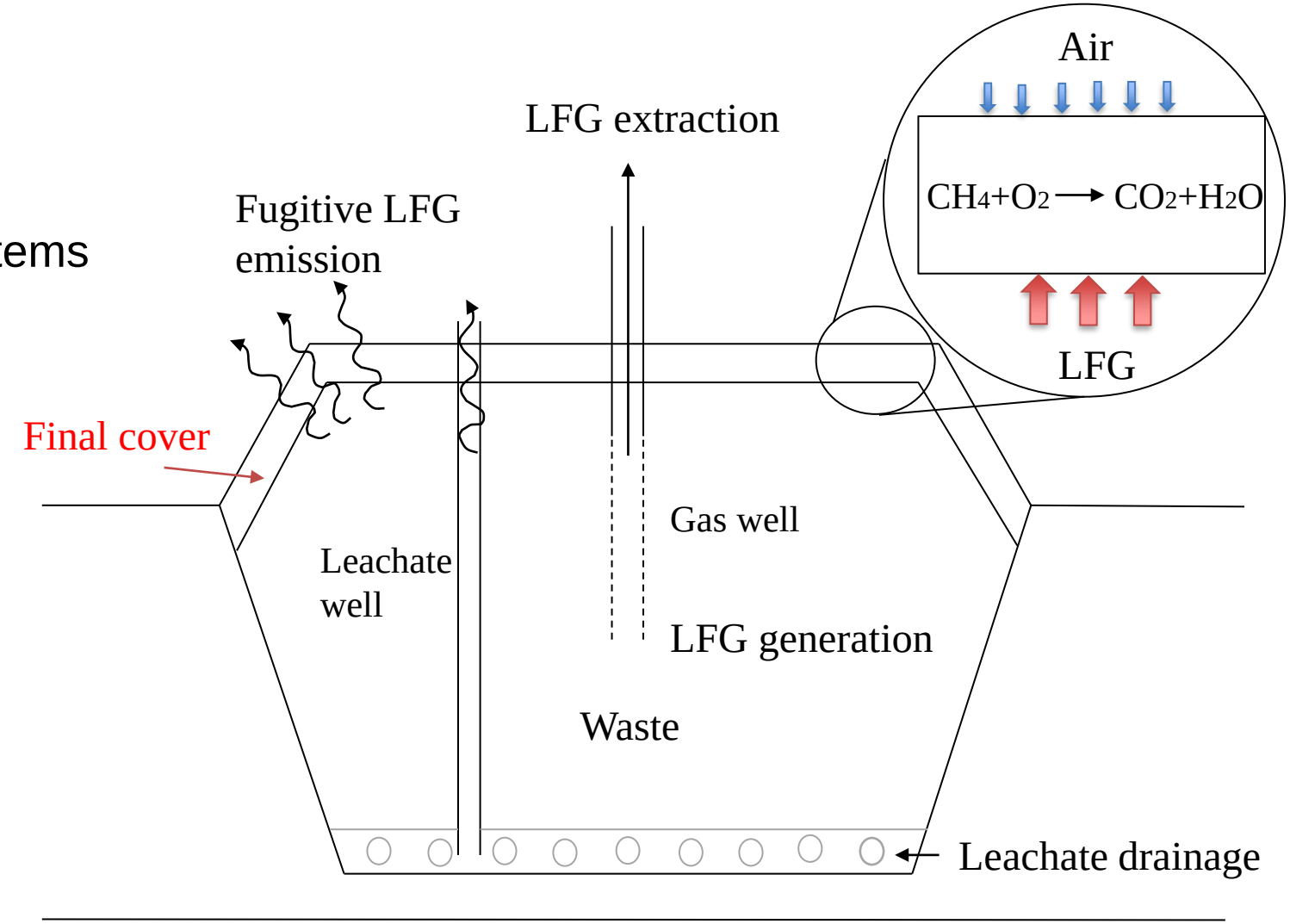
- The anaerobic decomposition of organic wastes
  - (55-60%) CH_4
  - (40-45%) CO_2
- Landfills in Canada → *20% of national CH_4 emissions*
- Global Warming Potential (GWP) → *29-fold over a 100-year time period*

