United States Environmental Protection Agency Office
Office of Air and Radiation (6202J)
430-F-01-006
January 2001

LANDFILL METHANE OUTREACH PROGRAM

Adapting Boilers to Utilize Landfill Gas: Feasible and Cost-Effective

The use of landfill gas (LFG) in place of natural gas in boilers is an established and well-tested technology with a track record of over 20 years of success. This fact sheet summarizes the basic technology issues that a facility manager may encounter when retrofitting a natural gas boiler to use LFG.

Over 70 companies have switched to the use of LFG in their commercial and industrial boilers. These companies recognize LFG as an attractive renewable fuel that offers significant cost savings – typically 10 to 40 percent net of conversion costs – in addition to environmental benefits. A facility manager that switches to LFG will also reap the benefits of a secure fuel supply at a constant and known price.

Facilities that use LFG in their boilers – "direct" end-users of LFG – can accommodate this new fuel through cost-effective retrofits to existing natural gas and oil-fired boilers, while maintaining their units' efficiency. Boilers successfully retrofitted for LFG range in size from 2 million British Thermal Units per hour (MMBtu/hour) to 150 MMBtu/hour. The average boiler conversion can cost as little as several thousand dollars for minor adjustments on small boilers to tens of thousands for more elaborate retrofits on larger units.

Boilers That Can Be Successfully Retrofitted for Landfill Gas

The most typical boiler technology suitable for retrofitting is the package boiler used in a variety of commercial and industrial applications. The two most common types of package boilers are water wall boilers and fire tube boilers. These boilers have been demonstrated to operate successfully on LFG.

- Water wall boilers use walls consisting of tangential tubes that surround the flame, and are typically used in larger capacity, high-pressure applications.
- Fire tube boilers pass hot flue gases through fire tubes immersed in water, and are typically employed in smaller capacity, low-pressure applications.

Retrofit Challenges Are Easily Managed

To successfully retrofit a boiler for LFG use, certain characteristics of LFG must be taken into account. LFG has about half the heat content of natural gas (approximately 500 Btu) and burns at a lower temperature than natural gas due to the greater volume of nitrogen, carbon dioxide, and moisture contained in LFG. Minor modifications are needed to adapt a boiler to the greater gas flow, higher corrosivity, and lower flame temperature associated with LFG. All of these issues, which are described in the following paragraphs, are easily resolved through cost-effective boiler retrofits.

Greater Volume of Gas Flow

Since the methane content of LFG is half that contained in natural gas, the gas flow required to supply the same energy content with LFG is twice as great. To accommodate this difference in flow, the valve orifices for fuel control need to be enlarged. Using a larger fuel valve orifice can mean additional cost savings since the larger orifice reduces the amount of compression required to attain the boiler's pressure specifications.

Flame Stability

The average lower heating value of LFG due to its lower concentration of methane, together with fluctuations in its heating value, can affect a boiler's flame stability after switching to LFG. This issue can be addressed by the application of redundant ultraviolet (UV) sensors and dual fuel capability.

UV sensors are standard safety features that monitor the boiler flame and verify that the flame has not been extinguished. Since the flame from LFG is more difficult to detect due to its lower temperature, redundant UV sensors should be employed and equipped with voltage indicators.

Retrofitting the boiler with dual fuel burners that can accommodate natural gas as a back-up fuel is another method of ensuring fuel constancy and flame stability. Dual fuel burners are fed by separate gas lines that connect at an intake flow regulator valve, equipped with a Btu content sensor. The valve regulates the proportionate flow of the two fuels to maintain a constant Btu value of the gas entering the burner. Although LFG is most often used together with natural gas, it can also be used with other fuels like propane or coal.

Lower Flame Temperature

A direct effect of LFG's lower flame temperature is the need to increase the superheater size by 20 percent. If a flue gas recirculation (FGR) feature is used as a control measure for nitrogen oxides (NOx), flame temperatures may be even lower, and the size of the superheater will need to be increased proportionately.

