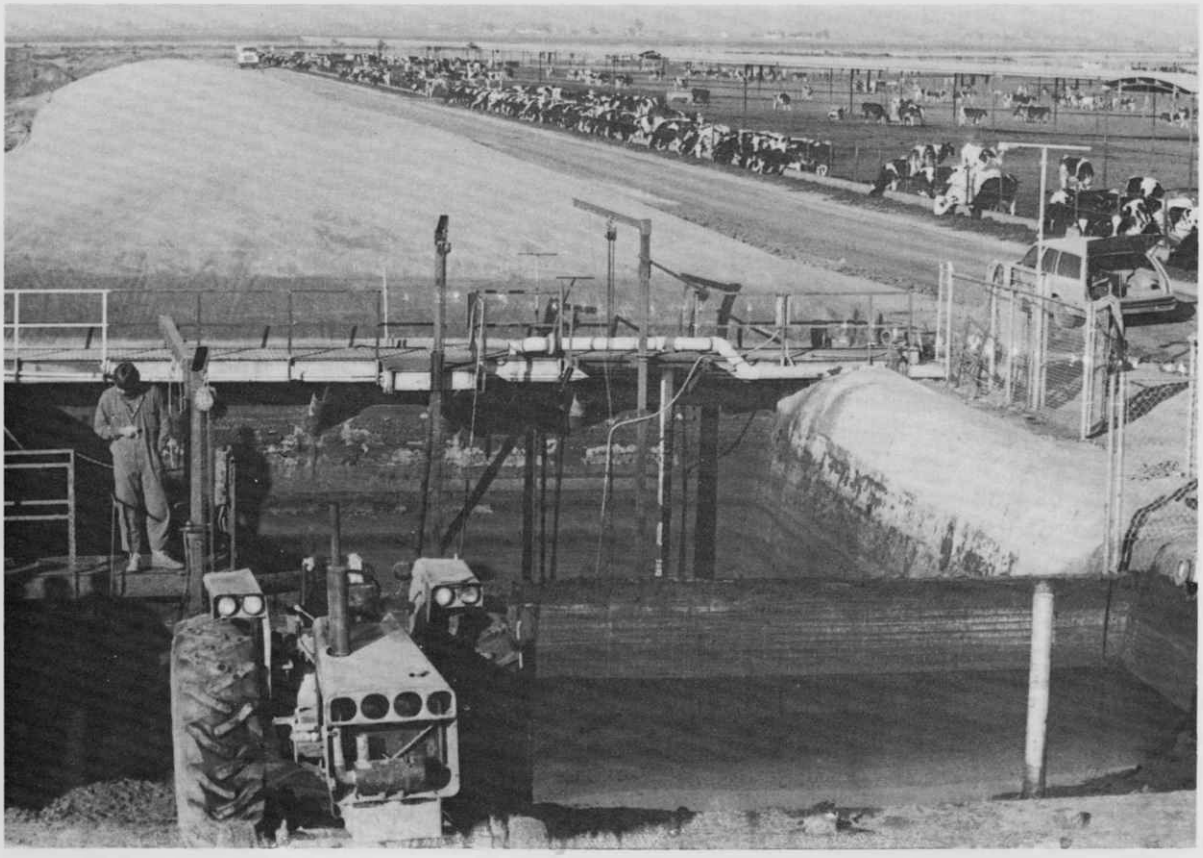


Dairy Milks Energy Supply From Manure-Fed Bacteria

Arizona Dairy at Higley is turning the manure from 8,000 cows and calves into electricity to run the dairy.

In three 150-foot-long troughs under plastic covers, bacteria digest the cattle's wastes and produce their own wastes, which include methane and other gases. Pipes carry this "bio-gas" fuel to a generator that supplies almost all of the dairy's power needs. The fuel supply inflates the sealed plastic covers each day.

The digester system has been making methane since March, said Jim Tappan, manager and co-owner of Arizona Dairy. It is the largest dairy manure digester in the world, said its designers at Cornell University.

At full capacity, the digester takes 50 tons of corral manure per day, mixed with the waste water from the dairy's four milking parlors. Each day's load shoves earlier loads further through the series of covered troughs. Bacteria digest the material countinously during the 15 to 25 days it takes the manure to pass through the system. The bubbling of the bio-gas that the bacteria produce helps to churn the mixture.

Each cubic foot of manure slurry in the digester yields one to two cubic feet of bio-gas daily.

The input manure also yields half its volume in digested manure that is valuable as fertilizer. The digestion takes most carbohydrates and

Photograph: Arizona Dairy at Higley has the world's largest system for generating power from dairy manure. From the mixing and heating tanks in the foreground, the manure slurry travels through three covered cells where bacteria digest it and produce fuel gas. (Photo by Guy Webster.)

odor out of manure, but leaves in the fertilizing nutrients of nitrogen, phosphorus and potassium, said Tappan.

The digester system cost $165,000 to set up, he said. He expects it to pay for itself within five years on energy-cost savings alone, with fertilizer sales as a bonus. In the past, the dairy's power bills have run about $15,000 a month.

Big dairies need power mainly for taking the heat out of milk, running vacuum pumps for milking equipment, and pumping water; said University of Arizona dairy expert Otis Lough. Several dairies in the state, including Arizona Dairy, conserve energy by using heat-exchanging systems that concentrate warmth from fresh milk to boil the water used for cleaning equipment.

Some special factors related to expansion of its Higley operation prompted Arizona Dairy to try bio-gas on a large scale. However, both Tappan and Lough expect that large digesters will also be practical for other dairies in the state.

