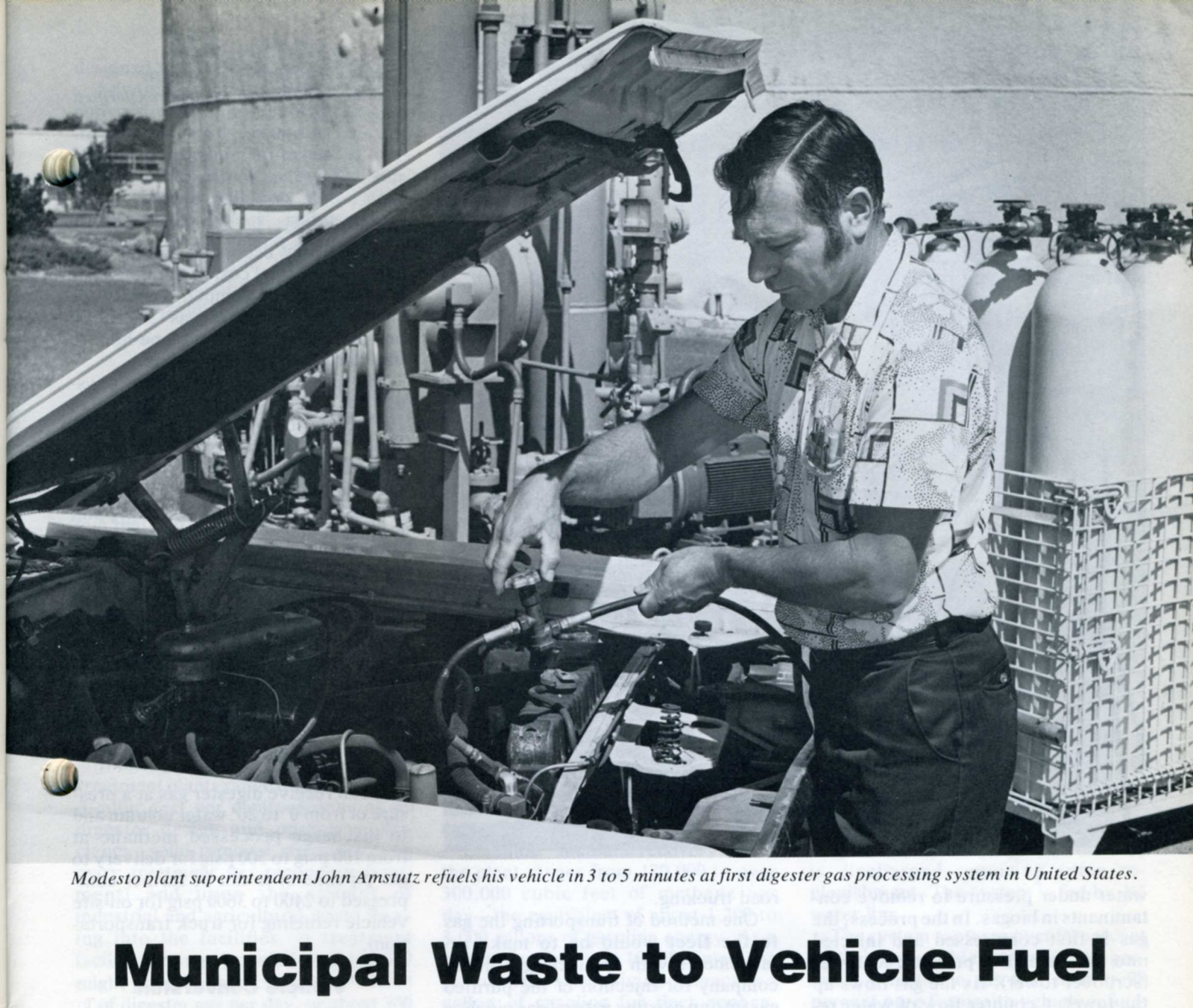


Modesto plant superintendent John Amstutz refuels his vehicle in 3 to 5 minutes at first digester gas processing system in United States.

Municipal Waste to Vehicle Fuel

This methane recovery project at the Modesto, California wastewater treatment plant shows how cities and industries can become more energy self-reliant.

R.A. HENRICH
Central Plants, Inc.
Commerce, Cal.

