Global Resource Recovery Organization
FPPC – Pork Nutrient Reduction Project
Marshalltown, Iowa

Final Report
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OBJECTIVE

GRRO's objective is to demonstrate to the FPPC that more than 75% of the nutrients can be removed from the swine facility's wastewater effluent and treated to a safe and potentially useful product, in an environmental friendly and economical manner. GRRO proposes to process 0.20 dry tons per hour (dtph) or 2.0 wet tons per hour (non diluted swine waste at 9% total solids) for the demonstration. Initially, an estimated 2000 finishing hogs will be required to generate this amount of manure for processing in an eight hour day.

FACILITY DESCRIPTION

Burt Farm & Livestock Co.
2747 170th Street
Marshalltown, Iowa 50158

Allen Burt & Darrel Burt Owners
Telephone 641.753.1264
Four Barns – each capable of 1000 finishing hogs with three groups per year.
Average weight in 60 pounds, average weight out 260 pounds.
Average Animal Units – 640 at any one time

PILOT PROJECT DEMONSTRATION DESCRIPTION

The demonstration pilot project anticipates utilizing two of the four barns at the Burt Farm & Livestock Co., Marshalltown Iowa. The pilot project is planned to be operated 8 hours per day for 365 days per year and process the wastewater effluent from 2000 finishing hogs. The hours of operation will be dependent upon the actual size of the finishing hogs and will be operating 8 hours per day when they are near final weight for slaughter. The addition of the remaining two barns can be implemented through additional hours of operation.

The two barns will be plumbed together with the total wastewater being treated within 24 hours of being generated. The wastewater will be pumped from the barns to a static screen to remove the coarse solids. This effluent will go to a surge tank, which will feed the IC-SEP (Induced Cyclonic Separation Process). The IC-SEP will generate a cake solid with a total solid content of approximately 15% and an effluent stream. The effluent stream will be sent back to a barn that is not tied into the process for final disposal through irrigation. The solids will be processed in the Tempest and dried to a desirable Total Solids Content.

PROJECT RESULTS

The original flow configuration was for a static screen to mechanically remove the coarse solids from the hog manure. The static screen and IC-Sep were housed in an enclosed room to protect the system from freezing during the winter months. This enclosure created a space that contained the Hydrogen Sulfide which was liberated from the hog manure while flowing over the static screen. Curtains and exhaust fans were added but Hydrogen Sulfide levels were still too high for employee health and safety. The static screen was replaced with a Screw Press that was leased from Vincent Corp., Tampa, Florida.

An Acqua IC-Sep Dissolve Air Floatation unit was designed to handle 3,000 lph of hog manure with a total connected Hp of 7. The processing was anticipated to remove over 80% of the nutrients from the waste stream with the utilization of low dosing rates of acid, coagulant and flocculant. Previous trials in Australia had indicated that over 80% of the nutrients would be captured in the floated solids.

The ability of the IC-Sep to reduce nutrient concentrations is dependent upon the manure's reactivity with polymers to produce a high quality low water volume flocculated particle. Initially it was expected that the use of a pH adjustment would cause the manure to easily react with the coagulant and flocculant. The manure reacted violently with the acid generating large volumes of foam that were unmanageable and not containable. This led to months of bench trials to find coagulant and flocculants that would work together and form an acceptable pin floc that could be processed through the IC-Sep. The dose rates were initially expected to be a maximum 100 ppm for the coagulant and 40 ppm for the flocculant.

Jar testing of the non screened hog manure with coagulant/flocculant addition would produce variable results ranging from no appreciable flocculation to an acceptable pin flocculation. The only variables were the hog manure and dosing rates of the coagulant

and flocculant. Large dose rates (>2000 ppm for both the coagulant and flocculant) would produce a high water volume floc, but was not realistic due to cost. The manure pumping system was designed to mix the deep pit before pulling the manure out for processing. One, two and three hours of mixing and agitation of the pits produced the same variable flocculation results. Total solids content were consistent at 4.5 % with small deviations of the ratio of suspended to dissolved solids.

The IC-Sep flow rate was initially set at 3,000 lph and reduced in 500 lph increments until an acceptable effluent was obtained. A good quality effluent was obtained at a 1,000 lph flow rate of manure effluent from the screw press. The manure was treated with Ferric Chloride at 2000 ppm followed by Cesco 601 at 80 ppm and produced a yellow tinted effluent. Increasing the dosing rates of either coagulant or flocculant did not result in additional flocculation. The solids generated by the IC-Sep ranged between 8 – 12% total solids.

A Fiber Filter was rented from Vincent Corp., Tampa, Florida, to mechanically remove more of the fine suspended solids. The Fiber Filter effluent was processed through the IC-Sep at dose rates at 1500 ppm FeCl and 80 ppm for the 601 polymer at a flow rate of 1000 lph.

The IC-Sep process can treat hog manure at 1000 liters per hour, which is one-third of the predicted flow rate. This reduction in flow rate is due to the lack of reactivity in the finishing hog manure with the coagulants and flocculants to successfully separate the dissolved and suspended solids from the effluent. Pretreatment with Ozone and Zeolites was tried to increase the reactivity of the hog manure. There was some success with increasing the reactivity, but there was a time factor delay of 22 hours. Bench trials of the ozone/Zeolite treated hog manure show no flocculation until 22 hours after pretreatment. This time delay was tested on three separate occasions with the third batch of material being processed through the IC-Sep with over 90% nutrient removal.

