DESIGNING OF POWER GENERATION PLANT FROM LANDFILL GAS (BIO FUEL)

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ABSTRACT

Energy from renewables has been sought to replace current fossil fuel energy generation. Landfilling is one of the most commonly adopted technologies for Municipal Solid Waste (MSW) disposal as an alternative to waste burning and composting. Landfill gas (LFG) mostly results from the anaerobic decomposition of biodegradable fraction. . Landfill gas is a mixture of several gases with its main constituents being methane and carbon dioxide. Landfill gas can be collected by either passive gas collection system or active gas collection system, both of which consist of gas collection wells that provide a preferential migration route for the landfill gas. Landfill gas utilization is a process of gathering, processing, and treating the methane gas emitted from decomposing garbage to produce electricity, heat, fuels, and various chemical compounds. Landfill gas has great potential to generate power since it contains methane 40 to 60%. Utilizing an enhanced landfill gas as fuel for power generator is also beneficial to reduce greenhouse gas emission from landfill otherwise it will escape to the atmosphere. Current technology in power generation from landfill gas includes organic Rankine cycle (ORC) and Stirling cycle engine (SCE) to add the traditional reciprocating Internal Combustion Engine (ICE) and Gas Turbine (GT).

Keywords- Landfill gas, Gas Turbine, biodegradable fraction, Generation of LFG, Electricity generation

1. INTRODUCTION

Landfills are the physical facilities used for the disposal of residual solid waste in the surface soils of the earth. In the past, the term sanitary landfill was used to denote a landfill in which, the waste placed in the landfill was covered at the end of each days operation. Today sanitary landfill refers to an engineered facility for the disposal of MSW designed and operated to minimize public health and environmental impacts. Landfills for the disposal of hazardous wastes are called secured landfills. A sanitary landfill is also sometimes identified as a Solid Waste Management Unit.Landfilling is the process by which the residual solid waste is placed in a landfill. Landfilling includes monitoring of the incoming waste stream, placement and compaction of the waste and installation of landfill environmental monitoring and control facilities

2.LANDFILL GAS BASICS

2.1 LFG:

LFG is a natural byproduct of the decomposition of organic material in anaerobic (without oxygen) conditions. LFG contains roughly 50 to 55 percent methane and 45 to 50 percent carbon dioxide, with less than 1 percent non-methane organic compounds (NMOCs) and trace amounts of inorganic compounds. LMOP uses a methane global warming potential (GWP) of 25 in program calculations to be consistent with and comparable to key Agency emission quantification programs such as the U.S. GHG Inventory.

2.2 GENERATION OF LFG:

When municipal solid waste (MSW) is first deposited in a landfill, it undergoes an aerobic (with oxygen) decomposition stage when little methane is generated. Then, typically within less than 1 year, anaerobic conditions are established and methane-producing bacteria begin to decompose the waste and generate methane.

Phase I: Aerobic bacteria—bacteria that live only in the presence of oxygen—consume oxygen while breaking down the long molecular chains of complex carbohydrates, proteins, and lipids that comprise organic waste.

Phase II: Using an anaerobic process—does not require oxygen—bacteria convert compounds created by aerobic bacteria into acetic, lactic and formic acids and alcohols such as methanol and ethanol.

Phase III: Anaerobic bacteria consume the organic acids produced in Phase II and form acetate, an organic acid.

Phase IV: The composition and production rates of LFG remain relatively constant. LFG usually contains approximately 50-55% methane by volume, 45-50% carbon dioxide, and 2-5% other gases, such as sulfides. LFG is produced at a stable rate in Phase IV, typically for about 20 years.

