PENNSTATE
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Department of Agricultural
and Biological Engineering

Brendle Farm Case Study

Type of farm: Caged Layer
Name of farm: Brendle Farm
County: Somerset
Digester designer: Bert and Dick Waybright
Digester installer: Brendle Farm
Construction start date: Spring 1984 (designed in 1983)
Date Digester became operational: June 1984
Number of animals contributing manure to the digester: 72,000
Manure handling system: caged layers manure belt, augered to liquid mix tank
Type of digester: slurry loop
Digester cover: flexible
Digester temperature: mesophilic 95^{o}F
Biogas uses: operate the CHP unit to produce electricity and heat
Biogas utilization equipment: engine generator
Heat Recovery Utilization: engine generator water jacket to heat the digester
Power Purchase Agreement: Yes
2007 status of digester: operational

Introduction:

Brendle Farm is located in Somerset County, Pennsylvania. Total farm acreage is 725, growing 115 acres of corn and 80 acres of hay with 360 acres in the Conservation Reserve Program (CRP). This caged layer facility has two operating houses with 36,000 birds each for a total of 72,000 laying hens. Brendle farm also raises their own pullets. On this particular farm visit, the end of October 2006, the pullets had been laying eggs for one week. The manure belts are run every other day in each of the two houses. Earlier research on anaerobic digestion while in graduate school motivated application of the technology to the family farm. This way the farm could be proactive in the community, innovative and turn the millions of gallons of liquid manure into a resource. The farm's goal of handling the manure as a liquid was to have the capability to apply the nutrients to crop land through irrigation.

Brendle Farm was awarded the "Governor's Energy Award for Outstanding Contribution to Pennsylvania Energy Security" in 1990.

During the case study farm visit, Robert Brendle informed us that his farm was the second inline egg grading system installed in Pennsylvania. He employs four workers to process 50,000 eggs per day, performing the candling, cleaning, sizing and packaging in three hours.

Partial view of the digester, construction of the new roof and the storage pond in the background.

Digester information:

Early in the 1980's, a feasibility study was performed by the area engineer from the Natural Resources Conservation Service (NRCS). Bert and Dick Waybright of Mason Dixon Farm, Gettysburg, PA designed the digester. Brendle Farm performed the installation. The construction of the heated, slurry loop (modified plug flow) digester started in the spring of 1984.

The chicken droppings fall from the conveyor belts into a trench and cross augured to a pit where water is added and mixed using a Houle mixer. When the manure mixture is the right consistency a piston pump moves the manure into the pre-treatment tank. This 14,350 gallon concrete tank has a hard top and a flat bottom with dimensions of 8 ft X 8 ft X 30ft (1920 ft^3). Here the chicken manure is heated, limestone grit is allowed to settle out and the feathers to float. The pre-treatment keeps the digester from filling up with grit and feathers which would greatly lower biogas production. Pre-heating the manure before it enters the digester prevents shocking the digester with cold manure. Every three months the pre-treatment tank needs to be hydraulically mined using storage pond water to remove the grit and feathers for land application.

The flexible covered digester is 42 ft in diameter and has a depth of 14 ft with only a few inches of concrete above grade. It has an internal dividing wall with heating pipes and a capacity of 145,000 gallons (19,400 ft^3). The digester operates at a mesophilic temperature of 95^oF with 8% solids and a hydraulic retention time (HRT) of 27 days. The digester is fed once a day using a timer controlled pump in the pre-treatment tank. The digester does not use commercial insulation for heat retention. It utilizes earth that is maintained dry by proper surface sloping and a vegetative cover.

Biogas system:

Biogas produced and collected under the flexible cover is conveyed through PVC piping to the engine-generator set room. No biogas conditioning is performed.

Combined heat and power unit (CHP):

The biogas is piped to a Caterpillar 3306 6-cylinder, internal combustion engine purchased from Martin Machinery Inc., Ephrata, PA. Martin Machinery completed an engine over-haul early October 2006. The engine runs 24/7, 365 days a year. The oil is changed and spark plugs checked once a month, with the plugs replaced approximately twice a year.

The generator rating is 65kW and 60 Hz. Waste heat from the engine generator set water jacket is used to heat the digester, pre-heat wash water for egg processing and to heat the egg processing area and the office.

Power purchase agreement:

The electricity produced from the biogas is used on the farm during the day and is sold to the utility at night with monthly sales of approximately 2500 kWh.

Digester effluent:

Digested manure gravity flows from the digester to the storage pond. Three-quarters of the digested slurry is pumped to irrigation equipment for land application onto crop fields, the other one-quarter is hauled by trucks and applied. A limestone island in the storage pond has to be removed every five years. The limestone grit recovered from the pre-treatment tank and storage pond is left to dry and then land applied to the crop fields.

