



Pine Hurst Acres Case Study

Type of farm: Swine

Name of Farm: Pine Hurst Acres

County: Northumberland

Digester designer: Schick Enterprises, Kutztown, PA

Digester installer: Schick Enterprises

Construction start date: November 2003

Date digester became operational: October 2004

Number of animals contributing manure to the digester: 4,400 grow/finish hogs

Housing system: 2 barns, 4 auto-sort pens per barn, 550 head per pen

Manure handling system: slotted floor, deep pit under floor

Type of digester: complete mixed, below ground, heated

Digester cover: flexible

Digester temperature: mesophilic 95°F

Biogas uses: operate the CHP unit to produce electricity and heat

Biogas utilization equipment: engine generator set and flare

Heat recovery utilization: heat digester

Power purchase agreement: no

2007 status of digester: operating

Introduction:

Pine Hurst Acres is located in rural Northumberland County Pennsylvania among the mountains and was purchased in 1978 and had 500 finishing hogs. The farm plants a total of 2,800 acres growing corn and soy beans. In 2002, two hog finishing barns with a total capacity of 4,400 head were built on a new site. Schick Enterprises of Kutztown, PA designed and installed the new finishing houses and also designed and installed the anaerobic digester. Construction of the digester began in November of 2003 and was operational in October 2004. Only the 4,400 hogs in the new finishing barns provide feed for the digester. Each barn has four pens holding 550 hogs and a food court. These new buildings incorporate auto sorting of hogs by weight in the four pens inside each barn. The manure storage is an under floor pit using a slotted floor design. The pit is divided into five sections longitudinally; the second and fourth, are used to collect the raw manure and the other three, located under the resting areas, are used to store digested manure. Due to the unique dunging patterns from the large pen and food court designs, about 78% of the raw manure is collected in the central part of the pen which is above the second and fourth pits. Gas monitoring was conducted inside the barn to evaluate the atmosphere for the workers and the hogs. Results showed no increase in methane, ammonia or hydrogen sulfide gases due to the under barn digested manure storage.



Piglets lie along the outside wall and dung towards the center of the pen

Digester information:

The construction for the Pine Hurst Acres heated, complete mixed digester started in November 2003. The digester is a round concrete tank, 45 feet in diameter, depth of 12 feet, in ground with a divider wall down the center. Styrofoam insulation is installed on the external walls but the floating insulation under the cover was removed early in the start-up phase. It is designed for 4,400 finishing hogs and has a capacity of 143,000 gallons (19,075 ft³), operating at a mesophilic temperature of 95°F. Heating coils using the waste heat from the engine generator set are located inside the digester but external of the concrete walls. The digester is designed to operate with a hydraulic retention time (HRT) of 28 days at 6% solids. Actual operating HRT is 35 days with 6.2 % solids. A 45 mil reinforced polypropylene geomembrane cover manufactured by Industrial & Environmental Concepts, Inc. Minneapolis, MN collects the biogas and stores it until used by the engine

generator or the flare. The swine manure is collected continuously through slots in the barn floor into two receiving pits underneath the two hog barns. Three thousand gallons per day of manure enters the digester as influent. The influent is pumped using Houle pumps, timers cycling eight times a day, feeding 375 gallons of manure to the digester inlet pit during each cycle. The manure enters the digester through a hole in the wall of the inlet pit to the digester internals. A Houle submersible pump is located in the inlet pit and is used for digester internal mixing. When this pump cycles on, it draws manure from the inlet pit and from the digester and directs it to a retrofit plumbing system that directs the manure to manually operated valves equipped with nozzles located around the first half of the digester. These nozzles are directed at different internal elevations and are used as necessary for surface crust dispersion and internal mixing.



Digester inlet pit

After the digestion process is complete the effluent leaves the digester into an effluent pit also equipped with a Houle submersible pump. This pump performs the same agitation function as the inlet pit pump, only supplying manure to the second half of the digester. An overflow pit in the effluent pit directs digested manure to return to the hog barns by gravity flow to the three holding pits under each barn. A wood framed arch building with a fabric cover was constructed over the digester in October 2004 to help protect the digester cover from wind damage.



Wood framed arch building over the digester

Biogas system:

Biogas is collected under the flexible cover into a 3 inch diameter metal pipe and leaves the digester through a 3 inch PVC ball valve then is reduced to 2 inch PVC pipe. A back pressure regulator was installed in 2006 in this 2 inch line. From the back pressure regulator, the 2 inch PVC piping is directed underground to a manually water filled drip pot that acts as a pressure relief and as a moisture collection removal location. The gas line is directed vertically from the moisture collection location then horizontally entering the engine generator set room.

