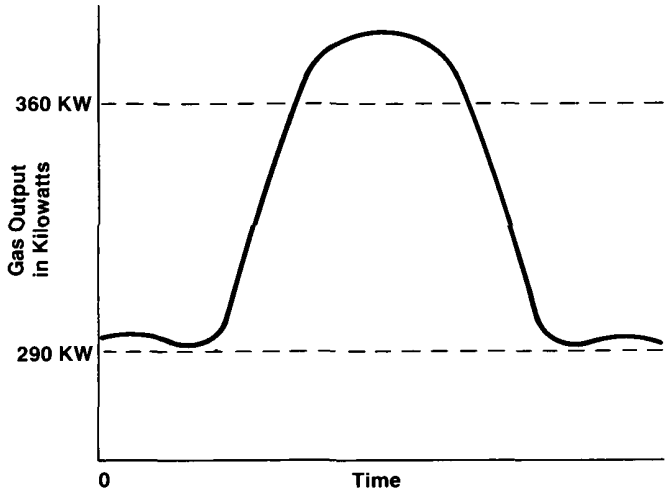
CONSTA-MIX

Natural Gas/Air Mixing System

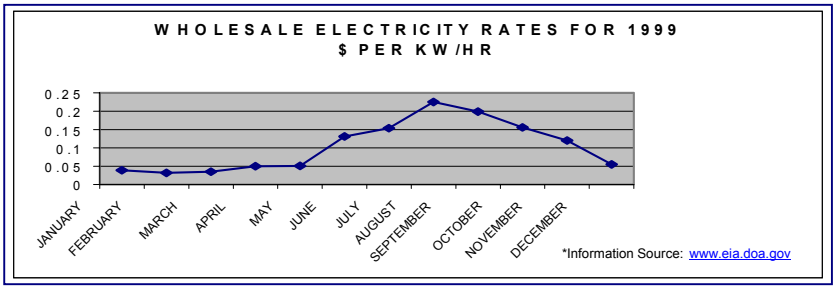
- **Generate Electricity With Your Digester Gas-Don't Flare It!**
- **Maximize The Efficiency Of Your Waste Water Treatment Plant With The CONSTA-MIX.**
- **Paybacks In Less Than 1 Year!**
- **Insulate Your Waste Water Treatment Plant From Volatile Electricity Prices.**

Unfortunately, digester gas production is erratic. Therefore, you can not maximize the amount of electricity generated……unless you have a **Consta-Mix**.

The **Consta-Mix** blends natural gas with air to burn with the same characteristics as digester gas. When digester gas production is low the Consta-Mix will supplement the load, allowing your waste water treatment plant to generate the maximum amount of electricity.



Typical gas production of anaerobic digester



- Insulate yourself from volatile electricity prices.
- Sell electricity back to the grid when prices peak.

The Consta-Mix offers:

Waste Water Treatment Plant Efficiency

- Consume all of your digester gas and use only the amount of natural gas needed to supplement the load.
- Minimize the size of your digester gas collector.
- Sell electricity back to the grid and payback time reduces even further.

Extreme Flexibility

- The Algas-SDI Consta-Mix combines any combustible gas with air to burn with the same characteristics as digester gas.
- No engine adjustments required.

Unparalleled Reliability

- Easy to start-up and minimal effort to maintain.

Superior Turndown

- 100 to 1

Environmentally Friendly

- Flaring digester gas causes pollution

Algas-SDI

APPLICATION REPORT

Consta-Mix gas augmentation system in Waste Water Treatment Plants

Energy conservation methods are rarely as effective as those used by many waste treatment plants. Besides converting municipal sludge into saleable fertilizer, these plants generate electricity by burning methane gas in internal combustion engines. Surplus power is sold to the local utility, and waste heat generated by the various processes is reclaimed for maintenance purposes. Brown & Caldwell, a consulting engineering firm located in Walnut Creek, California, is a leading designer of such installations. Among the equipment they specify is an Algas-SDI Consta-Mix gas augmentation system used to supplement the normally fluctuating methane supply from the digestors.

