

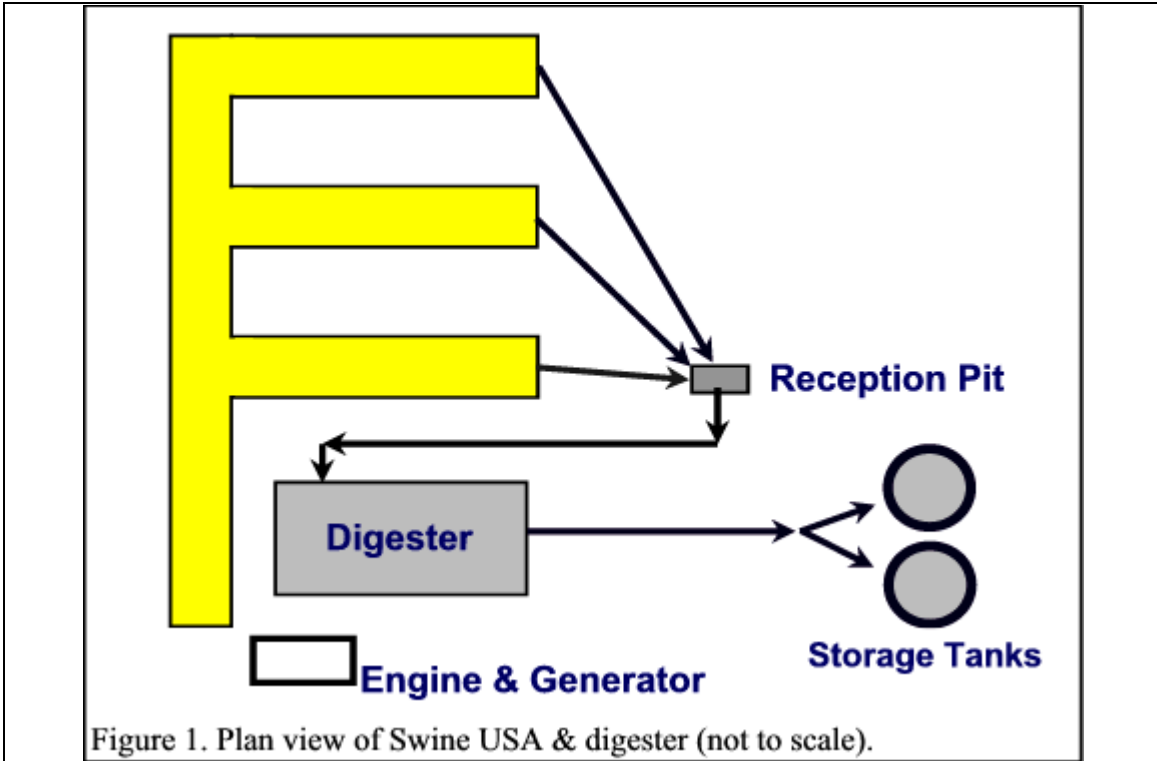
SWUSA: Swine USA Anaerobic Digester

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Swine USA Anaerobic Digester

Swine USA operates a 5000 sow gestation-farrowing facility in Southern Iowa. It uses shallow pull plug gutters that drain to a reception pit. Raw manure is pumped from there to a 70' X 90' X 16' heated, complete mix anaerobic digester operating since July, 1999. The methane is burned in a Caterpillar engine to drive an 80 Kw generator. The electricity is used on the farm. To date the digester system has been able to provide approximately 35% of the farm's energy needs. When excess methane is produced (more than the engine can use) it is flared off to the atmosphere. The digester started operation August, 1999.

The digester was designed by Mark Moser of RCMDigesters, Inc. as part of the AG Star program. Total construction cost was approximately \$500,000, or \$100 per sow. Government cost sharing for the project was provided by the Iowa Department of Natural Resources (IDNR), and the Natural Resources Conservation Service (NRCS) for approximately half of the total cost.



ISU has monitored the digester and storage system by sampling at 4 locations since October 8, 1999. Samples were initially taken at two week intervals, and are now taken monthly. Sample locations are 1) the reception/transfer pit, 2) outlet of the digester (overflow liquid), 3) north storage tank, 4) south storage tank. The following charts show data summaries for 17 sample dates taken from Oct. 8, 1999 through Sept 2, 2000.

Loading rate has been 1.46 Kg/M³-day of COD, or 1.23 Kg/M³-day of VS.