Corrosion

Corrosion potentially resulting from LFG use can be circumvented with technically simple solutions. Air preheaters and stacks are susceptible to corrosion from chlorine compounds in the exhaust gas of boilers that use LFG. Sulfur trioxide (SO_3) formed from the sulfur content in LFG raises the dew point in boiler exhaust gas to approximately 280 degrees Fahrenheit. If the temperature of the exhaust gas falls below the dew point, the chlorine in the gas will corrode even stainless steel components.

Air preheater corrosion can be prevented by coating the preheater with porcelain and maintaining the temperature of the exhaust gas at 300 degrees Fahrenheit or higher. Using steam coils to pre-heat the combustion air helps keep the temperature high enough.

Stack corrosion can be prevented by insulating the stack to prevent the exhaust gas temperature from lowering to the dew point. In addition, the stack should be made of carbon steel coated with corrosion-resistant materials such as inorganic zinc. Fuel control valves and associated piping should use stainless steel to protect against corrosion.

Proper water circulation needs to be ensured after the conversion to LFG. The lower flame temperature of LFG can affect the circulation in water wall boilers and cause steam blanketing against the walls of the steam tubes. On some boilers with low circulation velocity, the lower energy of the steam can result in water condensing out of the steam onto the water wall tube risers where corrosive impurities may be deposited. The circulation pattern of the boiler should be checked independently to alleviate these concerns.

Deposits

Deposits of silica, iron, sulfur, and chlorine are known to accumulate on air preheaters and flue gas ductwork. The deposits are easily removed by soot blowing and manual cleaning during routine maintenance.

Successful Boiler Conversions to LFG

Ajinomoto Pharmaceutical Company

In 1989, pharmaceutical firm Ajinomoto partnered with Natural Power and the City of Raleigh, North Carolina, to develop a direct-use project to produce steam from LFG. Natural Power pipes LFG recovered from the city's Wilder's Grove landfill to a nearby Ajinomoto plant, where the LFG fuels a gas-fired boiler owned by Natural Power. Ajinomoto uses the steam produced by the boiler to heat and supply power for manufacturing processes. Combustion of LFG now supplies more than 95 percent of Ajinomoto's steam needs. The project is expected to continue until 2020 when the supply of LFG diminishes below economically recoverable levels.

The original 800-horsepower boiler was fired by natural gas prior to the retrofit for LFG. The boiler now has dual fuel capability with separate fuel lines supplying LFG and natural gas. This boiler has been running efficiently on LFG for more than 10 years. In 1997, Natural Power added another LFG-fired boiler, an 800-horsepower Cleaver Brooks fire tube boiler, also equipped to operate on both LFG and natural gas. Both boilers operate on a full-time basis and require only routine inspection and maintenance.

Sanitation Districts of Los Angeles County

The Sanitation Districts of Los Angeles County, California have used landfill gas projects since 1984, using the collected gas to generate electricity. The district's projects are at four landfills that use nine boilers–five Zurn water walls and four Kewanee fire tube boilers. The boilers range in size from 6 MMBtu/hr to more than 300 MMBtu/hr. Minor retrofits were required to adapt the natural gas boilers to LFG specifications, and the boilers have all operated efficiently and free of corrosion since the conversion. The revenues derived from generating electricity and selling it to the grid help defray the cost of operating the landfill.

Challenges in LFG Conversions	Solutions
Greater volume of gas flow	Use larger orifices on fuel control valves.
Flame stability	Equip ultraviolet sensors with redundant scanners. Employ dual fuel burners.
Lower flame temperature	Increase superheater size.
Corrosion	Insulate preheater and flue stack. Preheat combustion air with steam coils. Ensure that water circulation meets manufacturer's specifications.
Deposits	Remove deposits during routine maintenance.

For More Information

The LMOP is a voluntary program that helps landfill owners, project developers, and communities develop landfill gas use projects. The LMOP can offer technical assistance, resource documents, and other tools to help landfill owners and operators realize their facility's LFG use potential. For more information, call 888-782-7937 or visit the LMOP website at www.epa.gov/lmop.