Combined Heat and Power Unit (CHP):

The engine generator set room is a separate building adjacent to the digester building. The biogas enters a gas compressor, a gas flow meter then is directed to the 350 cubic inch, Chevy V-8 engine coupled to a 47 kW biogas rated 220 volt, 3 phase, 60 Hz generator. The entire combined power and heat recovery skid was provided by Martin Machinery Inc., Ephrata, PA. This skid recovers the waste heat from the engine water jacket and exhaust stack and uses thermal sensing valves to automatically maintain the digester temperature. Excess heat is exhausted to atmosphere using a radiator. Engine maintenance requires oil replacement every 150 hours of run time.

A separate gas meter was installed for the flare. Accurate gas production records are needed for the creation of carbon credits. This farm was the first farm in Pennsylvania to create and sell carbon credits on the Chicago Climate Exchange.

A boiler in the engine generator room was used for initial digester warm-up and also can be used to maintain digester temperature if the engine generator is inoperable. The boiler only uses propane fuel. Biogas is not used to heat the barns or any other buildings.

Power purchase agreement:

The electrical power generated is used to power the farm and 5 kWh is sold back to the power company. Pennsylvania Power and Light (PPL) is the utility for the farm. There is not a power purchase agreement with the utility at this time. This digester electrical generating plant went on line just before Pennsylvania enacted a net metering agreement. Pine Hurst Acres is still trying to reach an agreement with the utility and until then only a small amount of power will be sent to the utility and the rest will be flared to create the carbon credits and to reduce wear and tear on the electrical generating equipment.

Digester effluent:

As influent enters the digester, controlled by the pumps located at each barn, digested manure leaves the digester as effluent. The odor reduced, nutrient rich effluent gravity flows back to the two barns under floor pits. The under floor pits in each barn were divided into two raw manure sections and three digested manure sections.

The digested manure is stored in the under floor pits until ready for land application of the nutrients. Gas concentration monitoring has been performed on the air quality of the atmosphere at hog elevation. Ammonia, hydrogen sulfide, methane and carbon dioxide gas concentration levels are low and revealed no hazard to either animals or humans.

Project costs:

Total project costs were \$256,620.00. Pine Hurst Acres received five different grants totaling \$95,408.00 leaving \$161,212.00 in the farm owner's out-of-pocket expenses. The two largest expenses were the digester's walls and floor and the combined heat and power unit including the utility tie-in. Cost per head was \$51.87; cost per animal unit (AU) was \$334.66; and the estimated monthly operation and maintenance cost is approximately \$100.00.

Lessons Learned:

While talking with the owner/operators, it was very clear that they wanted to have their new, expanded hog operation be accepted into the rural but ever expanding community. The primary goal of the digester was to control odor of the manure storage and during land application of the nutrients. Everyone involved with the digester, including the neighbors, are pleased with the level of odor, or should it be said, the lack of odor that is released from the farm.

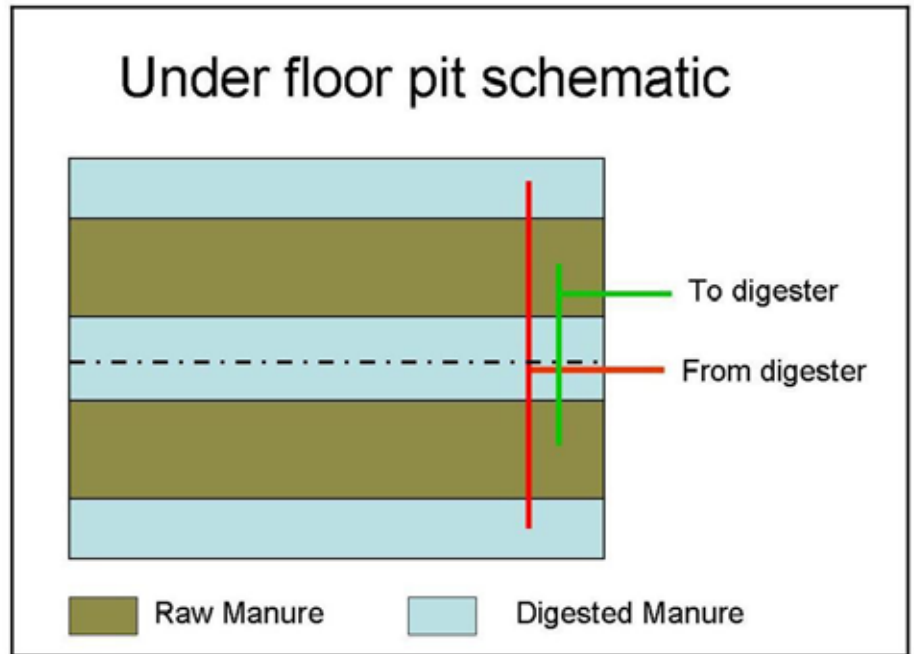
The farmer did express his concerns of costs and construction overruns and digester system designer experience. He recommends that anyone considering a digester should do extensive but timely research before proceeding. Get good estimates from knowledgeable vendors. The digester designer for this project was the hog barn designer. This firm had never built or designed a digester. This being their first digester project, there were design flaws that needed correcting during start-up before the digester became fully operational.