SOLIDS AND NUTRIENT DATA

Total and volatile solids Figure 1 shows the means of 17 samples for Total Solids (dark bars), Volatile Solids (light bars), with the VS/TS percentage written above the bar. One would expect the TS percentage to decline through the digester. The increase along with the large decrease in TS indicates the likelihood of some TS settling within the digester.

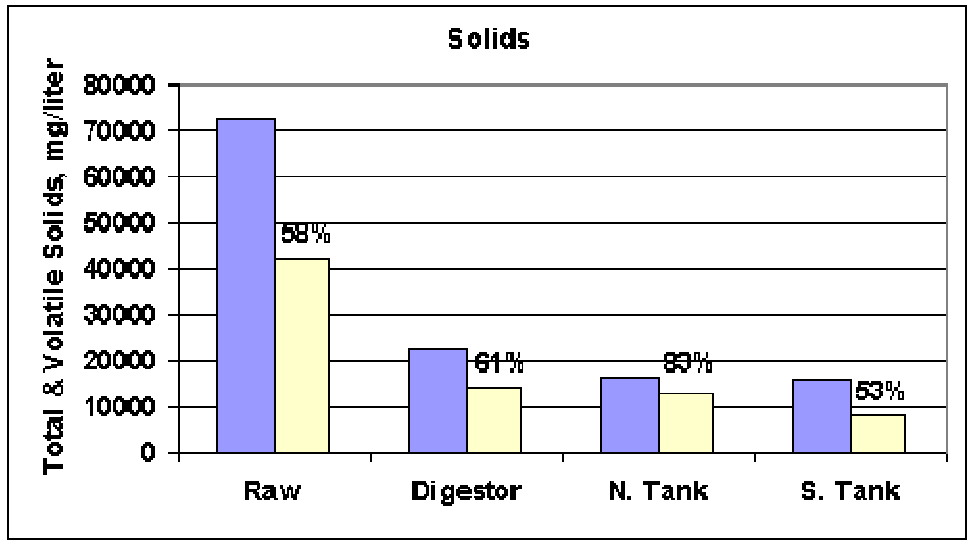


Figure 2. Solids concentrations at four locations

Chemical Oxygen Demand provides a gauge of how complete the digestion process is. Figure 3 shows before and after COD of the manure. COD leaving the digester has averaged 37.7% of the incoming COD. The lower COD in the storage tanks is the result of a combination of dilution, settling, and continued biological stabilization in the tanks.

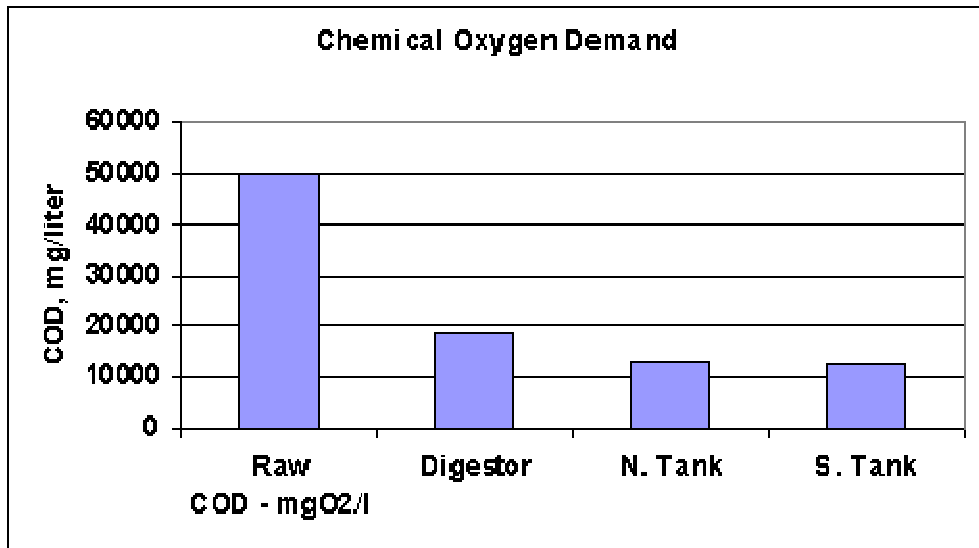


Figure 3. COD at four locations

Nitrogen: TKN and ammonia are tested at the four sampling points. Figure 4 shows results. As expected, ammonia concentration increases through the system relative to TKN. TKN concentrations were 10% less coming out of the digester than going in. The decrease could be due to either ammonia loss in the gas (pH has averaged 7.9), or to solids settling. Lower TKN concentrations in the storage tanks may result from either ammonia volatilization, settling, and/or dilution from precipitation.