Project costs:

1984 total construction costs, $115,000.00

Lessons learned:

Do not use metal roofing or siding and carbon steel nails on buildings near or over the digester or for the building housing the engine generator set because of hydrogen sulfide gas corrosion. A new building was in the process of being constructed over the digester, since a wind storm severely damaged the old building a month prior to our farm visit. Double-dipped galvanized nails were being used and non-metal, non corrosive, corrugated roofing panels for the roof.

What would you do differently?

The pre-treatment tank was originally designed for a skid steer to enter and remove the settled grit and feathers. A larger, circular tank would be easier for hydro mining. Maximizing the distance between the digester and the engine generator building and the chicken houses would reduce corrosion from the hydrogen sulfide gas.

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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 Brendle Farm and discussions with owners during 2006 and 2007.

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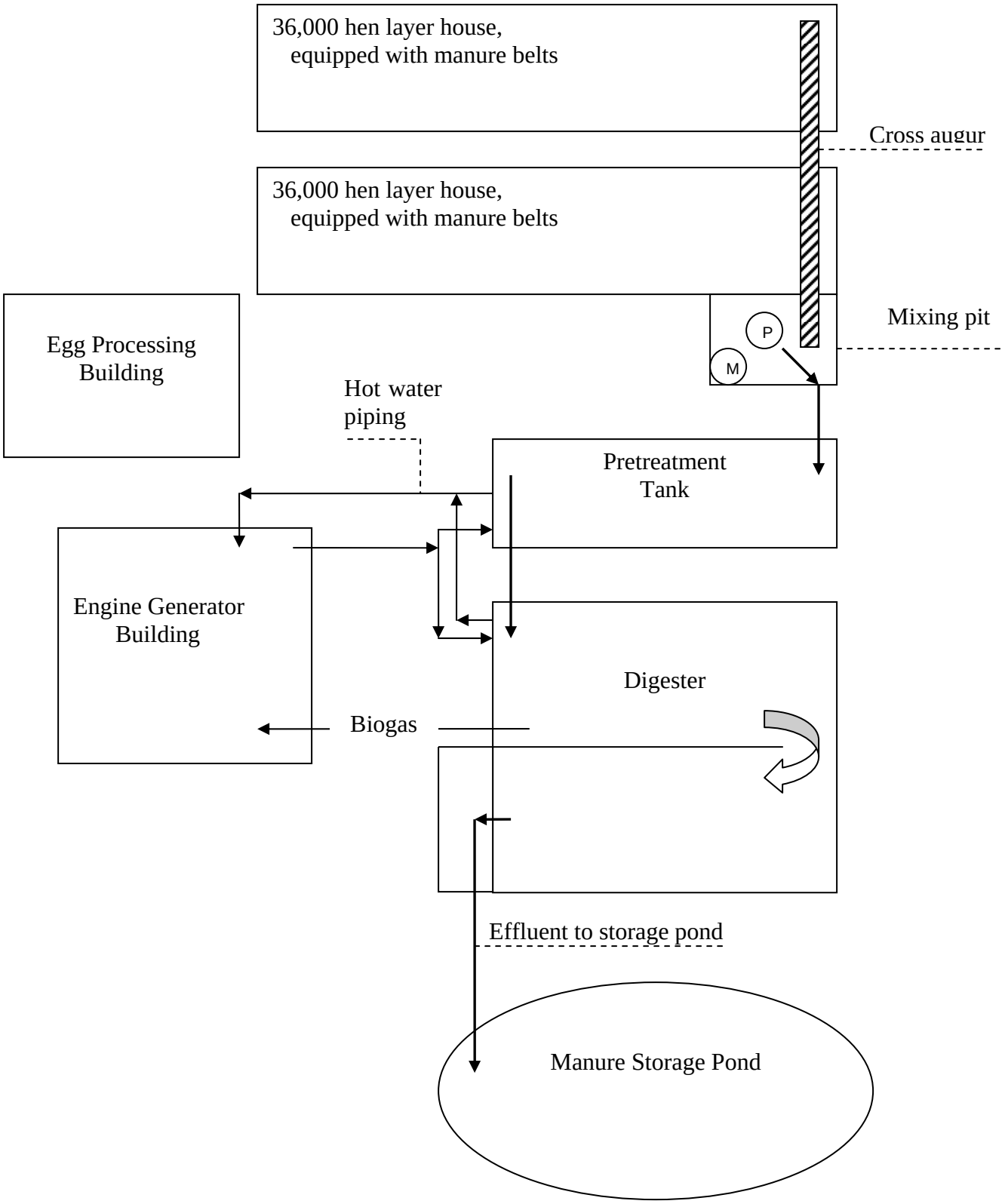

Schematic of Brendle Egg Farm Anaerobic Digester System