What would you do differently?

Conduct more intensive research into the design of anaerobic digesters. Hire an experienced, proven designer.

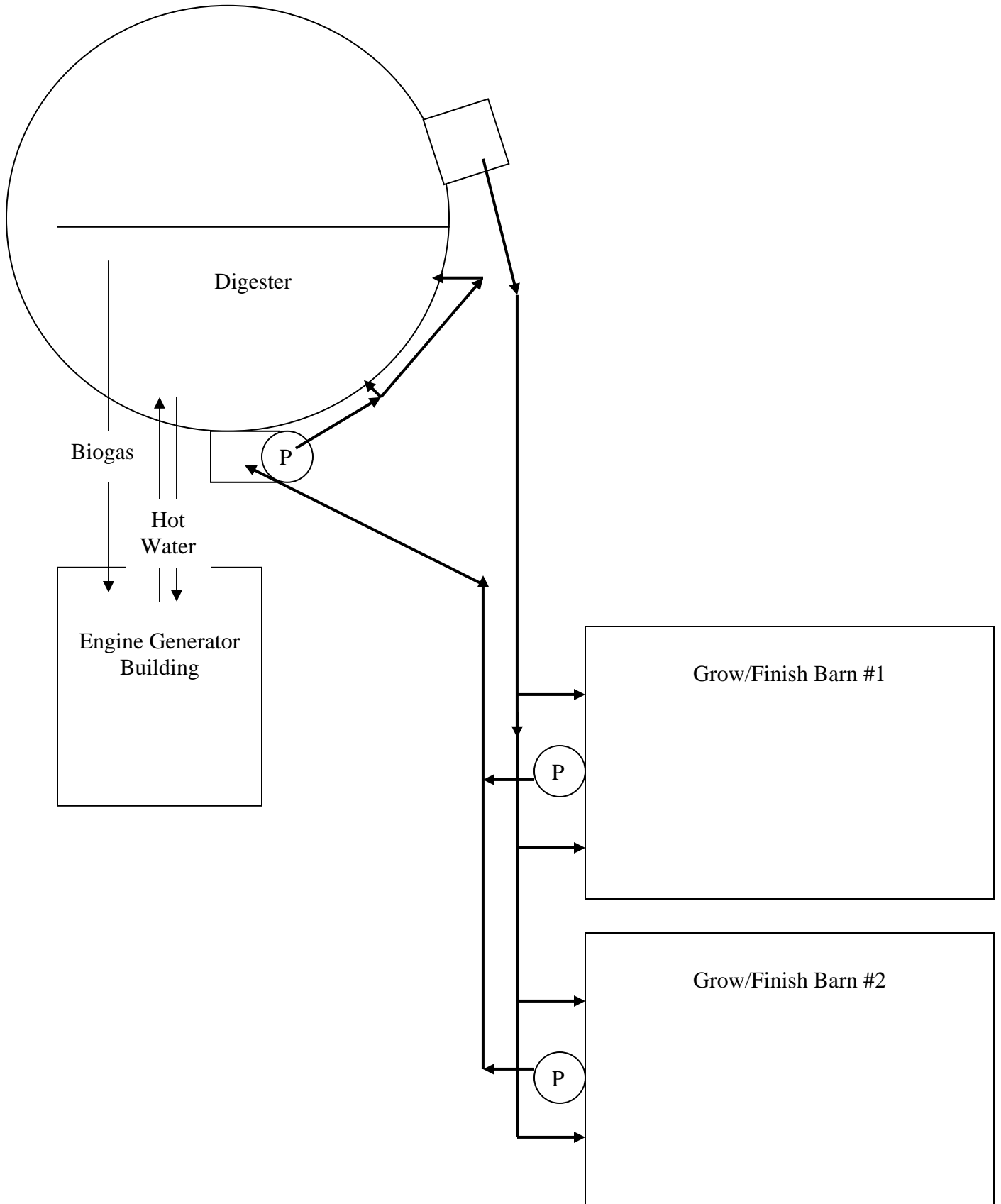
Would you build a digester again?

Yes, the digester does an outstanding job of reducing odors and off setting electrical costs for the farm. The owners like being innovative and are pleased there have been no odor complaints from the encroachment of neighbors into the area.





The information obtained in this case study was collected by Penn State researchers, Deborah Topper, Patrick Topper and Robb Meinen, Sr. Extension Associate during farm tours at the Pine Hurst Acres Farm and discussions with farm owners in 2006 and 2007.
01/10/08



Schematic of Pine Hurst Acres Anaerobic Digester System