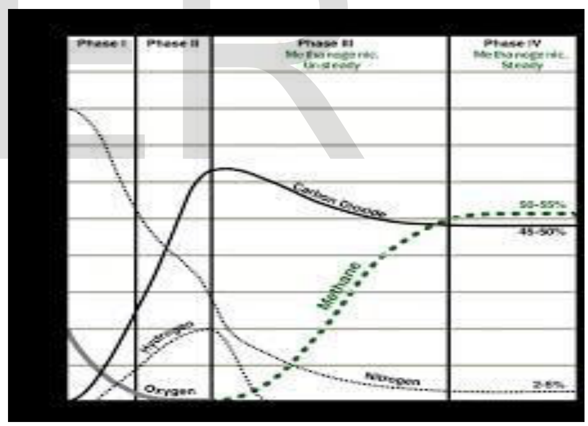


Fig . 1 Generation of LFG

2.3 LFG COLLECTION AND FLARING:

LFG collection typically begins after a portion of the landfill (known as a “cell”) is closed to additional waste placement. Collection systems can be configured as either vertical

International Journal of Scientific & Engineering Research Volume 9, Issue 3, March-2018
ISSN 2229-5518

wells or horizontal trenches. Most landfills with energy recovery systems include a flare for the combustion of excess gas and for use during equipment downtimes discussion of collection system and flare costs .

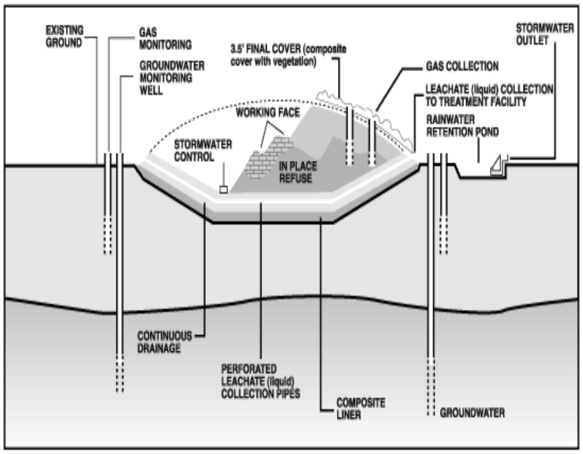


Fig . 2 Section of Landfil

2.4 GAS COLLECTION WELLS AND HORIZONTAL TRENCHES:

The most common method of LFG collection involves drilling vertical wells in the waste and connecting those wellheads to lateral piping that transports the gas to a collection header using a blower or vacuum induction system. Another type of LFG collection system uses horizontal piping laid in trenches in the waste. Horizontal trench systems are useful in deeper landfills and in areas of active filling.

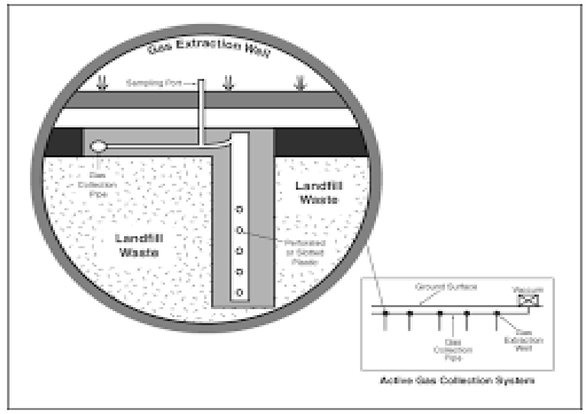


Fig. 3 Gas collection wells

Condensate Collection: Condensate forms when warm gas from the landfill cools as it travels through the collection system. If condensate (water) is not removed, it can block the collection system and disrupt the energy recovery process.

Blower: A blower is necessary to pull the gas from the collection wells into the collection header and convey the gas to downstream treatment and energy recovery systems.

Flare. A flare is a device for igniting and burning the LFG. Flares are a component of each energy recovery option because they may be needed to control LFG emissions.

2.5 LFG TREATMENT:

Using LFG in an energy recovery system usually requires some treatment of the LFG to remove excess moisture, particulates and other impurities. The type and extent of treatment depend on site-specific LFG characteristics and the type of energy recovery system employed.

LFG ENERGY PROJECTS

3.1 LFG ENERGY PROJECTS:

LFG energy projects first came on the scene in the mid-to Late -1970s and increased notably during the 1990s as a track record for efficiency, dependability and cost savings was demonstrated. LMOP's Landfill and LFG Energy Project Database, which tracks the development of U.S. LFG energy projects and landfills with project development potential, indicates that, in June 2017, 634 LFG energy projects are operating in 48 states and 1 U.S. territory.