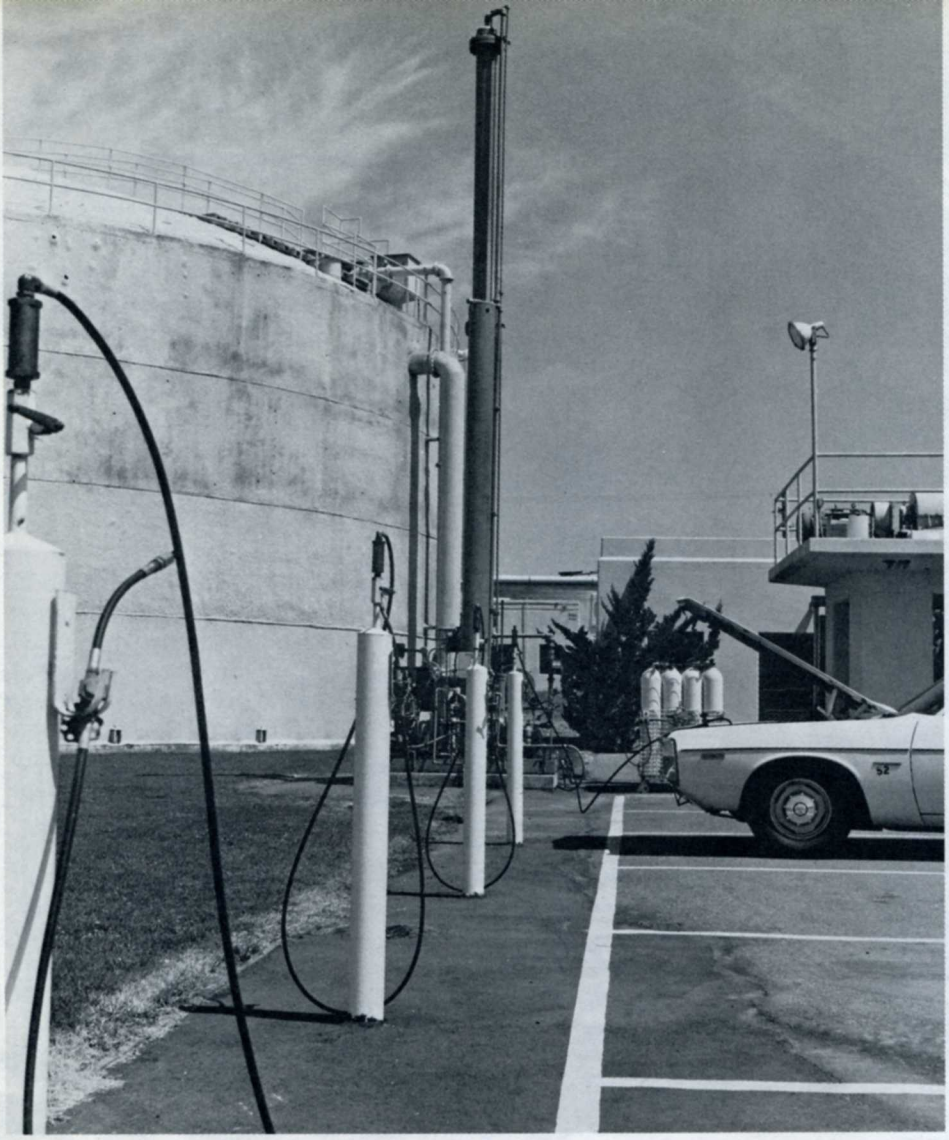
MUNICIPALITIES throughout the world have an untapped wealth of renewable energy potential in the methane gas that could be produced at wastewater treatment plants and landfill sites. The biogas produced from the anaerobic stabilization process, however, also contains 30 to 50 percent carbon dioxide and trace amounts of hydrogen sulfide. These contaminants lower the gas heating value and make it corrosive.

A new process system known as Binax has been developed by Central Plants, Inc. to remove the contaminants from the biogas, thereby producing a gas that is 98 percent methane, suitable for injection into a natural gas pipeline or use as a vehicle fuel.

This Binax system was first put into steady operation in 1978 at the wastewater treatment plant for Modesto, California (pop. 100,000), where the methane fuel has been used to "gas up" city vehicles. Typically, according to our calculations, a wastewater plant can produce enough methane to meet from 50 percent to more than 100 percent of a city's gasoline-powered fleet.

