Biogas generator benefits from precision pressure control

By Dave Lowles, Equilibar, LLC

Many wastewater treatment plants use anaerobic digestion to process their biological solid wastes, reducing landfill volumes and generating valuable electricity in the process. Controlling the biogas pressure that feeds the combustion engine is critical, especially because the flow rate coming out of the digester fluctuates. The Equilibar precision back pressure regulator has been successfully used in one biogas plant to effectively control the biogas pressure at 4 psig while circulating excess gas back to the digester for reuse.

About Anaerobic Digesters

Anaerobic digestion (AD) is a biological process in which biodegradable organic matters are broken-down by bacteria into biogas, which consists of methane (CH4), carbon dioxide (CO2), and other trace amount of gases. The biogas can be used to generate heat and electricity. The primary requirement for AD is an oxygen free environment. Other important factors, such as temperature, moisture and nutrient contents, and pH are also critical for the success of AD. Electricity can be generated on-site using a reciprocating engine, steam turbine, or gas turbine. When a reciprocating engine is used, the biogas must have condensate and particulates removed. (Source: California Energy Commission)

Anaerobic Digesters provide numerous advantages, including:

- Replacement of fossil fuels.
- Reducing or eliminating the energy footprint of waste treatment plants.
- Reducing methane emissions.
- Displacing industrially produced chemical fertilizers.
- Reducing trucking and related emissions.
- Reducing electrical grid transportation losses by generating electricity onsite.
- Reducing the volume of solid waste disposal and related costs.
- Simple and reliable systems
- Odors contained and eliminated
- Reduced operating cost

Gloversville-Johnstown's 350KW Plant

The Gloversville-Johnstown Waste Water plant in upstate Johnstown NY serves 25,000 residential customers as well as 30 industrial and commercial customers. Methane from the anaerobic digester is used to fuel two 350KW Caterpillar gas engines driving generators to produce electricity, which is

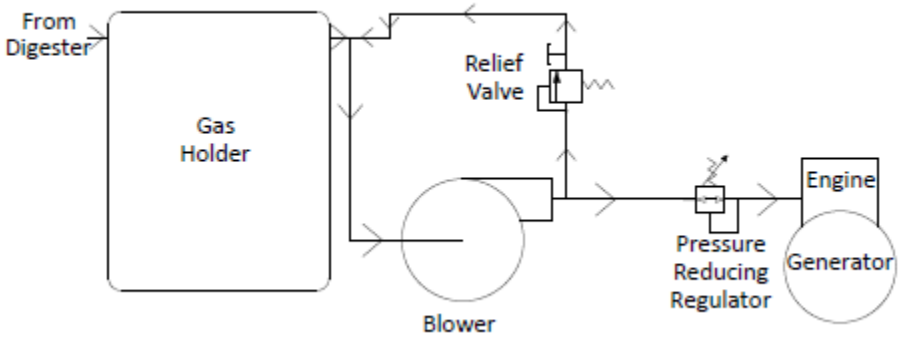
Aerial view of the Gloversville-Johnstown waste water treatment plant in New York.

utilized to operate the facility. The plant processes 6 million gallons of sewage per day, and 100,000 gallons of waste is treated each day by the digesters.

In the original design, a traditional mechanical relief valve was used to control the methane pressure. This valve is designed as a safety rather than as pressure control device in that the spring that controls the relief pressure allows the valve to open completely at very little over pressure. Such a valve is necessary for the protection of the system components and safety of the plant's personnel; however, the relief valve does not lend itself to precisely regulating the gas pressure. As a result the engines did not receive a constant pressure fuel supply and the engine rpm began to surge, something not desirable in a generator application.

Caterpillar 350kW gas engines powered by biogas at the Gloversville-Johnston treatment plant

The schematic below depicts the original system without the gas refinement and filtering devices.



Search for precision low pressure regulator

George Bevington, the plant manager, began a search for a more precise methane pressure control strategy and contacted Equilibar with his challenge. Although the regulator of the proper size (2 inch) and configuration was not in stock, Equilibar was able to quote, configure, fabricate, assemble and ship within 10 days so that the installation could be completed while the facility's subcontractor crew was still on site.