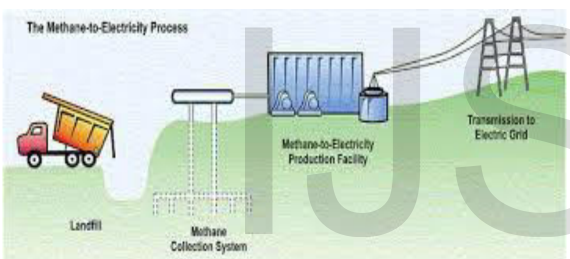


Fig . 4 LFG to energy process

3.2 ELECTRICITY GENERATION:

The three most commonly used technologies for LFG energy projects that generate electricity — internal combustion engines, gas turbines and microturbines — can accommodate a wide range of project sizes. Most (more than 75 percent) of the LFG energy projects that generate electricity use internal combustion engines, which are well-suited for 800-kW to 3-megawatt (MW) projects. Multiple internal combustion engines can be used together for projects larger than 3 MW. Gas turbines are more likely to be used for large projects, usually 5 MW or larger.

3.3 DIRECT USE:

Direct use of LFG can offer a cost-effective alternative for fueling combustion or heating equipment at facilities located within approximately 5 miles of a landfill

3.4 BENEFITS OF LFG ENERGY PROJECTS :

Using landfill gas (LFG) to generate energy and reduce methane emissions produces positive outcomes for local communities and the environment. LFG utilization projects create partnerships among citizens, nonprofit organizations, local governments, and industry in sustainable community planning. The benefits of LFG energy projects are significant for the following reasons.

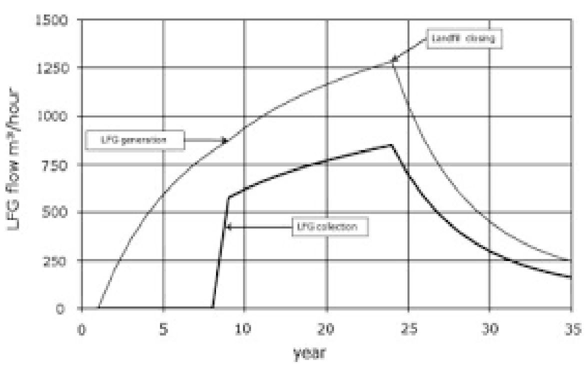
1. Reduce Greenhouse Gas Emissions
2. Reduce Air Pollution by Offsetting the Use of Non-Renewable Resources
3. Create Health and Safety Benefits
4. provide revenue for landfills.
5. Reduce Environmental Compliance Costs.
6. create jobs and promote investment in local business.

3.5 REGULATORY FRAMEWORK:

Landfills and LFG energy projects can be subject to federal, state and local air quality, solid waste and water quality regulations and permitting requirements. In addition, project developers should contact relevant federal agencies and state agencies for more detailed, current information and to obtain applications for various types of construction and operating permits.

Estimating Collection Efficiency

To help address this uncertainty, EPA has published estimates of reasonable collection efficiencies for landfills in the United States that meet U.S. design standards3 and have "comprehensive" LFG collection systems. A "comprehensive" LFG collection system is made up of vertical wells and or horizontal collectors that cover 100 percent of all waste areas within 1 year after the waste is deposited. Reported collection efficiencies at such landfills typically range from 50 to 95 percent, with an average of 75 percent most commonly assumed.



LFG generation and recovery rates

DESIGN OF SLAB

SLABS:

Slab is a structural element of modern buildings, more often used in construction of floors and ceilings. Slabs are classified based on many aspects.