Introduction- landfill gas (LFG) control

- Engineered LFG collection systems

- Landfill final cover

→ CH_4-oxidizing bacteria (Methanotrophs)



Introduction – Engineered Landfill cover (biocover)

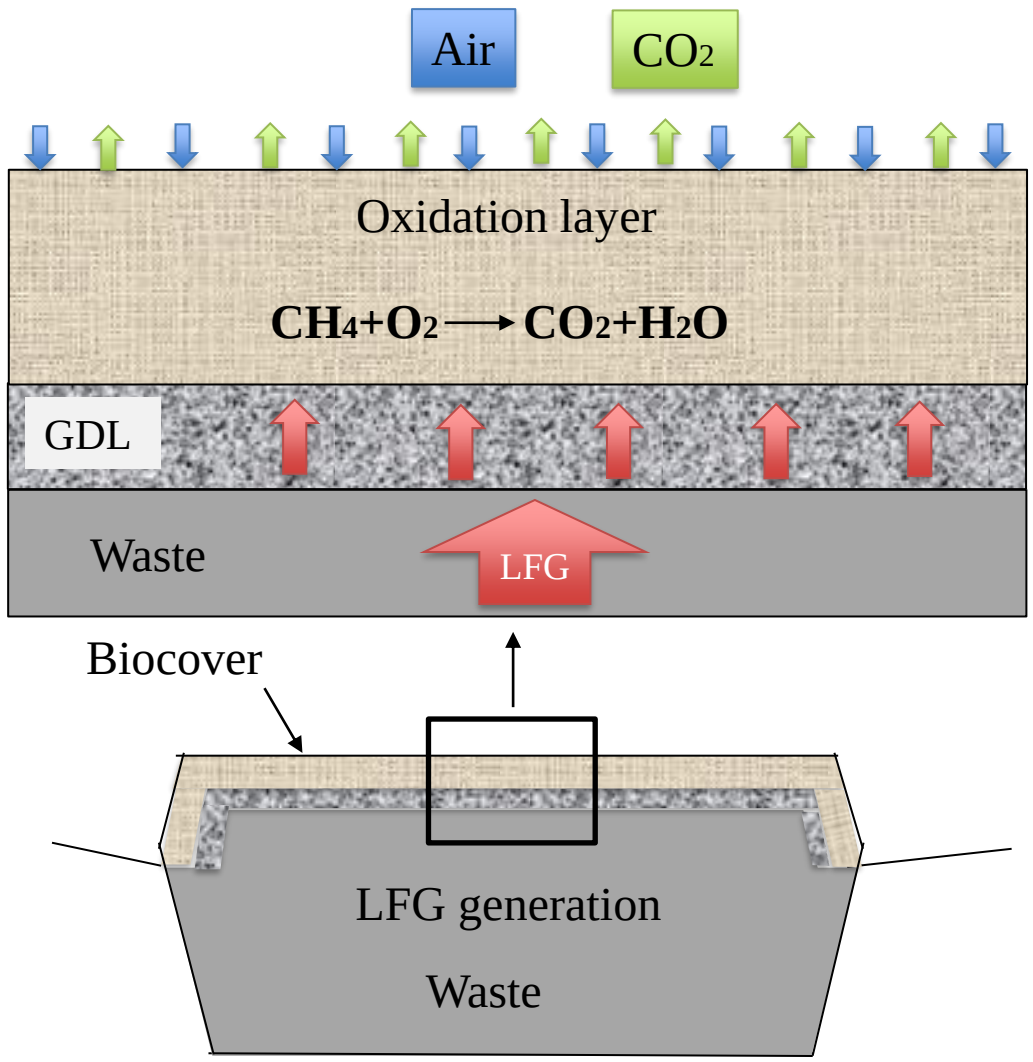
Small and medium size landfills

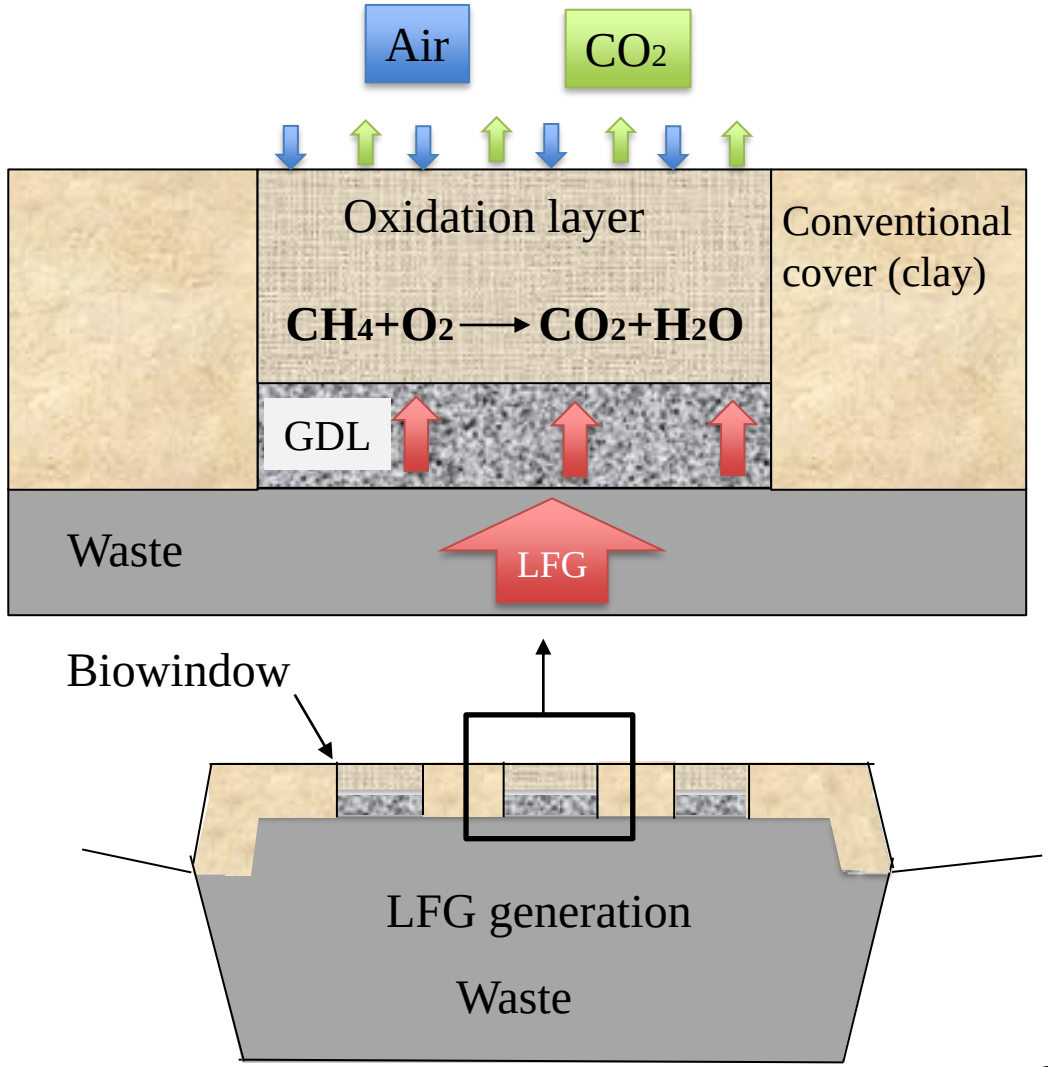
Large landfills after reaching the threshold of CH_4 production

→ **Biocovers**

- *To optimize the growth of methanotrophs*
- *A low-cost alternative approach to reduce LFG*

Introduction – Biocover vs biowindow





Introduction

- Composts
  - Retaining a suitable combination of
    - Porosity,
    - Moisture retention
    - Temperature regulation,
    - pH value
    - Nutrient sources