Certain types of anaerobic bacteria decompose municipal sludge into non-digestible solids and a sludge gas composed of 60-75% methane and the remainder carbon dioxide. With a lower heating value of 550-700 Btu/scf, the gas can be used as a fuel for internal combustion engines driving electrical generators. Sludge gas is produced at pressures up to 12" w.c. in closed, heated chambers known as digesters. Unfortunately, the methane generating bacteria have unpredictable production rates. Figure 1 shows methane production versus time for a typical operating period at a plant located in the San Francisco Bay area. Engines for this plant could be sized for a 290 kW input, and any excess gas produced by the digester would be burned off by a waste gas flare. Alternately, the engines could be sized for an input of 360 kW. A gas augmentation system would be used to supply an equivalent natural gas/air or propane/air mixture during periods of low sludge gas production. The additional 70kW recovered from the sludge gas by this method provides significant cost savings.

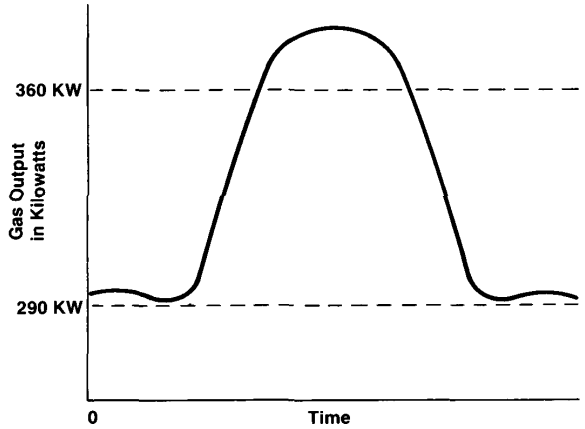
The pay-off period depends largely on the cost of power, the price of natural gas or propane, and the rate of inflation. In a cost analysis of one recent job, the revenue to the user over a twenty year life cycle was estimated to be $80,000 to $400,000 per year, based on projected electrical power costs of $0.075 to $0.125/kW. This study included a 10% general inflation rate, a 12% annual inflation rate for electric power, and a 14% inflation rate for supplemental natural gas. Other expenses are always involved, so the overall pay-off period for this example was calculated to be about four years, an economical figure for many waste water treatment plants.

Digester gas may be used by either turbocharged or naturally aspirated internal combustion engines. Turbocharged engines require a gas pressure in the range of 30-60 psig. Although the engine itself may be more efficient, the complications of compressing wet, dirty digester gas to these pressures significantly increases maintenance and downtime of the entire engine.

Naturally aspirated gas engines, however, require a steady gas inlet pressure of only 4-5" w.c. It may appear that with 12" w.c. pressure at the digester and only 5" w.c. needed at the engine, gas transportation would only require adequately sized pipe. This is generally not the case. Moisture separators, drip traps, flow meters, pressure regulators, manual and automatic control valves, check valves and piping losses all reduce the available pressure, necessitating a boost in the transmission pressure of about 14" w.c. This is easily accomplished with an Eclipse Series HB Hermetic Booster. By keeping the gas supply pressure to the engines under 14" w.c., unreliable low pressure relief valve venting required by paragraph 421 of the NFPA standard 37 can be avoided. A sketch of a gas management system is shown in Figure 2.

In addition to methane and carbon dioxide, sludge gas may contain fine particulate matter, 20% to 100% humidity, greasy oils, and traces of hydrogen sulfide,

FIGURE 1—TYPICAL GAS PRODUCTION OF ANAEROBIC DIGESTER



ECLIPSE Innovative Thermal Solutions
Algas • SDI

hydrogen, and nitrogen. The gas is typically produced at a temperature of 90-100°F (xx-yy°C). To prevent corrosion, all surfaces in contact with the digester gas must be protected. The Eclipse boosters used for these applications have an airtight steel construction with no motor seal, a non-sparking aluminum rotor, and a Class I, Division 1, Group D explosion-proof motor with a 1.15 service factor. All of the surfaces contacting digester gas are coated with epoxy having a minimum dry film thickness of eight mils. Booster sizing must allow for the specific gravity and temperature of the sludge gas, as these affect the ratings of the booster. Performance curves specifically developed for digester gas are available for most of the commonly used Eclipse boosters.