A vehicle conversion system (BiPac System) developed by Central Plants' affiliate Dual Fuel System, Inc. allows gasoline-powered vehicles to operate interchangeably on compressed methane and gasoline. Central Plants and Dual Fuel Systems are subsidiaries of Pacific Lighting Corporation, whose major holding is Southern California Gas Co.

The Binax system uses ordinary



Vehicles at Modesto's wastewater treatment plant can be refueled on purified digester gas.

water under pressure to remove contaminants in biogas. In the process, the gas is first compressed and injected into the base of a pressurized tower (scrubber tower). As the gas flows up the tower, a counter flow of water removes the contaminants. The water from the bottom of the scrubber is then piped to the top of a second tower (regenerator tower). In the regenerator tower, the contaminants are removed from the water, and the water is then recirculated. The removed contaminants (CO_2 and H_2S) are vented to the atmosphere; options are available to remove H_2S first. The purified gas (methane) leaving the scrubber tower is dried and then piped to the point of use—onsite or remote.

Delivery and Economics

Frequently the need for the gas is outside the treatment plant or landfill. Transfer of the biogas to locations outside the plant can be accomplished by a number of methods—existing natural gas pipelines, new pipeline, over-the-road trucking.

One method of transporting the gas to the fleet would be to make arrangements with the local gas utility company for injection of the purified gas into an existing natural gas pipeline at or near the treatment plant or landfill. The city might sell the gas to the utility, pay a transport fee, or receive a credit for the gas injected. This type of arrangement, if available, would eliminate the need to construct a new pipeline between the plant and the fleet and would balance fluctuations in the digester gas production throughout the year with daily vehicle fuel demand.

Or, the city would construct its own pipeline between the plant and the point(s) of use. The technology for engineering, installing and maintaining a pipeline is well established by the natural gas industry.

A third alternative would be to use gas transport trucks to transport the gas in high pressure cylinders. Total storage capacity ranges from 10,000 cf to about 200,000 cf (methane) per truck.

Preliminary economic studies indicate that the total cost of the Binax gas produced can be competitive with the current price of natural gas (30¢ to 70¢ per 100,000 BTUs) and one-half to one-third the cost of gasoline.

The gas produced by the Binax system has a heating value of about 980 to 1000 BTU/scf (natural gas averages about 1000 to 1070 BTU/scf). The water content of the Binax gas can be reduced to 7 lbs/million cf and hydrogen sulfide content to about 4 ppm, normal standards in the gas industry.

Design Specifications

The processing capacity of the Binax system ranges from about 5,000 cf/day to over 2,000,000 cf/day.

The system is designed to capture 90 percent or more of the available methane in the digester gas. The purified gas from the system is odorized as a normal safety precaution for leak detection.

It can receive digester gas at a pressure of from 0" to 20" water column and to discharge processed methane at from 100 psig to 500 psig for delivery to gas pipeline or it can be further compressed to 2400 to 3600 psig for on-site vehicle refueling (or truck transportation).

Vehicle Conversion

A simple conversion system allows vehicles to operate on either gasoline or compressed methane (natural gas). The same system enables vehicles to run on the refined methane from the Binax system. Installation of the conversion equipment requires little modification to a vehicle, and the equipment can be transferred easily to a replacement vehicle, so the equipment is a one-time investment.

A fuel gauge and selector control mounted on the dash lets the driver see when the methane gas is getting low and enables him, while driving, to switch to gasoline.

Refueling with methane is easy. Depending on the fleet's needs refueling stations can either "quick fill" a vehicle in about two to five minutes or "time fill" overnight. A station can be

designed to have both capabilities.

Advantages of the BiPac system conversion include significant savings in fuel costs, the use of an alternate fuel instead of gasoline, an extended driving range because of the two fuel supplies, reduced pollution of the environment from exhaust, and usually, a reduced cost of vehicle maintenance and longer engine life. And the methane-powered vehicle can operate in all environments, from tropical to arctic.

Conversion Cost

Currently, the cost of converting a car or truck to run on compressed methane averages about $1,500 including installation. The cost of a refueling station for the vehicles begins at about $50,000 (installed) for a system that can provide the equivalent of about 180 to 200 gallons of gasoline per day. Larger refueling systems average about $1,500 per vehicle installed. For example, the cost to convert a 100 vehicle fleet that uses four to seven gallons of gasoline per day would require a capital investment of about $150,000 in vehicle conversion costs and $150,000 for an installed refueling station.