1. **BASED ON SHAPE:** square ,rectangular, circular and polygonal in shape.
2. **BASED ON TYPE OF SUPPORT:** Slab supported on walls, slab supported on beams, slabs supported on columns.
3. **BASED ON SUPPORT OR BOUNDARY CONDITION**: Simply supported, cantilever, overhanging, fixed or continuous slab.
4. **BASED ON USE**: Roof slab , floor slab, foundation slab, water tank slabs.
5. **BASED ON CROSS SECTION OR SECTIONAL CONGIGURATION:**

   Ribbed slab/grid slab, solid slab, filler slab, folded plates.

6. **BASED ON SPANNING DIRECTIONS:**

DESIGN OF BEAMS

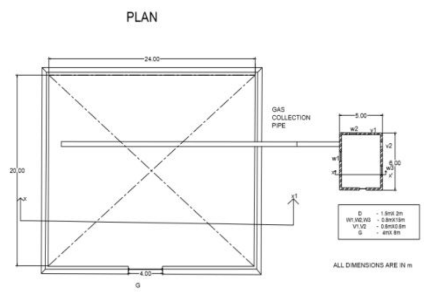
BEAMS:

A beam is a structural member used for bearing loads. It is typically used for resisting vertical loads, shear forces, bending moment.

BASED ON SHAPE OF CROSS SECTIONS: I beam, rectangular beam, T beam, square beam.

BASED ON TYPE OF SUPPORTS: Simply supported beam, continuous beam, overhanging beam, cantilever beam and fixed beam.

DRAWINGS



. Fig 5 PLAN OF BUILDING

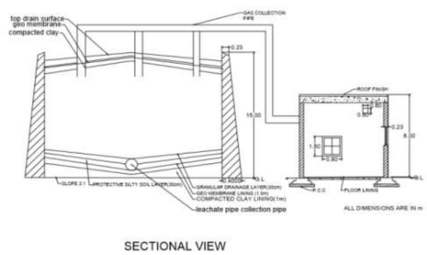


Fig. 6 SECTIONAL VIEW OF BUILDING

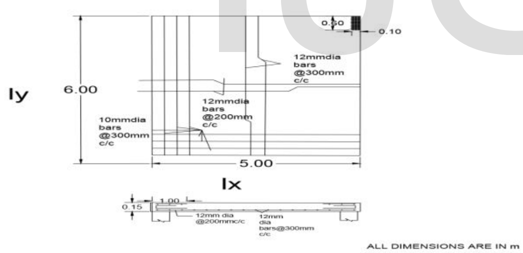


Fig. 7 REINFORCEMENT DETAILS OF SLAB

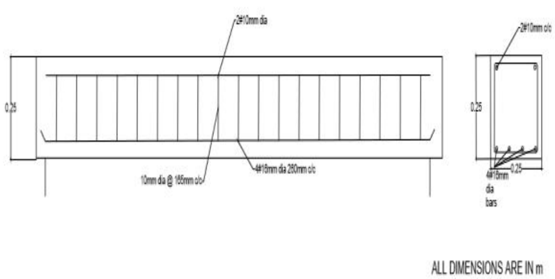


Fig .8 REINFORCEMENT DETAILS OF BEAM

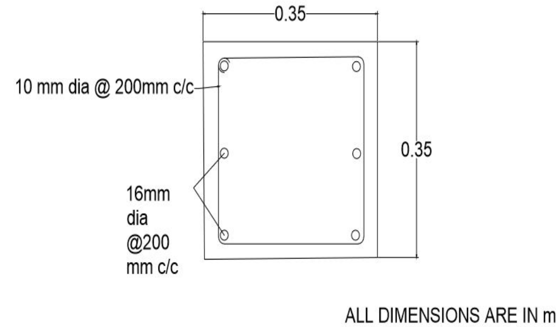


Fig . 9 REINFORCEMENT DETAILS OF COLUMN

COCLUSION

These projects are popular because they control energy costs and reduce greenhouse gas emissions. These projects collect the methane gas and treat it, so it can be used for electricity or upgraded to pipeline-grade gas. Because gases produced by landfills are both valuable and sometimes hazardous, monitoring techniques have been developed. . Based on the flow rate of the landfill gas, it was found that the amount of power generated will vary over time. It will initially increase until it reached a peak.