



Fair Oaks Central Digester System at a Glance

The central digester system at Fair Oaks Dairy Farms:



Includes a 7.5 million-gallon digester



Treats 14,000 cows' manure



Provides compressed natural gas (CNG) to trucks



Generates 1.06 MW of electricity



Produces phosphorus-rich solids

ANAEROBIC DIGESTION TECHNOLOGY IN INDIANA

Fair Oaks Central Digester System

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Anaerobic digestion (AD) technology employs microbiological processes that decompose biodegradable materials and (in the absence of oxygen) produce biogas, which is a renewable energy. Municipal wastewater treatment plants around the world have used AD for decades.

Since 1997, more than a dozen farms and companies in Indiana have implemented AD for agricultural and agro-industrial waste treatment. The central digester system at Fair Oaks Dairy Farms located in Newton County, Indiana, is among the most successful of these AD waste treatment operations. This publication describes some of the AD technology used in the Fair Oaks central digester system.

The Anaerobic Digester Systems

Fair Oaks Dairy Farms was established in 1999 in northwest Indiana and consists of five 3,500-cow dairy units. In 2003, Fair Oaks Dairy Farms built a vertical plug-flow anaerobic digester system equipped with two 350-kilowatt generators at dairy unit 2. In 2006, they developed a second DVO Two-Stage Mixed-Plug-Flow® digester system (central digester) that is centrally located to the four other dairy units.

This central digester system began operating in 2008, and it is now equipped with an advanced digester effluent treatment subsystem (Figure 1). The operation trucks in dairy manure and milking wastewater from approximately 14,000 cows from the four dairy units to the digester.

After a separation process that removes about 98 percent of the bedding sand for recycling, a pump feeds the liquid manure and wastewater into a 7.5 million-gallon digester that operates at 105°F and has a hydraulic retention time of 15 days (Table 1). The project's total capital cost was approximately \$12 million. The equipment is estimated to have a 20-year lifetime. The system is run by four full-time employees.

Energy Production and Use

The Fair Oaks central digester system produces about 1.2 million cubic feet of biogas daily (about 438 million cubic feet a year). Biogas consists of about 50 to 70 percent methane (CH₄), which is a combustible gas. A biogas upgrading subsystem removes hydrogen sulfide (H₂S) and carbon dioxide (CO₂) from the biogas and compresses it. The processed biogas contains higher concentrations of methane, which Fair Oaks Dairy Farms uses as CNG (compressed natural gas) for its milk transportation trucks.

The system also uses part of the CNG to produce combined heat and power (CHP) using a 1,060-kilowatt General Electric Jenbacher biogas generator. The CHP recovers waste heat from electricity generation to heat the digester.

Table 1. Some facts about the digester system.

Parameter	Fact
Initial operation year	2008
Digester volume	7.5 million gallons
Manure treatment	14,000 cows
Digestion temperature	105°F
Biogas production	~1.2 million cubic feet/day
Biogas treatment	Removes H ₂ S and CO ₂ and compresses
Biogas utilization	Produces CNG, electricity, heat
Digester effluent treatment	Recovers phosphorus (P)
Dewatered P cake production	~200 tons/day
Equivalent CO ₂ reduction	15,000 metric tons/year

Effluent Treatment and Phosphorus Recovery

In 2015, Fair Oaks Dairy Farms combined a Trident Nutrient Recovery subsystem with a rotary drum for coarse solid removal in their central digester. The subsystem first separates fine solids from the liquid in digester effluent. The solids are treated with polymers and float to the surface in two 400-square-foot dissolved air flotation (DAF) units. These floating fine solids are then mechanically skimmed and removed from the units.

Three sets of moving-disc presses separate the liquid from the floating fine solids. The result is a harvest of dewatered, high-phosphorous cake that contains approximately 23.39 percent total solids and 0.35 percent phosphorus (Table 2). A nearby fertilizer plant further processes the cake.

Table 2. The total solids, total Kjeldahl nitrogen (TKN), phosphorus (P), and potassium (K) concentrations in digester effluent before and after the treatment.

	Total Solids (%)	TKN (%)	P (%)	K (%)
Digester effluent	4.10	0.24	0.05	0.14
DAF influent	2.63	0.20	0.04	0.13
DAF liquid effluent	1.09	0.15	0.01	0.12
High-P cake	23.39	0.87	0.35	0.17

Greenhouse Gas Emission Reduction

Methane is a greenhouse gas that is roughly 30 times more potent as a heat-trapping gas than carbon dioxide. The Fair Oaks Dairy Farms digester captures methane from manure that would otherwise be emitted to the atmosphere. The system reduces emissions by the equivalent of about 15,000 metric tons of carbon dioxide per year.

References

- AgSTAR. 2014. Fair Oaks dairy digester – Fair Oaks, IN: Dairy farm in Indiana – CNG powering farm transportation. February, 2 p.
- Stoermann, M.; K. Doyle; C. Ramsey. 2016. Newtrient case study of Trident Processes Nutrient Recovery: Fair Oaks Dairy, Fair Oaks, IN. January 19. 12 p.
- Ramsey, C. 2016;2018. Personal communication.

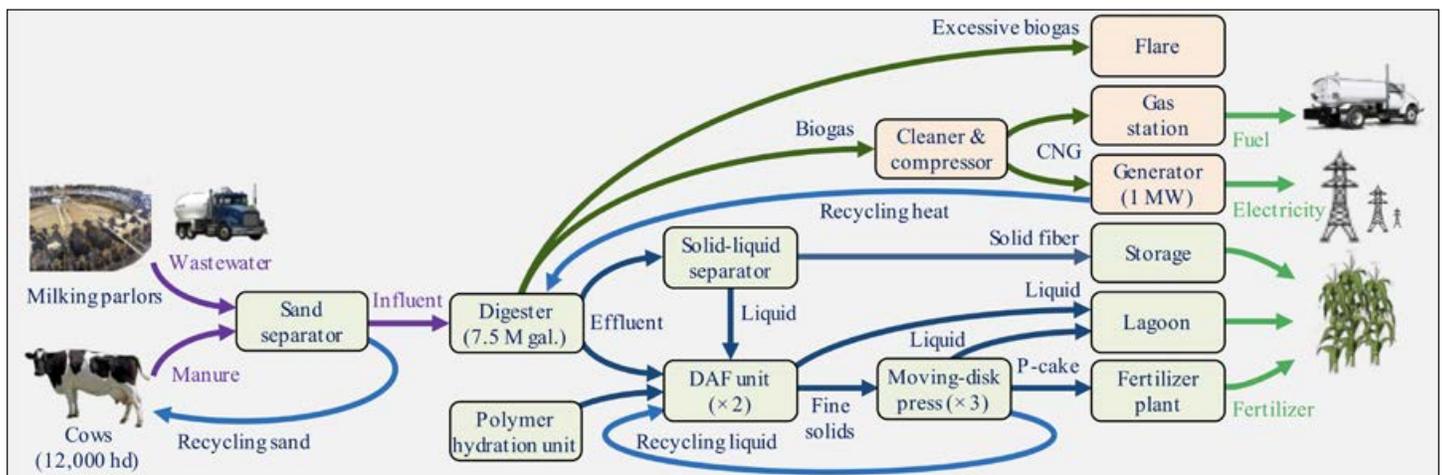


Figure 1. This illustration diagrams the process of the central digester system at Fair Oaks Dairy Farms.

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