PENNSTATE
1855
Department of Agricultural
and Biological Engineering

Schrack Farms Case Study

Type of farm: Dairy
Name of farm: Schrack Farms
County: Clinton
Digester designer: RCM Digesters (Mark Moser) Berkeley, CA
Digester Installer: Schrack Farms acted of the General Contractor
Construction start date: April 2005
Date Digester became operational: August 2006
Number of animals contributing to the digester: <600
Type of Barn: freestall
Manure handling system: alley scraped to tank
Type of Bedding: sawdust
Type of digester: plug flow (straight)
Digester cover: flexible
Digester temperature: mesophilic 100°F
Biogas uses: operate the CHP unit to produce electricity and heat
Biogas utilization equipment: engine generator set, auto flare
Heat recovery utilization: engine generator water and exhaust jackets to heat digester, hot water for milking parlor
Power Purchase Agreement: Yes
2007 Status of Digester: operational

Introduction:

Schrack Farms is located in Clinton County, Loganton, Pennsylvania. The 233 year old original 100 acre family farm was purchased in 1774. The Schrack dairy farm has grown from 100 acres with 10 dairy cows to 1,000 acres and 1350 cows. The family farm also received a Pennsylvania Bicentennial Award in 1974. The digester is located on the new section of the farm with 650 cows contributing manure to the digester. The remaining cows are comprised of 110 dry cows and 590 heifers and calves.

Digester information:

RCM Digesters (Mark Moser) from Berkeley, CA designed the Schrack digester. Team Ag Inc. from Ephrata, Pennsylvania provided the Professional Engineering services for the project. Schrack Farms acted as the General Contractor. Construction for the heated plug flow digester started in April 2005. A major problem with the concrete company building the digester tank delayed the entire project for almost a year (the groove along the entire top edge of the digester was not cast properly, along with bolts not being installed in the proper locations). The digester is designed for 1200 cows and an operating mesophilic temperature of 100°F. Currently the digester is operating at the designed 100°F, but with the manure from 650 cows. The original design included receiving offal equivalent to the manure from 200 cows from a local packing plant. This plant

burned down during digester construction, but Schrack Farm hopes to add this additional feedstock in the future. Alley scrapers are used to move the manure from the freestall barn to a concrete holding tank, where it is then pumped by a Houle, 10 horsepower (HP) piston pump up to the digester. The total amount of manure introduced into the digester each day is 20,000 gallons. The manure is mixed for five minutes before each of the three daily feedings of 7,000 gallons using a Houle 15 HP agitator. The flexible covered, rectangular, heated, below ground, concrete digester tank dimensions are 159' L x 32' W x 14' D capable of holding 495,000 gallons (66,144 ft^3) when a one foot freeboard is maintained. The placement of the digester internal heating pipes is proprietary information. Two inches of insulation covers the top of the digester to help maintain the 100°F temperature. Manure influent and effluent pipes to and from the digester are 12" diameter PVC. The heated plug flow digester is designed for a hydraulic retention time (HRT) of 20 days at 10 – 12% solids, and is currently operating at a 30 day HRT at the designed percent solids. Biogas is produced and collected under a flexible cover. The digester operator does not know the type of material, thickness or manufacturer of the cover, but stated the cover was specified by RCM Digesters.

Plug flow digester with cover

Influent and effluent temperatures are recorded daily from eight probes within the digester. If there is a problem with the digester then the pH is measured.

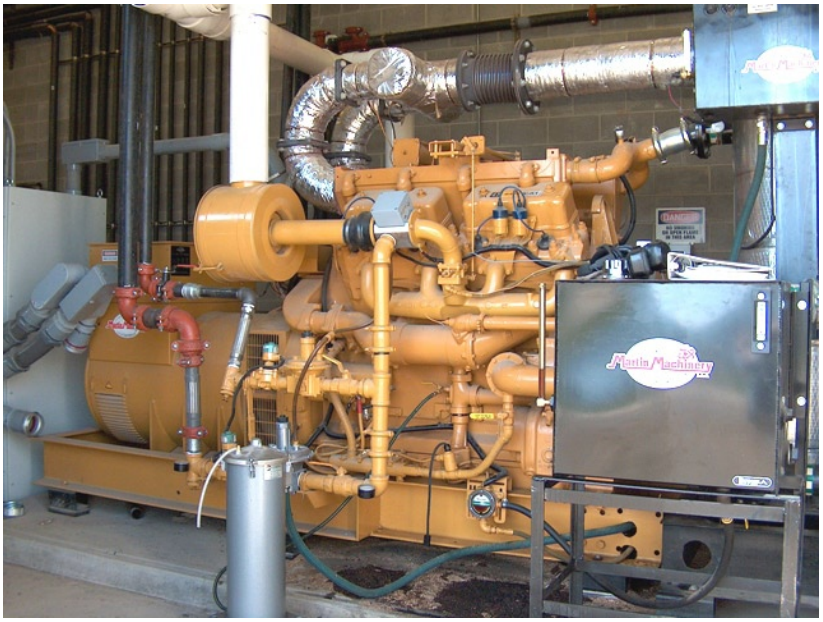
Biogas system:

Biogas is piped underground through six inch diameter PVC pipe to the engine generator set. At the digester exit, the piping is directed to two drip pots that remove water droplets and also act as pressure relief valves set at 1.5 inches of water column pressure. Biogas production measured on the Roots gas flowmeter averages 85,000 to 90,000 ft^3/day. An auto flare burns any excess biogas not consumed by the engine generator set. A Bacharach Fyrite® Gas Analyzer is used to measure the CO_2 concentration in the biogas and is typically between 36% and 38%, making the methane concentration 62% to 64%.

Drip pots that remove water droplets and act as over pressure relief valves set at 1.5 inches of water column pressure

Combined heat and power unit (CHP):

The biogas is piped to an 1800 rpm Caterpillar G379 engine coupled to a 480 volt, 3 phase 200kW generator purchased from Martin Machinery Inc. of Epharta, PA. The engine generator set is located down the hill from the digester. Heat recovery from the engine water jacket and exhaust and/or boilers supply hot water for the milking parlor and heat the digester. The CHP unit runs 24/7/365 days a year. All power needs for the new and old farm are met and any excess power is sold back to the electrical grid. DDS Brad-Penn engine lubrication oil is being used and changed every 900 hours of operation. Engine oil analysis is performed after each oil change and the results are reviewed by Martin Machinery.



G379 Caterpillar engine and 1800 rpm, 480 Volt, 3 phase generator

Power purchase agreement:

Schrack Farms has a power purchase agreement with PPL Electric Utilities Corporation. Daily power production averages 3,500 kWh/day. December 2006 net metering electrical production numbers show that 102,000 kWh were produced. The old farm using 38,000 kWh and the new farm using 39,000 kWh leaving 25,000 kWh in excess power production sold to PPL. Under the power purchase agreement the excess electricity generated is sold to PPL at the avoided whole sale cost of 4.5 to 7.0 cent per kWh. Schrack Farms will pay for stranded costs until the end of 2009 and are trying to keep demand charges to a minimum.

Digester effluent:

The nearly odorless digested manure collects in an effluent storage pit. Effluent can leave the pit through the 12” diameter, valved, PVC piping and can be directed to two different locations. Gravity flow directs the effluent to the storage pond. A submersible pump directs flow to the solids separation building. The solid/liquid separation room is above the separated solids storage bay. A Manure Monster solid/liquid separator with a 10 HP motor was used for six months before it failed and was replaced with an Anderson Model 300 with a10 HP motor. The solids fall through a chute constructed on the end of the separator to a hole in the floor, so the solids can fall directly into the digested solids storage bay. These separated solids are then used as bedding for the cows. The separated liquid effluent gravity flows through six inch diameter PVC pipe to the five million gallon storage pond. The effluent is stored and land applied by both drag hose and tanker haul twice a year to crop fields.

Solid/liquid manure separator with chute to direct solids to the storage bay below

Offal pit:

A pit 30' L x 30' W x 13' D was constructed adjacent to the effluent storage pit and was designed to receive offal from 400 cattle, which is the equivalent to the manure from 200 dairy cows. A submersible grinder pump was planned to transfer offal to the digester inlet. This pit is currently not in use since the packing plant is out of commission due to fire.

Project costs:

The digester project cost $950,000. The Schrack Farms applied for and received funding from the Department of Environmental Protection (DEP), receiving two Energy Harvest Grants totaling $575,000. The EQUIP program also provided $25,000. The farm borrowed the remaining amount needed for the project. Carbon credits were sold to Native Energy for $90,000 over the next 20 years. The digester had to be operating from two to six months before any payment would be received from Native Energy.

Lessons learned:

Biogas PVC piping should have been larger diameter to prevent head loss from occurring. A biogas blower was installed to achieve proper biogas pressure to the CHP.