Overview of previous works

Yard Waste and Leaf Compost (YWLC)
and Biosolids Compost (BSC)

- Optimums achieved

→

- *4:1 mixture of BSC to YWLC*
- *MC of 40% g g^{-1} wet basis*

Bio-window construction-BRRMF-Winnipeg

Digging the hole

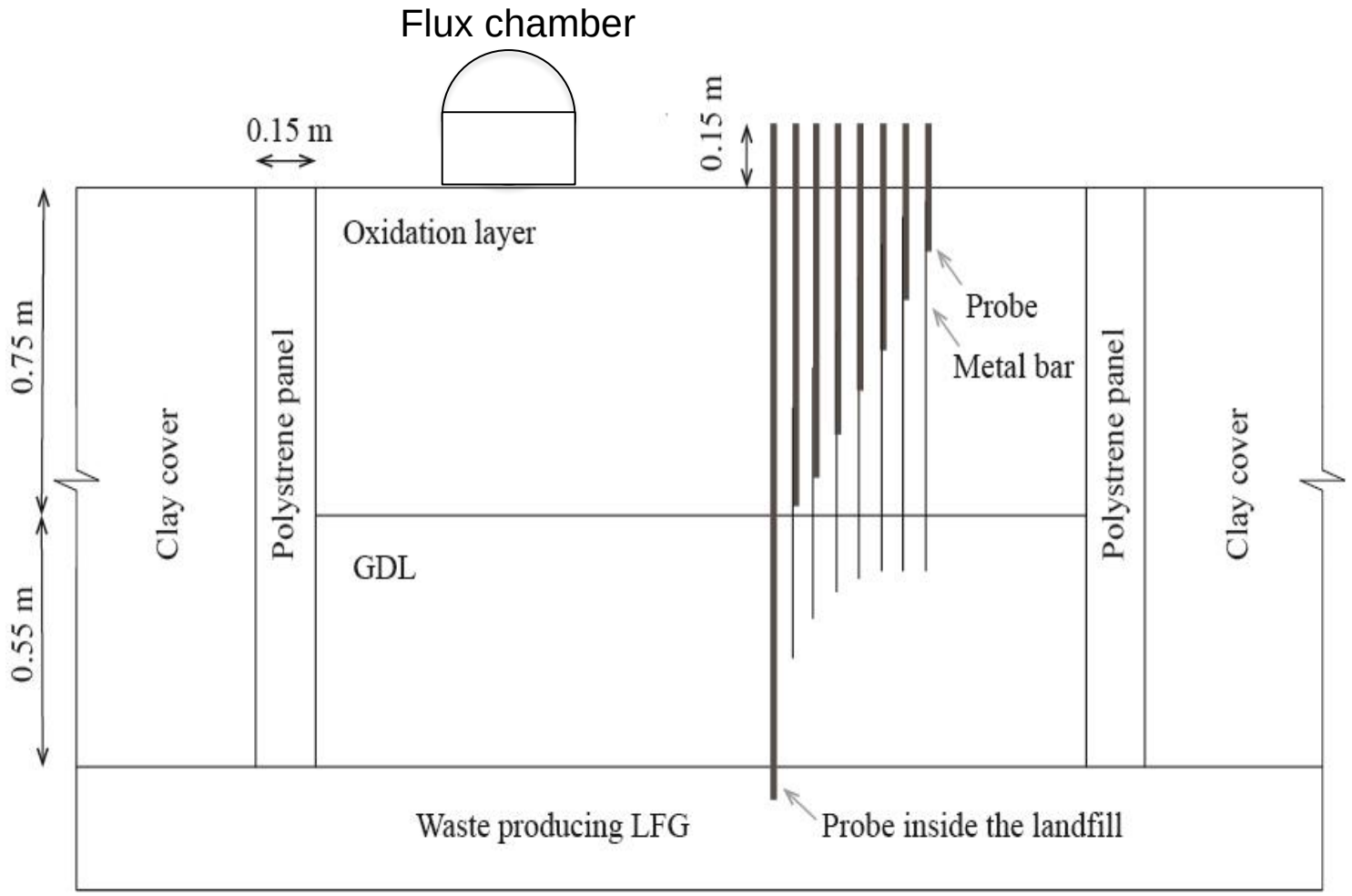
Excavation to below clay

The hole with 1.3 m depth

Compost oxidation layer

Gravel GDL

Assessment of the biowindow performance



Nest of gas probes

Compost sample collection throughout the year (2016-2019)