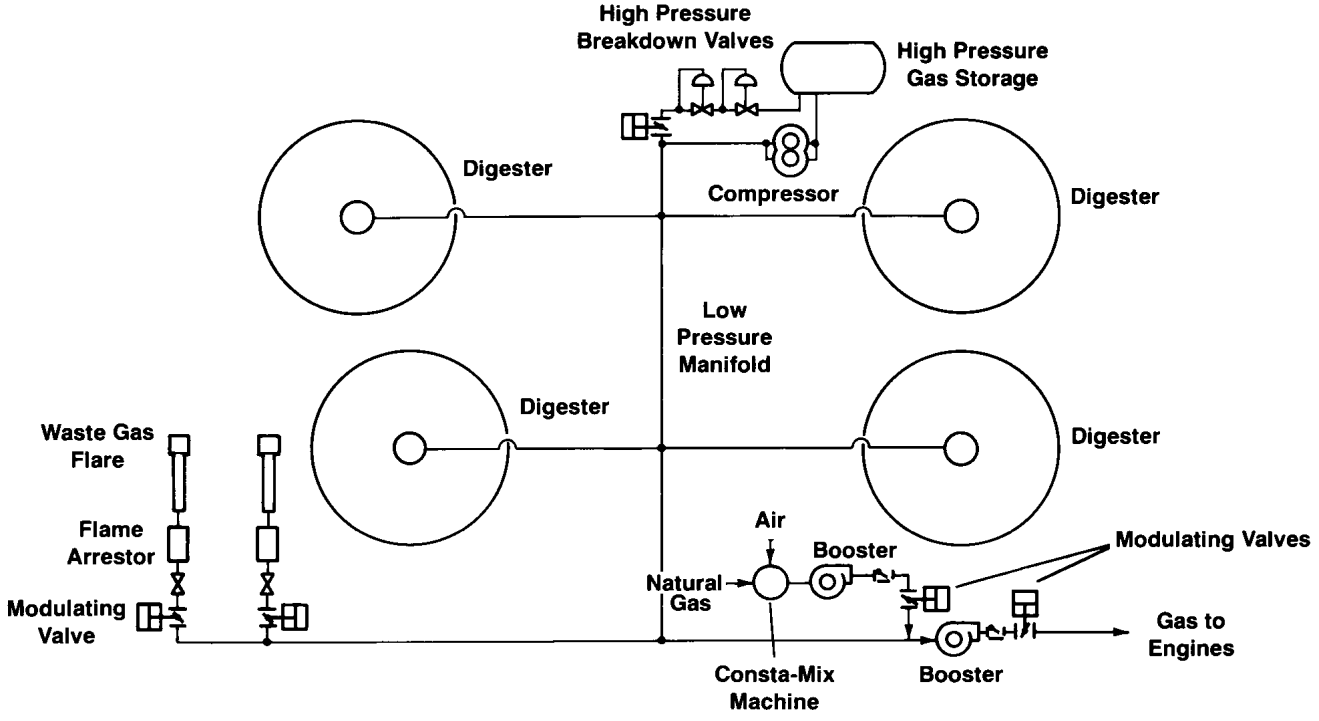
To maintain electrical generation during periods of low methane production, a propane or natural gas standby system is installed. At full capacity, the standby system should be capable of supplying the total input requirements of the engines. The digesters can thus be shut down for maintenance or servicing without disrupting the electrical supply. A very wide standby system turndown range is required, with a minimum of 100:1 commonly specified. Algas-SDI Consta-Mix machines are ideal for these applications. Consta-Mix machines feature precise adjustment of air/gas ratio, constant ratio over the rated turndown range, and reliable operation with a minimum of maintenance.

An example of a methane gas power generating facility is the Waste Water Treatment Plant in Oxnard, California. Oxnard continuously operates two 600 HP engines at a speed of 720 RPM. A third engine is provided for standby. The sludge gas, produced by two digesters, is insufficient to meet all of Oxnard's electrical needs. The plant is therefore connected to the public utility at all times, and no provisions are required for emergency power.