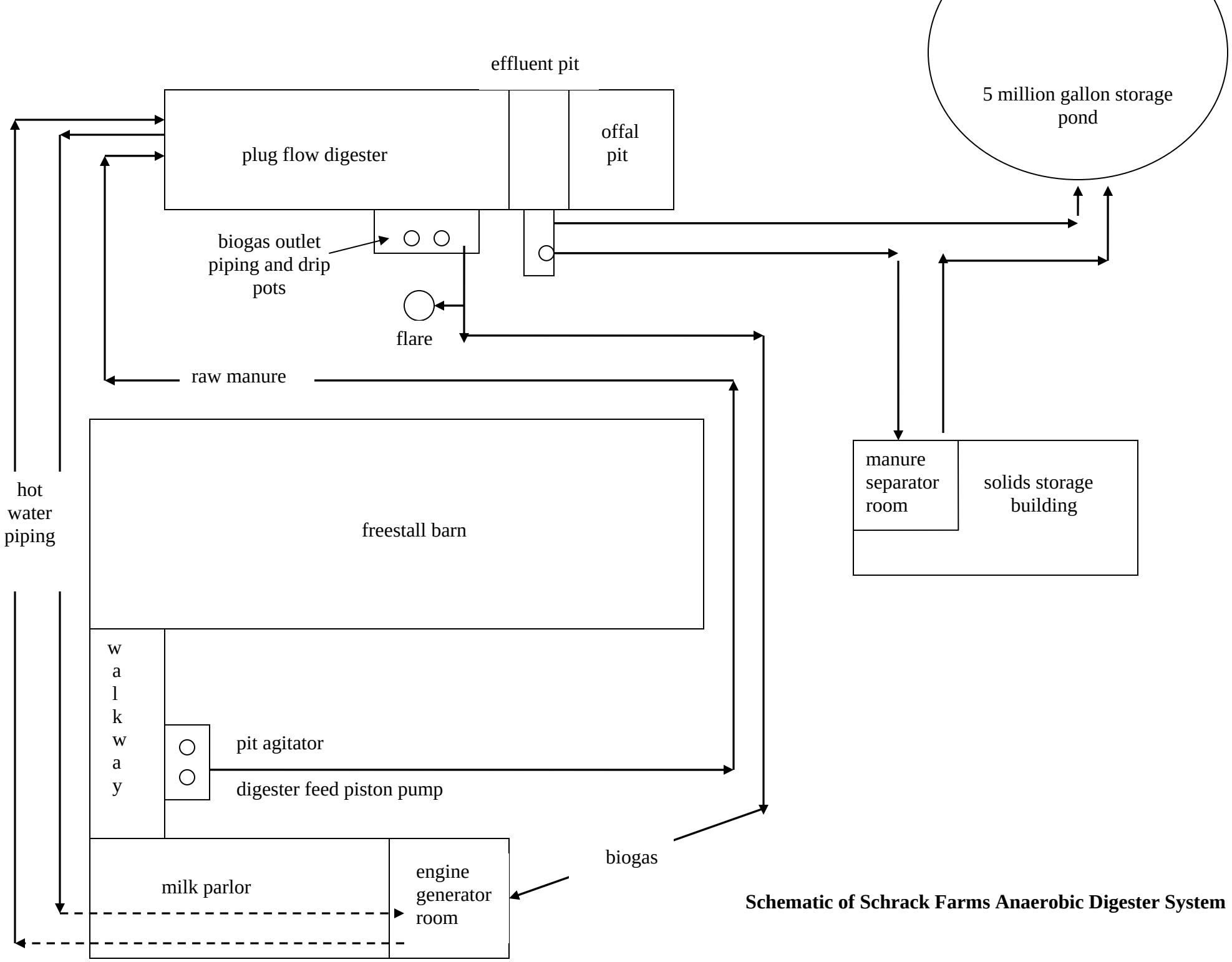
After discussions with the digester operstor, this writer believes if the farm is acting as it's own general contractor, have one person devoted **full-time** to the construction site overseeing the project to make certain that all plans are being executed correctly.

What would you do differently?

The operator stated that he would hire a concrete company with experience in the construction of digester tanks, instead of going with the lowest bidder. Also, when signing the contract with the designer make sure all charges for components are clearly understood by both parties.

Would you install a digester again? Yes

The information obtained in this case study was collected by Penn State researchers, Deborah Topper and Patrick Topper during a farm tour at the Schrack Farms and numerous discussions with the operator during 2006 and 2007.



Schematic of Schrack Farms Anaerobic Digester System