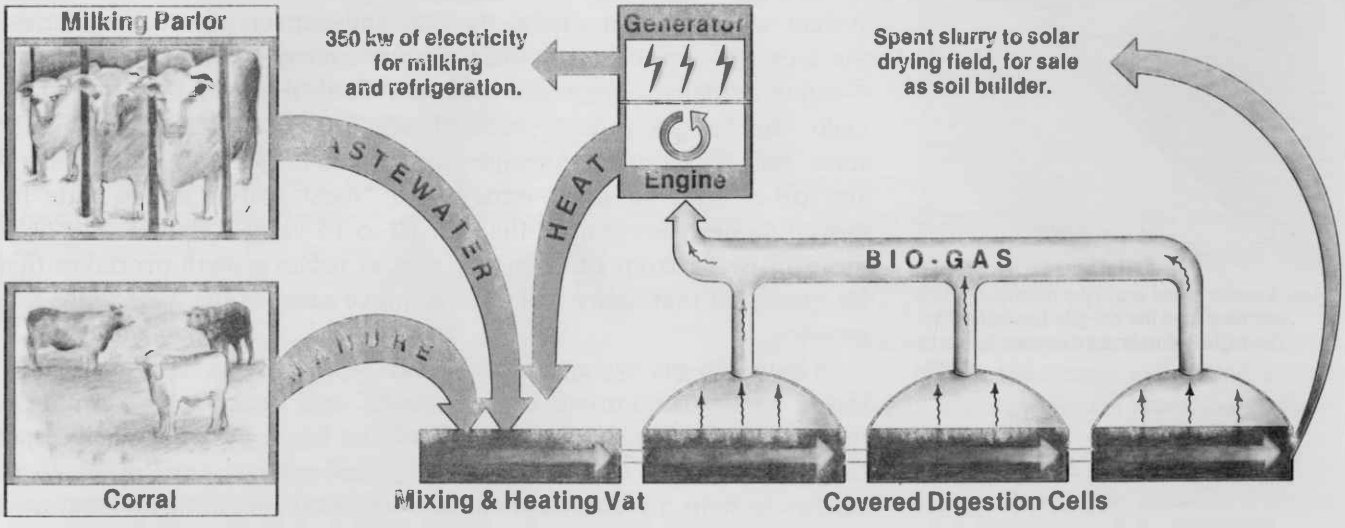
Arizona Dairy closed a farm at Gilbert in 1981 and added new facilities to its existing farm at Higley. The Higley farm now has the capacity for milking 4,500 cows three times a day with milking parlors used around the clock. The expansion plans included a new, on-site generator as a backup power supply and as an alternative to high daytime electricity rates. The dairy's rates are much lower for off-peak nighttime electricity.

At first, Tappan planned to buy natural gas for fueling the generator. After learning that the charge for installing a natural gas pipeline would be 50 to 60 percent of the cost of a digester, he changed his mind.

Dr. William Jewell and Don Sherman, agricultural engineers from Cornell University, designed the digester for Arizona Dairy, basing it on a system they developed for the U.S. Department of Energy.

Some heat from the engine that burns the bio-gas is used to warm the manure-wastewater mixture to 110 degrees as it first is loaded into the digester. The heating speeds up the bacterial action.

The generator engine uses 7,500 cubic feet of bio-gas per hour. "We anticipate having more than enough gas to run the engine 24 hours a day," said Tappan. The system generates more electricity than the



The "plug-flow" type of bacterial digester operating at Arizona Dairy turns each cubic foot of manure slurry daily into nearly two cubic foot of bio-gas, mostly methane. The gas fuels an engine that turns a 350 kilowatt generator. The system's other product, at the end of the series of digestion chambers, is nursery fertilizer with wholesale value around $100 per ton. Manager Jim Tappan expects fertilizer sales to bring the dairy more than one-tenth as much income as milk sales. (Diagram by Elizabeth Wolf.)

Arizona Dairy can milk 4,500 cows three times a day. In addition to lactating cows, dry cows, replacement heifers and calves all contribute to the manure supply.

Heat-transfer pipes warm the manure mixture with heat from the bio-gas-fueled engine. The higher temperature speeds bacterial action.

dairy needs in daytime, but less than it needs at night. Arizona Dairy evens out the power load for cooling milk by making ice during the night. The ice stores coolness used to refrigerate milk the next day.

"We're buying some power from the Salt River Project during the night and selling some back to them during the day," said Tappan. "Dollarwise, it works out that we'll be paying just a little per month."

One problem in the digester's first year of operation has been the accumulation of sand in the pits. Tappan needed to shut down the system temporarily in the fall to take care of it. He is optimistic that the system will work smoothly, though, and expects that other dairies in the area will also be using their manure's energy potential before long.

Arizona Dairy's large size and new facilities, two factors that help make the bio-gas system practical, are not unusual for dairies in the state, said Otis Lough. Average dairy size is bigger for Arizona than for any other state in the country, and "most dairies in the state have moved to new locations in the past 10 to 15 years," he said. The dairies move outward from the Phoenix area as urban growth overtakes them. He predicted that many will need to move again as the metropolis keeps growing.

"Good bio-gas systems could make Arizona-style dairying last a lot longer in the semi-urban environment," said Lough. "By running manure through a digester, you take off the black hat of a smelly operation and put on a white hat: You're creating energy and making a nice humus to help my garden grow, besides producing nature's most-nearly perfect food. That's milk."