Landfill Gas Extraction

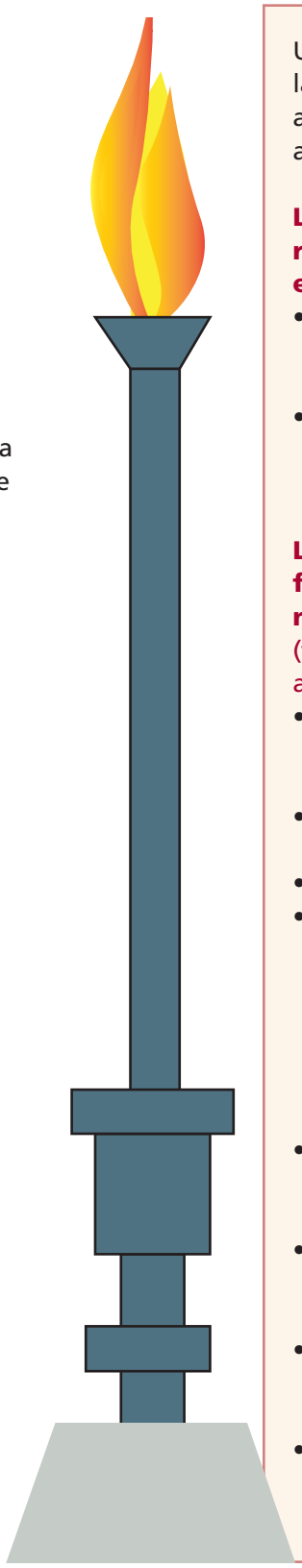
The organic waste in landfills is covered and compressed by heavy equipment, creating conditions that leads to decomposition of the organic matter. There are four stages of decomposition:

1 Aerobic bacteria break down the material while consuming oxygen. The primary byproduct is CO_2.
2 Once the oxygen is used up, an anaerobic process converts matter to acids and alcohols. These cause some nutrients to dissolve. The byproducts are CO_2 and hydrogen.
3 This stage starts when the anaerobic bacteria consume the organic acids produced in stage two and form acetate. At this point, methane-producing bacteria begin to establish themselves.
4 When both the composition and production rates of landfill gas are relatively constant you are in stage four. At this point, the gas usually consists of 45-60% methane by volume, 40-60% CO_2 and 2-9% other gases, such as sulfides. Gas is produced at a stable rate in this stage for about 20 years.

If allowed to build up, the gases can cause explosions. If leached into the atmosphere, they contribute to smog as greenhouse gases.

If the methane gas is acquired (see criteria in box), it can be either burned off (flared) or cleaned to pipeline quality renewable natural gas (biomethane).

If the gas is being flared, we plot a vacuum curve and call the multistage centrifugal an "exhauster." If we are saving the gas for storage, heating or a process application, we call it a "blower" and plot a pressure curve.



Under the Clean Air Act, the EPA requires landfills meeting certain design capacity and emissions criteria to collect landfill gas and either flare it or use it for energy.

Landfills that meet both of these criteria must collect and control landfill gas emissions:

- Capacity: design capacity greater than or equal to 2.5 Mg and 2.5 million cubic meters.
- Emissions: annual nonmethane organic compound (NMOC) emission rate greater than or equal to 50 Mg.

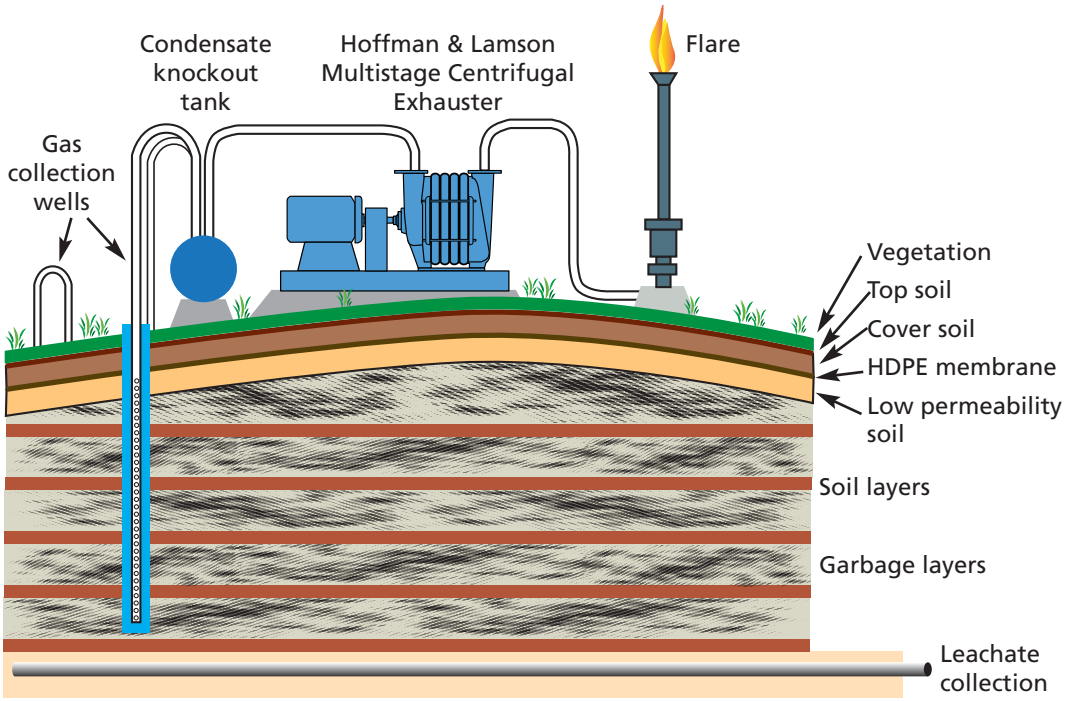
Landfill gas recovery systems cite the following factors as important for economically feasible landfill gas recovery (though there have been successful projects at smaller landfills):