Dec to Feb

March

April

May **June** **July** **August**

Methanotrophic potential at different layers

20% methane-in-air headspace

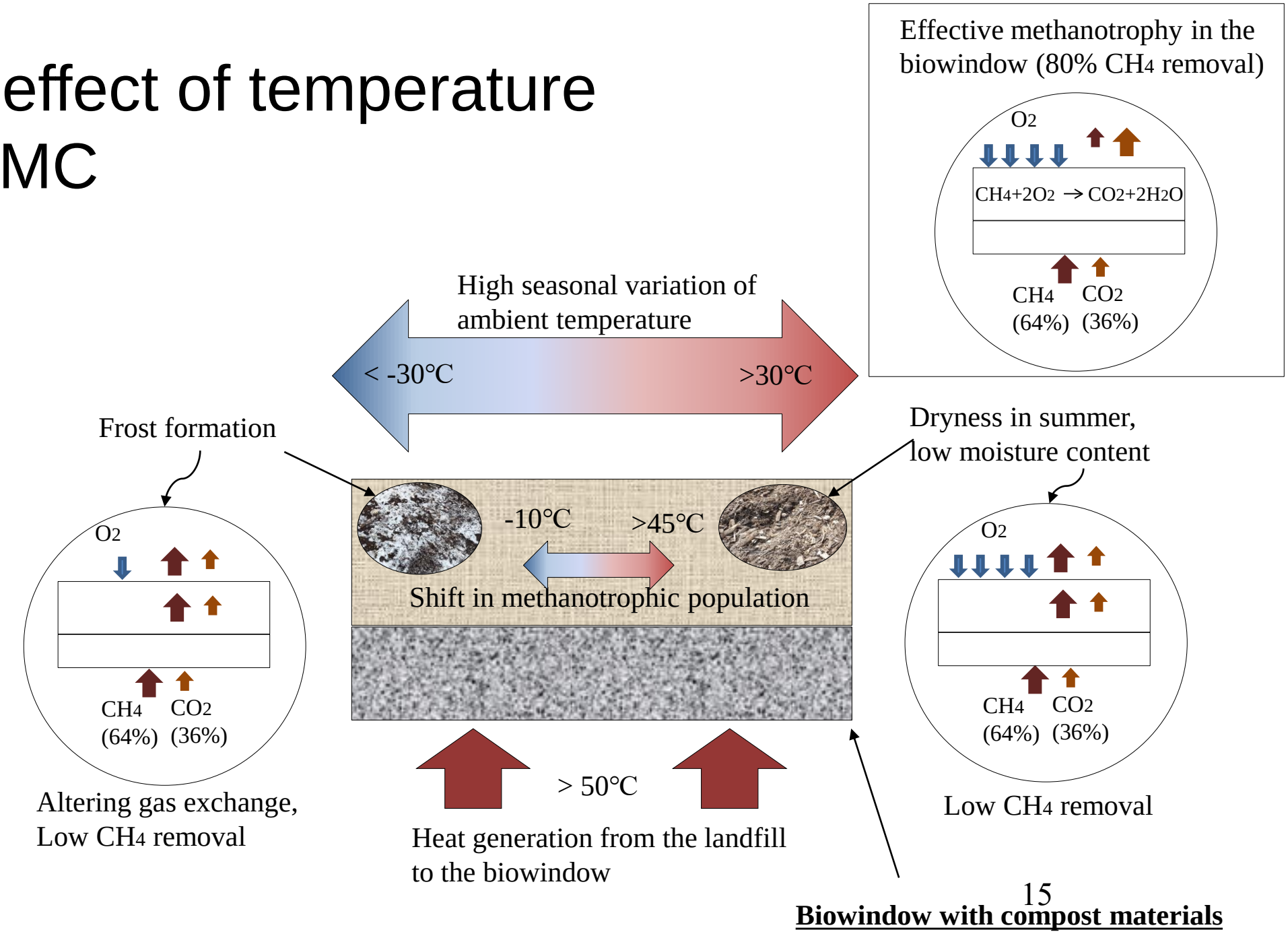
Incubations at 22℃ and 45℃