The supplemental gas system consists of two Eclipse Consta-Mix machines. One machine is adjusted to supply a natural gas/air mixture with a heating value of 600 Btu/scf. Gas manifold pressure is maintained at 11" w.c. The second Consta-Mix machine is calibrated for propane gas. Due to the higher cost of propane, this unit is only used as a back-up for the natural gas machine. Operating logs show natural gas to sludge gas ratios ranging between 1:0.6 and 1:2.8 during normal operation. The system is capable of operating with any mixture from 100% natural gas to 100% sludge gas. Waste gas flares installed to burn off excess sludge gas are rarely used at this facility.

Equipment reliability is essential, as Oxnard is operated by a staff of only five people. In two years of operation, little attention beyond routine servicing has been required. Operators follow a preventative maintenance schedule which includes replacing the engine spark plugs every 500 hours, lubricating the Eclipse motorized valves and shut-off valves, inspecting, and if necessary, cleaning the Consta-Mix slide gate, and keeping a log of inlet and outlet gas pressures.

FIGURE 2 — TYPICAL SYSTEM



Consta-Mix Valves

Algas-SDI Consta-Mix valves are precision gas/air or gas/gas mixers and controllers, designed specifically for use in these applications: Pre-mix systems to supply a combustible gas/air mixture to gas burning equipment; Gas/air or Gas/gas mixing to supplement digester gas for use in engine generators to generate electricity at waste-water treatment facilities or landfill reclamation sites; Standby systems to replace or augment the supply of natural gas by mixing LP-gas with air in the event of interruption; and enriching or trimming natural gas with LP-gas or air to achieve a stable heating value for process quality improvement.

The Consta-Mix valve offers extreme flexibility. Any type of commercial fuels can be used. Once the gas/air ratio is set, no further adjustments are required. Regardless of demand requirements, exact mixing ratio is maintained with smooth, pulse-free operation. Consta-Mix valves and systems are designed for continuous use.

Algas-SDI Consta-Mix valves are Factory Mutual Research approved and are available with maximum capacities ranging from 3,000 to 140,000 cfh. Delivery pressure is dependent on the booster or compressor used. Turndown ratios from maximum to minimum flow exceed 100:1.

To aid in the selection of the proper Consta-Mix valve to suit your requirements, contact your nearest Algas-SDI representative or the factory.

Operation

Algas-SDI Consta-Mix valves are variable area, constant pressure drop devices incorporating two precision cones mounted on a common shaft, which float over a pair of precision orifice plates. The two cones and their respective orifices are machined to maintain the same mixing proportion of the two gases throughout the entire operating range.

The two cones are factory preset to just close off the annular areas but do not actually rest on the orifice plates, minimizing wear on the cones. Consta-Mix valves have been in operation for over 50 years needing only minimal maintenance.

Referring to Figure 1, when suction is created, the two gases (both at atmospheric pressure) are drawn into the mixing valve chamber through their respective openings. The ratio of the gases is controlled by the annular orifice area which is created by the opening between the cone and orifice. Within the mixing chamber, the two gases are mixed and then drawn into the booster/compressor where the pressure is elevated.

Suction in the valve is transmitted to the diaphragm through an impulse line. As the demand increases, the resulting pressure drop across the orifices forces the diaphragm further open until the pressures balance and the demand is satisfied.

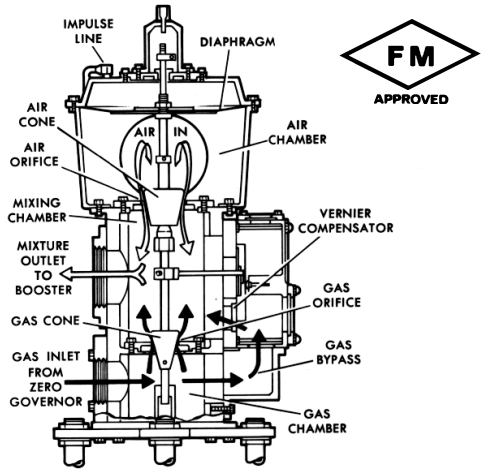


Figure 1

The reverse happens as the demand decreases.

A predetermined amount of the primary gas is diverted through a bypass containing the vernier compensator. The vernier compensator provides very precise and controlled tuning of the final gas mixture over the entire flow range. The vernier compensator illustrated in Figure 2 features a large adjustable slide for adjusting the mixing ratio over the entire range and an array of smaller individual slides that can be used to fine tune the mixture at any specific flow rate within the flow range of the Consta-Mix.