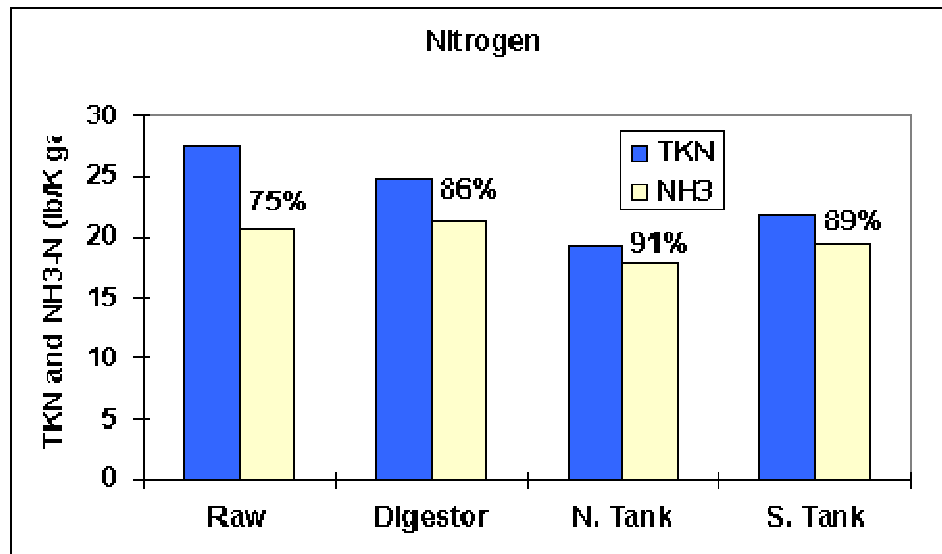


Figure 4. Nitrogen concentrations at four locations

Phosphorus concentrations decrease significantly as the manure passes through the digester. Phosphorus does not volatilize and is generally quite insoluble, so it is associated with the solids portion of the manure. The loss of phosphorus means that solids are settling in the digester.

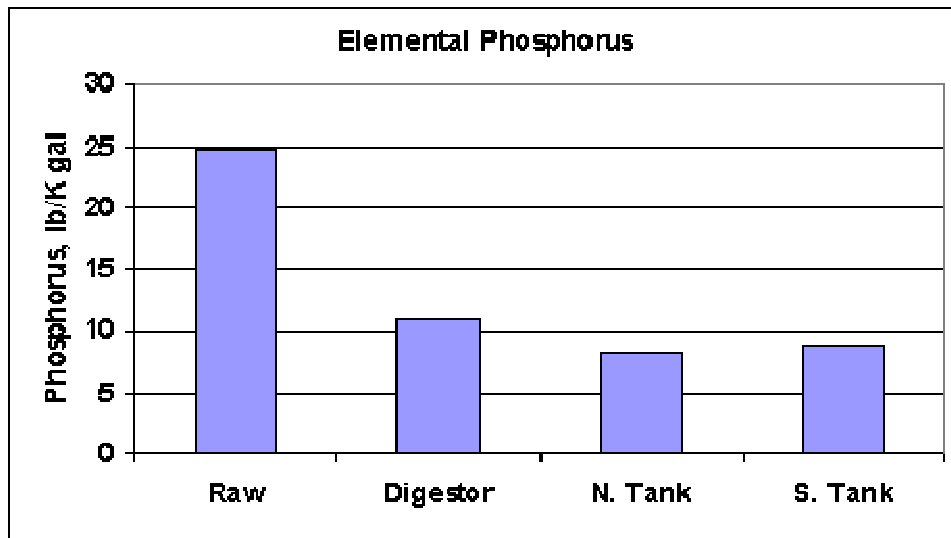


Figure 5. Elemental phosphorus at four locations. (to get P_2O_5 , multiply by 2.29).