Measured environmental factors

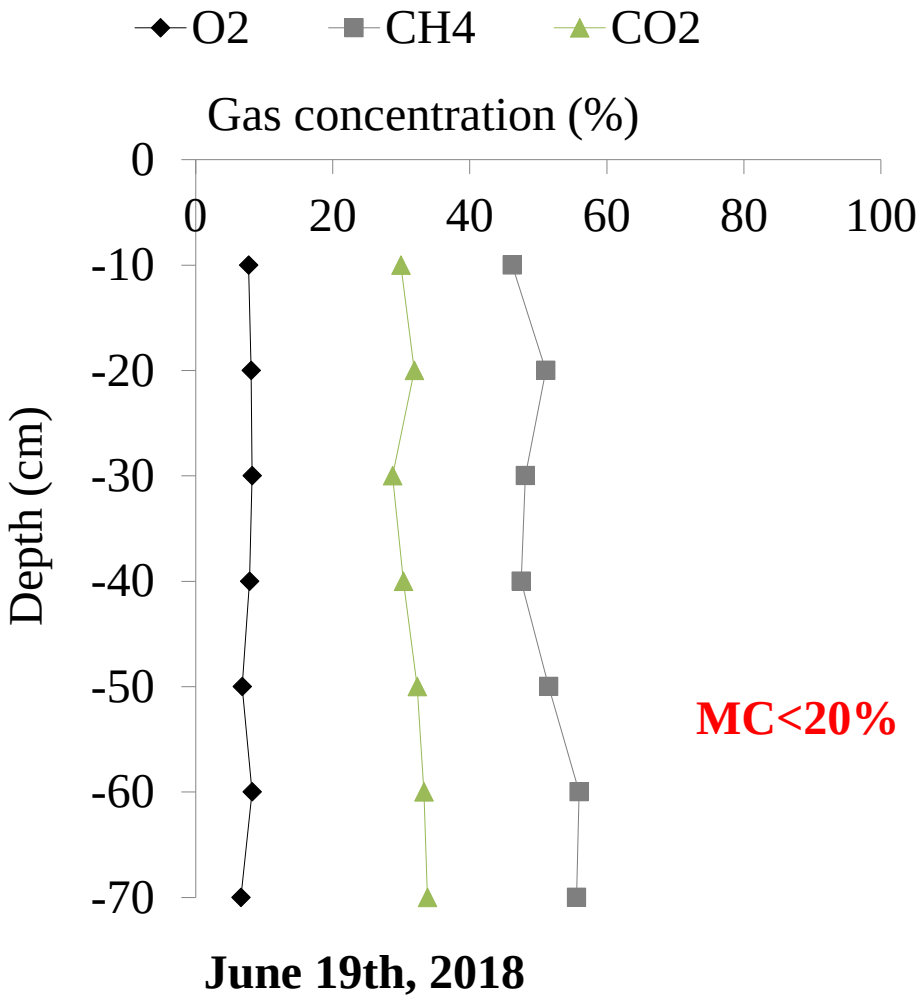
- Barometric pressure
- Wind speed
- Daily temperature
- Temperature in the biowindow
- Moisture content in the biowindow