2" Equilibar EB10NLB16 used at Johnstown-Glove Waste Water Treatment Facility

Back pressure regulators work similarly to relief valves, but the emphasis is on steady state pressure control instead of on/off pressure protection.

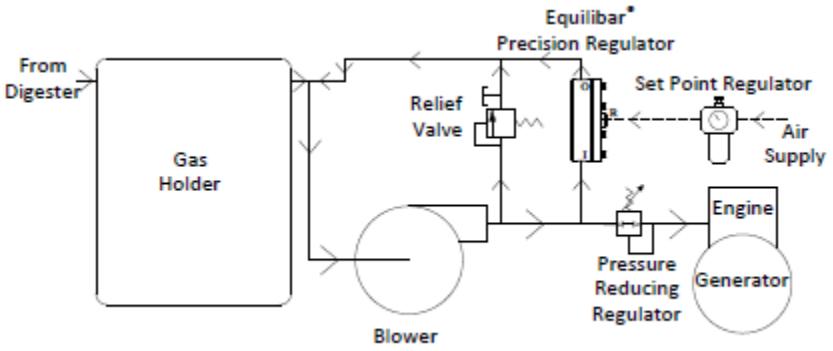
The Equilibar® back pressure regulator uses only a frictionless flexible membrane to modulate the pressure. The inlet pressure of spring controlled back pressure regulators vary significantly with changes in process flow

In this installation, the set point is determined by a small manually operated pilot regulator (not shown) supplied with filtered shop air. The controlled pressure is in the 4 psig range. This can be adjusted to achieve optimum performance from the engine-generator system.

Stable performance

The installation of the Equilibar regulator in parallel with the safety relief valve provides much more precise pressure control in the range required by the engines. The quick acting safety relief valve only comes into play in rare instances of excess pressure above a new higher set point. With the system pressure now smoothly controlled by the Equilibar regulator and only the over pressure relief function assigned to relief valve, the pressure reducing regulators on each engine are not necessary. However, they were left in the system to avoid re-piping.

View of Equilibar EB10NLB16 installed in the engine process.

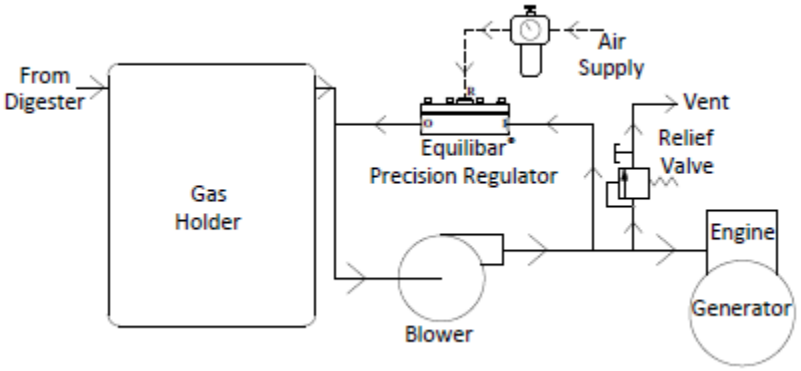


Gas emitted from the pressure regulator and relief valve circulates back to the head of the blower.

The results: Tests have shown that the system can be smoothly throttled up and down the load range including taking one engine off line or running both engines wide open (700KW) with no loss of methane pressure or engine speed control.

Per George Bevington "In order to properly operate a gas compression system for anaerobic digester fueled engines, an Equilibar pressure regulator is needed to precisely modulate the gas pressure"

Refining the concept for other installations: Several changes could be made in a new installation, such as piping the relief valve exhaust to atmosphere or a flare to meet local codes. Also, the pressure reducing regulator on the gas inlet of the engine can be eliminated, simplifying the installation. With those changes the piping schematic would look like the illustration below.



Conclusion: Precision back pressure control offers a better solution to anaerobic digester gas pressure control than alternative means of controlling the pressure of biogas. Learn more about Equilibar precision back pressure regulators

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