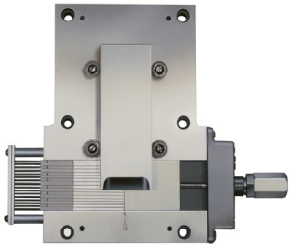
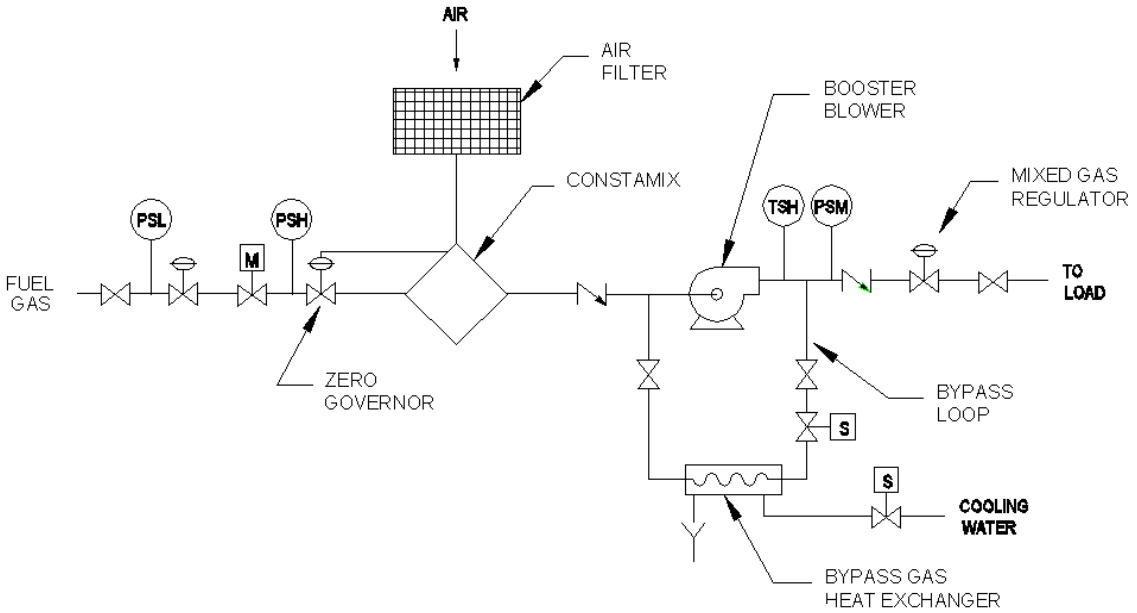


Figure 2

Waste Water Treatment and Landfill Gas



Typical WWTP Consta-Mix P&ID

Consta-Mix systems are used at wastewater treatment facilities that burn digester gas in internal combustion engines to generate electricity. In these applications the Consta-Mix system supplies a natural gas/air or propane/air mixture to the engines as a supplement to the fluctuating digester gas supply. In actual operation, as the digester output varies, the supply from the Consta-Mix makes up the difference allowing the engines to maintain continuous output all-the-while using all of the digester gas available. Only as much natural gas or propane is as is needed to make up the difference. In the event the digester is down for maintenance or repair, the Consta-mix system can be used to continue full operation of the engines. The superior turndown of the Consta-Mix machine assures smooth engine operation at all levels of demand. The typical mixture setting for natural gas/air is 60% natural gas and 40% air, with discharge pressures ranging from 10" w.c. to 3 psig.

All Consta-Mix systems are supplied mounted on a heavy-duty steel base with solid top plate. All systems come standard with FM-style inlet gas train with zero-gas governor and all safeties, air inlet filter, discharge booster with starter, check valve, low mixed gas pressure safety switch and Consta-mix valve. Standard configuration meets Class I, Division 2, Group D.

In some applications it may be necessary to use an optional booster by-pass cooling circuit to remove excess heat from the gas in the booster during down cycles.

Model	Mixing Capacity, scfh
30CM	3,000
116CM	10,000
124CM	25,000
32DV	40,000
32SDV	72,000
40DV	140,000

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