- The amount of waste in place at a landfill is greater than approximately 1 million tons.
- The waste is greater than 35 feet deep and is stable enough for well installation.
- The landfill area is greater than 35 acres.
- The landfill is composed of refuse that can generate large quantities of landfill gas composed of 35% or more of methane. An industry guideline states that gas recovery is economically viable at landfills with gas generation rates of 1 million cubic feet per day (EPA 1996).
- If a landfill is still open, active landfill operation will continue for several more years.
- If a landfill is already closed, a short time (no more than a few years) has elapsed since closure.
- The climate is conducive to gas production (very cold or very dry climates can inhibit gas production).
- The energy user is located nearby or in an area accessible to the landfill.

Landfill Gas to Flare

Landfill areas are carefully prepared with a base of clay, sand and membrane designed to prevent leachate from reaching groundwater. A layer of garbage is added, compacted mechanically and topped with a layer of soil. The process is repeated until the landfill is deemed full. The area is then topped with special, low permeability soil, an HDPE membrane, more soil and a vegetation cover. Holes are bored and piping inserted to collect the methane gas. The quantity of pipes is determined by issues such as decomposition rate, climate, thickness and number of layers. A multistage centrifugal exhauster encourages the gas mixture - mostly methane and CO_2 - to leave the landfill and sends it to the flare.

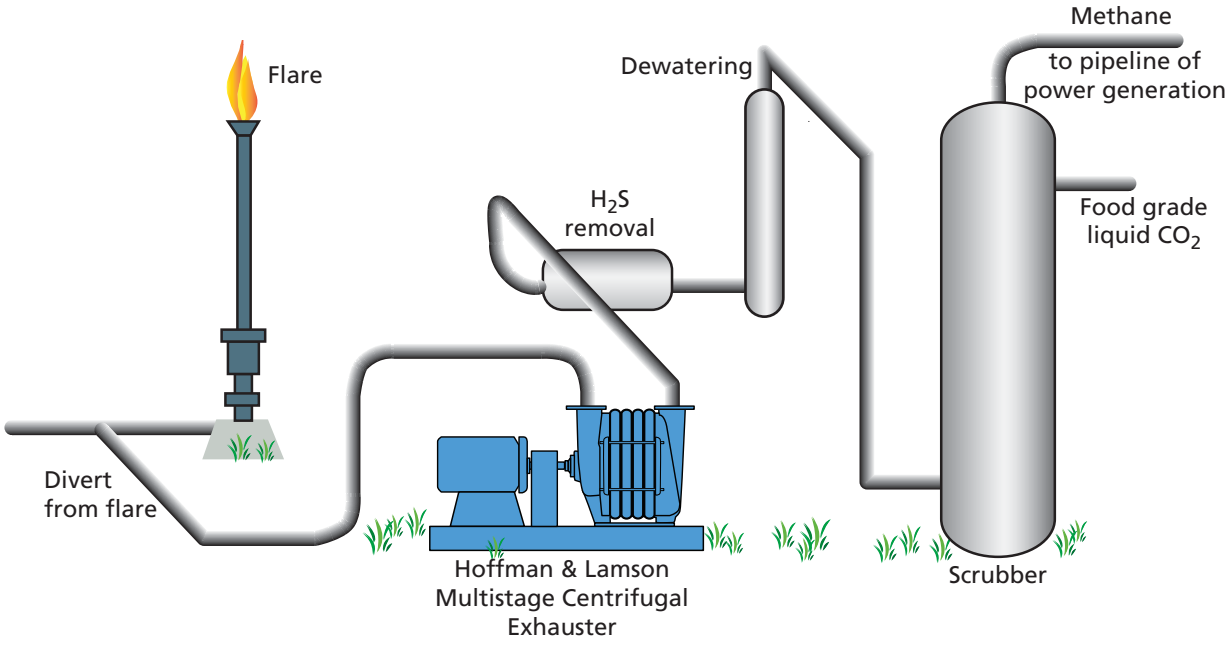
This process can use one or multiple exhausters. A single exhauster could draw from twenty to fifty pipes, however the vent pipes must be engineered to draw an even vacuum. Using multiple exhausters makes this less of a problem.



Landfill Gas to Save

If economically feasible, landfill gas is cleaned to pipeline quality, added to the gas pipeline grid and mixed with natural gas. It can also be used to heat water or air or heat part of an industrial process. If compressed, biomethane can power internal combustion or fuel cell vehicles.

After the multistage centrifugal exhauster has been extracted and sent on, it is diverted to a second blower. During the subsequent processing, food grade CO_2 can be separated from the methane and siloxane trace contaminants, which hinder combustion, are removed.



HOFFMAN LAMSON

www.HoffmanandLamson.com
info.hoffmanlamson@gardnerdenver.com
Phone: +1 724-239-1500 Fax: +1 724-239-1502