Potassium is expected to change little as the manure passes through the digester. Sampling has confirmed it. Although Figure 6 looks like the storage tanks are significantly higher in potassium than the raw or digested manure, the scale only spans

2 lb/1000 gallons, so almost no difference in concentration is shown (1.1 lb/1000 gal). The lack of a difference says that little outside water such as rainfall diluted to the storage tanks

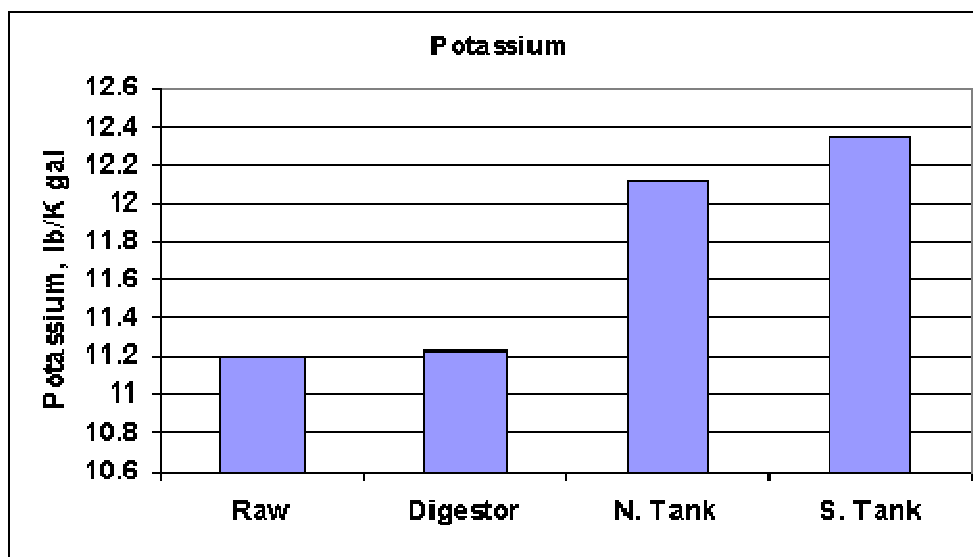


Figure 6. Elemental potassium at four locations. (to get K₂O, multiply by 1.2)

Odors Odors were tested in Dr. Dwaine Bundy’s pit additive columns at ISU. Figure 7 shows that the gases from above the digested manure has very much reduced H₂S and odor threshold as compared to the undigested manure gases.

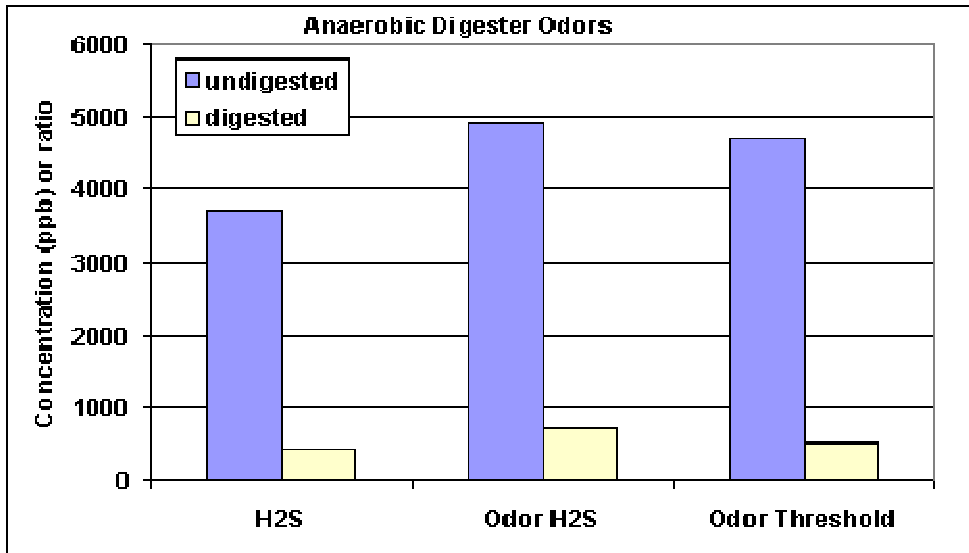


Figure 7. Hydrogen sulfide and odor threshold in gases from digested and undigested manure.

OPERATIONAL DATA

In general the digester has operated reliably since startup. The 80 Kw generator has produced approximately 460,000 Kw-hrs of electricity through June, 2000, worth \$30,400 to swine USA at 6.6 cent/Kwh. The following operational data averages have been documented:

Average gallons fed daily	14,730 gallons/day
Overall generator run time since startup	84%
Biogas production: ~950,000 ft ³ /mo	= 190 ft ³ /sow-mo (6.3 ft ³ /sow-day)
CO ₂ measured concentration	26%
Methane production (assumes 74%) =	140 ft ³ /sow-mo (4.7 ft ³ /sow-day)