Biogas production from wastewater treatment plants range from about ¼ to 3 cubic feet per capita depending on digester design and operating efficiency, solid removal efficiency (primary treatment vs. secondary treatment) and upon the amount of industrial and agricultural waste flowing into the facilities. A treatment facility serving a population of 100,000 might produce from 50,000 to 300,000 cf of digester gas per day, or about 300 to 1,800 gallons of gasoline. Most treatment plants in the United States probably serve a population of 10,000 to 50,000 and produce a respective 10,000 to 100,000 cubic feet of digester gas per day.

Modesto Case Study

The Modesto treatment plant serves a population of just over 100,000 plus a seasonal agricultural industry. Influent to the plant varies in both volume and quality according to the activity of the packing plants in the area. Daily flow varies from about 20 mgd to about 45 mgd. The existing digester produces approximately 180,000 to 300,000 cubic feet of biogas per day, although new equipment planned for installation should increase the maximum available daily production to over 400,000 cubic feet per day.

Potential "methane recovery" from the plant ranges from 120,000 to over 300,000 cubic feet of methane per day—the equivalent of about 1,200 to 3,000 gallons of gasoline energy. As a rule of thumb, about 100 cf of methane provides the same driving distance as a gallon of gasoline for fleet applications.

The pilot Binax system developed for Modesto was designed to process 900 cubic feet of digester gas per hour and to operate a maximum of 14 hours per day.

Total daily output is about 8,500 cubic feet of methane, the equivalent of about 85 gallons of gasoline energy. Tests show that the maximum processing capacity of the Modesto unit is in excess of 25,000 cf per day or about 10% of the plants total biogas production.

The system is skid-mounted and sits on an 8′ x 8′ concrete slab base. Height of the system is about 30′. The design incorporates two towers—one for scrubbing the digester gas (with water) and one for removing the contaminants from the water. The water used in the system is recirculated although minor evaporation does occur when the CO_2 is discharged requiring some replenishment. The system is fed by ¾″ water line.

The system captures over 90 percent of the recoverable methane and produces a methane gas that is over 98 percent pure for onsite vehicle refueling. Purified gas from the system is discharged at either 2,400 psig for direct refueling of vehicles overnight or at 3,600 for injection into high pressure storage cylinders for quick refueling of vehicles in 2-5 minutes.

Based on the favorable results of the pilot system, the city is investigating the installation of a system to process all of the raw digester gas produced at the wastewater treatment plant and to pipe the processed gas to their nearby maintenance yard for use as a vehicle fuel.

Future applications of these technologies include animal feedlots, landfill sites, farms, food processing plants, industries which currently discharge into wastewater treatment plants and, of course, treatment plants across the United States.

"On Being More Independent of Imported Gasoline"

"We know the importance of being more self-reliant in developing our own vehicle fuels system . . . on being independent of imported gasoline. On that basis, we're proceeding with the project," says Ross Campbell, Modesto's Director of Public Works.

If further government grants don't become available, Campbell says that his Department will proceed on a piece-meal basis — first converting city cars to run on methane. The Modesto City Council has already budgeted $300,000 for the project — enough to cover that phase of the biogas-to-vehicle fuel project.

"We're still trying to get a loan to do the whole project," Campbell says, "or we could go ahead with a lease-purchase option." Total cost is estimated at about $1,300,000.

As part of the pilot program, seven city-owned vehicles — four automobiles and three pickup trucks — were converted to burn methane as well as gasoline, at an estimated cost of $1,200 each. According to John Amstutz, superintendent of Modesto's sewage treatment plant, who drives one of the cars, the cost is about 35 cents for the equivalent of a gallon of gasoline. The methane gas also proved cleaner, and less destructive to engines than gasoline.

Concludes Ross Campbell:

"We recognize that there are alternatives, such as generating power and selling it to Pacific Gas & Electric. But it's important to go beyond present economics and look to the future. I'm convinced our approach will be dollar-effective, especially as we become more independent of imported oil.

"The bottom line is that the project is well and healthy . . . and we're proceeding."