EQUILIBAR®
PRECISION PRESSURE CONTROL

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Biogas generator benefits from precision pressure control

Background

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 consisting of methane (CH_4), carbon dioxide (CO_2), and other trace amount of gases. The biogas can be used to generate heat and electricity. The primary requirement for AD is an environment absent of O_2. Other important factors, such as temperature, pH, moisture and nutrient contents are also critical for the success of AD. Electricity can be generated on-site of an anaerobic digester 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 plant;
- 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;
- Creating simple and reliable systems;
- Containing and eliminating odors;
- Reducing operating cost.

Gloversville-Johnstown's 350 KW plant

The Gloversville-Johnstown wastewater plant in upstate Johnstown NY serves 25,000 residential customers as well as 30 industrial and commercial customers.

Fig. 1 Aerial view of the Gloversvillle-Johnstown wastewater treatment plant in Gloversville, New York

Methane from the anaerobic digester is used to fuel two 350KW Caterpillar gas engines driving generators to produce electricity, which is 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.

Fig. 2 Caterpillar 350 KW gas engines powered by biogas

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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 controlling 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, an undesirable condition in a generator application.

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

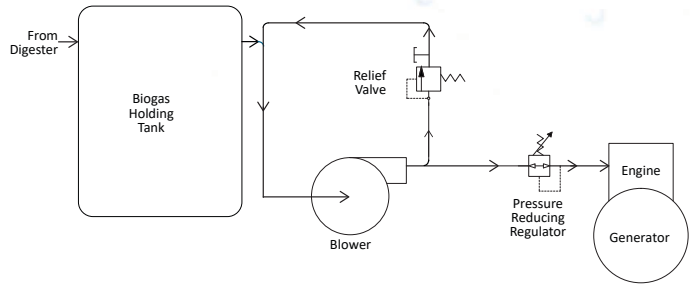

Fig. 3 Schematic of original biogas feed system to generator

Search for precision low pressure regulator

George Bevington, 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 the desired control valve in 10 days so that the installation could be completed while the facility's subcontractor crew was still on site. (Note, Equilibar is not always able to meet such tight timing. Please ask an Equilibar applications engineer about current timing estimates).

Back pressure regulators (BPR) 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 incorporates a dome-loaded design and uses multiple parallel orifices sealing against a supple diaphragm to better maintain pressure stability. The dome loaded design uses compressed air to load the internal diaphragm rather than a coil spring used in traditional designs. The advantage is that the supple diaphragm responds instantaneously to setpoint changes and process variations to achieve a precise pressure control.

In this installation, the setpoint is determined by a small manually operated pilot regulator (not shown in photo) 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.

Fig. 4 Equilibar BD16 2" control valve fabricated with 316 stainless steel

Stable performance

The installation of the Equilibar regulator in parallel with the safety relief valve provided 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. A schematic is shown below.

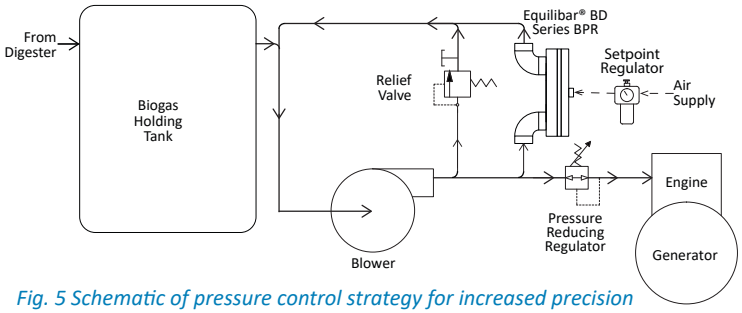

Fig. 5 Schematic of pressure control strategy for increased precision

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

"We learned that In order to properly operate a gas compression system for anaerobic digester fueled engines, an Equilibar pressure regulator was what we needed to precisely modulate the gas pressure."

- George Bevington, Plant Manager

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Fig. 6 View of BD16 installed in the biogas engine system

Refining the design

Several changes could be made in a new installation, where retrofitting into existing piping is not a concern. One upgrade would be piping the relief valve exhaust to atmosphere or a flare to meet local codes. The pressure reducing regulator on the gas inlet of the engine could be eliminated, simplifying the installation. With those two changes the system schematic would look like the illustration at right.

Conclusion

Tests at the Gloversville-Johnstown wastewater plant showed 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.

Precision back pressure control offers an excellent solution to anaerobic digester gas pressure control. *Contact an Equilibar application engineer* for more information about improving pressure control in your specific process.

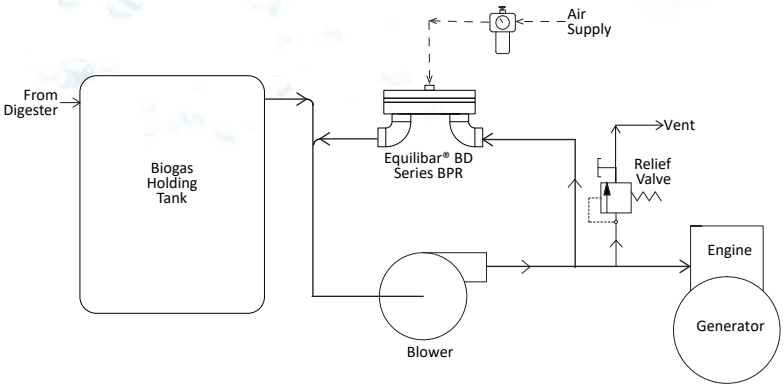

Fig. 7 Schematic of optimized biogas feed system to generator

Contact Equilibar

Equilibar is a provider of unique and innovative fluid control solutions based near Asheville, North Carolina. The patented fluid control technology is used in a wide array of processes including catalyst, petrochemical, supercritical and other industrial applications. For more information contact an Equilibar application enigneer at inquiry@equilibar.com or 828-650-6590.

Author Bio

Dave Lowles is a former executive in the semiconductor fluid controls industry. At this writing of this article, Dave was acting as a consultant for Equilibar, LLC in Fletcher, NC. Learn more about precision pressure control at www.equilibar.com.