Elec. Produced per month	42,290 Kw-hr/mo
Per day	1375 Kw-hr/day
Per sow per month	8.5 Kw-hr/sow-mo
Value (\$0.066/Kw-hr)	\$2790/mo

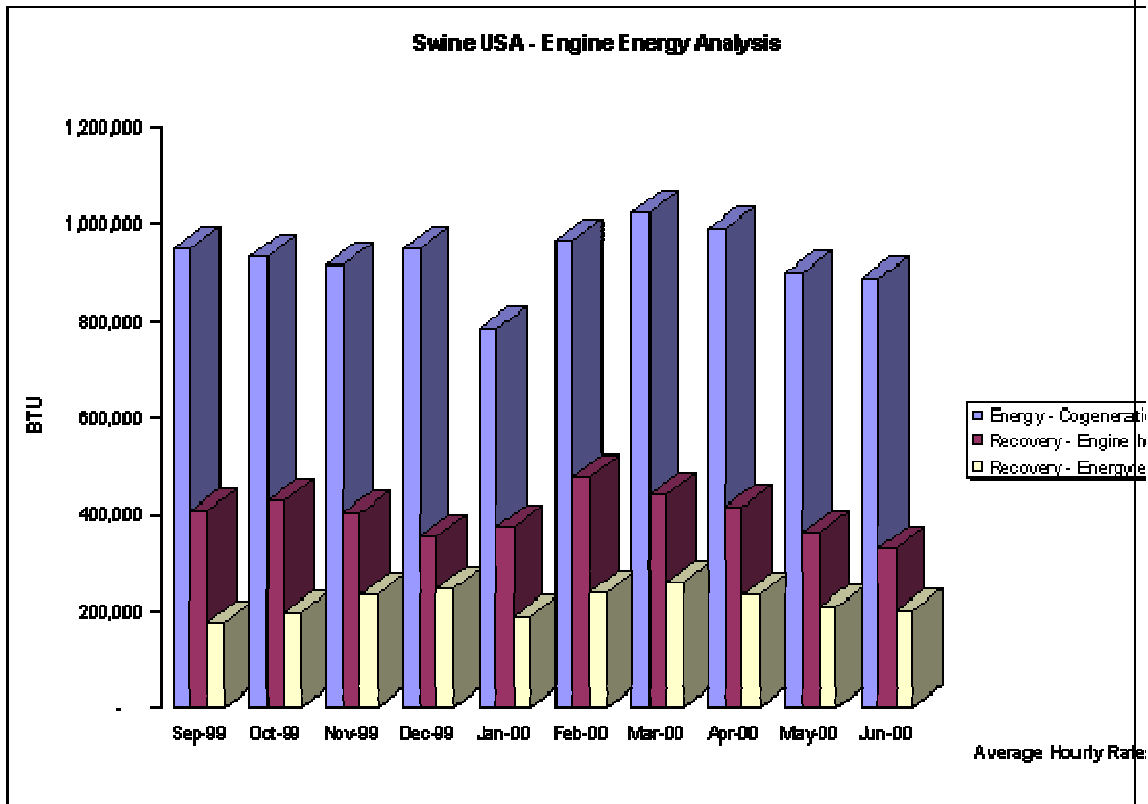


Figure 8. Total energy distribution.

Labor requirements: Digesters require management input. Normal labor requirements for this system have been approximately 1.5 hours per day. This includes manually starting feed pumps, taking temperatures, changing engine oil, etc. Some problems have occurred which have required additional management input. They are mentioned here not to emphasize problems, but to point out that *complex biological/mechanical system do require additional monitoring and management attention* compared to simply storing the manure.

Liquid Spill An elbow within the digester came apart, releasing some manure to the

nearby drainage ditch. The potentially serious spill was contained before reaching the river approximately 1 mile away.

Engine failure The engine failed resulting in an 11 day shutdown before being repaired/replaced. The engine was replaced at no cost to the operator, but resulted in down time and management input requirement.

Blown fuse Although a seemingly insignificant failure, a large fuse blew and required replacement. Several days elapsed before a replacement could be shipped in, resulting in engine/generator down time and management input requirement.

It should be noted that the labor requirements discussed above are somewhat elevated by additional data recording requirements imposed by the Iowa Department of Natural Resources in return for grant monies for construction.

Overall Operation

Overall the digester has functioned well and resulted in significant electrical savings for Swine USA. Methane generated electricity has replaced approximately 35% of their energy demand since startup. It replaces up to ½ of their demand during the warm season, and less during the cold months when the demands for heat of both the buildings and the digester are higher.