CH removal efficiency

The effect of temperature and MC

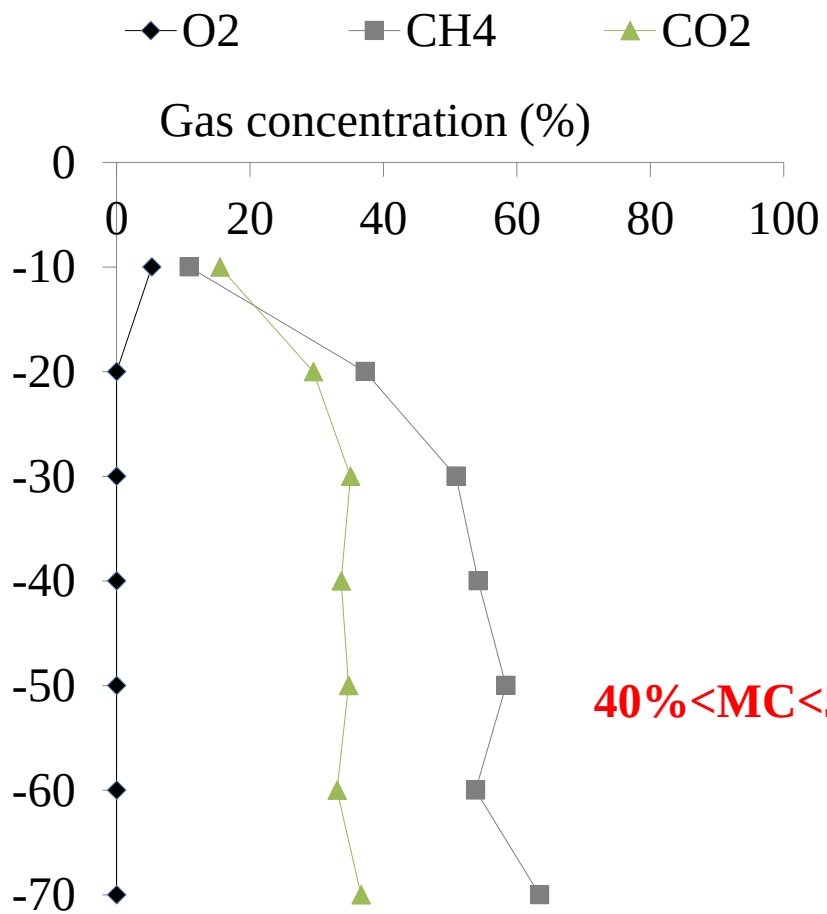


15



MC<20%

June 19th, 2018



40%<MC<50%

Sep 6th, 2017

Engineering significance

The temperature in the bio-window >45℃

→ **The existence of the thermophilic methanotrophs in the landfill set for the first time**

High-temperature landfills and those at the early stages of the methanogenesis phase.

Engineering significance-Extending shoulder season

Methanotrophic potential in the bio-window during the winter in a cold climate landfill

The importance of adopting appropriate measures to extend the shoulder season

Publications

Niemczyk, M., **Berenjkar**, P., Wilkinson, N., Lozecznik, S., Sparling, R., & Yuan, Q. (2021). Enhancement of CH4 oxidation potential in bio-based landfill cover materials. *Process Safety and Environmental Protection*, *146*, 943-951.

Niemczyk, M., **Berenjkar**, P., Sparling, R., Lozecznik, S., & Yuan, Q. (2022). Optimized design of a compost layer in a landfill biocover for CH4 oxidation. *Process Safety and Environmental Protection*, *160*, 354-361.

Berenjkar, P., Sparling, R., Lozecznik, S., & Yuan, Q. (2021). Methane oxidation in a landfill biowindow under wide seasonally fluctuating climatic conditions. *Environmental Science and Pollution Research*, 1-16.

Berenjkar, P., Sparling, R., Lozecznik, S., & Yuan, Q. (2021). The interactive effect of environmental factors on a landfill bio-cover at a seasonally fluctuating climate. Waste Management. (Under review)

Acknowledgement

Advisory Committee

- Dr. Qiuyan Yuan, *Department of Civil Engineering, University of Manitoba*
- Dr. Richard Sparling, *Department of Microbiology, University of Manitoba*
- Dr. Stan Lozecznik, *KGS Group*

KGS Group

Financial support, help on developing the technology, and participating in the Ph.D. advisory committee

Thanks you