When the IC-Sep DAF is processing correctly, its efficiency is over 79% removal of nutrients. See the Excel file named, Lab Analyses – AIB – DMB, for the complete lab analyses. The addition of Ferric Chloride and high molecular weight polymer has shown to remove a majority of the nutrients in the suspended and dissolved state. Although the IC-Sep process is working, the low flow restriction, chemical additives, cost per gallon and complexity of the IC-Sep process, does not favor the use of this process as a day to day operation that the typical Swine Producer would utilize. Initially the cost of operations (chemicals, labor and energy) of the IC-Sep was estimated to be $0.0135 per gallon of manure processed. With the higher dose rates and lower flow rate the cost of operations rose to $0.0803 per gallon of manure processed. See Table 1 - IC-Sep Operational Costs.

Screw Press – The Screw Press readily handled the coarse solids in the manure and produced a 30% TS product containing the particles greater than 1/32nd of an inch. The analyses showed that the resulting effluent from the screw press was basically unchanged from the influent, but slightly lower in mass flow. Of the dewatering processes, other

than the static screen, the screw press operations provided the most solids per unit of energy input. A total of 10 connected horsepower was required to operate the screw press with production related to manure input characteristics. There was a variability of coarse solids loadings going to the screw press due to the variability of the manure being pumped from the hog confinement pit. This variability occurs whether the manure pits are agitated for long, short or not at all by the manure transfer pumps.

Fiber Filter – The Fiber Filter works on the reverse principle of the screw press. The Fiber Filter presses the solids out of the flow rather than pressing the water out of the flow. A Fiber Filter was rented and installed to aid in solids capture and helped reduce the effluent total solids content by approximately 25%. The mass generated by Fiber Filter process was not significant when compared to the energy input. A total of 15 connected horsepower was required for the operation, while the output of the fiber filter was less than a few gallons of 8.5 – 12.0 % TS per hour. The vendor (Vincent Corp.) visited the site and observed the operation of this unit and the screw press and stated that the Fiber Filter was not a viable part of the process due to the amounts generated. This unit was cleaned, disassembled and returned to the vendor the end of July.

Table 1. IC-Sep Operational Costs

Burt Farm, Marshalltown, Iowa
IC-Sep Operating Costs

Existing

4000	gpd	$	1.00	$/liter Coag		15.12	Hours of Operation	
15120	lpd	$	3.00	$/liter Floc		5	Connected HP	
80	Coag dose ppm	$	0.06	$/kwh	$	20.00	$/hr labor	
2000	Floc dose ppm		1000	lph				

	lpd	lpd	gpd	gal/mo	No of 5 gal	$/day	$/gal manure
Coagulent	1.2096	1.2096	0.32	9.6	1.92	$ 0.39	$ 0.00010
Floculent	30.24	30.24	8	240	48	$ 90.72	$ 0.02268
Labor	0.75	laborer				$ 226.80	$ 0.05670
Energy	3.75	kw				$ 3.40	$ 0.00085
					Total	$ 321.31	$ 0.08033 per gallon c

Expected

4000	gpd	$	1.00	$/liter Coag		5.04	Hours of Operation	
15120	lpd	$	3.00	$/liter Floc		5	Connected HP	
100	Coag dose ppm	$	0.06	$/kwh	$	20.00	$/hr labor	
40	Floc dose ppm		3000	lph				

	lpd	lpd	gpd	gal/mo	No of 5 gal	$/day	$/gal manure
Coagulent	1.512	1.512	0.4	12	2.4	$ 0.60	$ 0.00015
Floculent	0.6048	0.6048	0.16	4.8	0.96	$ 1.81	$ 0.00045
Labor	0.50	laborer				$ 50.40	$ 0.01260
Energy	3.75	kw				$ 1.13	$ 0.00028
					Total	$ 53.95	$ 0.01349 per gallon c

Tempest
The Tempest part of the process worked as predicted and produced a product with 75-89% TS content. The input material was predominately screw press solids at 30-35% TS and ran well through the unit. The end product has been stored in super sacks and has not reheated due to biological activity. This material was recently used for fertilizer at the Burt Farm.

Conclusion
The original plan was to provide a high solids removal rate at an operational cost slightly higher than land application. The Burt's were impressed with the ability to remove the solids but also quickly stated that they had no interest in operating the equipment due to its complexity and chemical requirements. The fact that the IC-Sep, which was the main process for solids removal, required additional operator attention with higher operational costs revealed that the total process would not be practical for an on farm system operated by farm labor. The operational cost per gallon of manure for the IC-Sep went from an estimated $0.013 to an actual cost of $0.080 per gallon processed. This was due to higher chemical dose rates and labor requirements with lower flow rates. Even if the water could be reused in the operations the actual cost could not be justified.

The Static Screen provided for high coarse solids production for minimal capital and energy requirements, but there is a need to have adequate ventilation for dissipation of hydrogen sulfide, and other gases, that are liberated from the mechanical screening. The enclosed screw press provided for the entrapment of the gases and improved the safety of the working environment. The hydrogen sulfide and ammonia liberated by the static screen caused a high degree of corrosion on the apparatus within the enclosed wet room.

The screw press production rate was significant but variable due to the characteristics of the manure being processed. The nutrient content of the influent compared to the effluent was not significantly changed. The solids produced by the screw press were similar in composition to the influent. Manure mass can be removed but there is still a high volume of liquid effluent that will need further treatment.

Fiber Filters were not efficient for the removal of fine suspended solids due to the low production rate compared to the capital requirements and energy input.

The Tempest product shows that the process worked as predicted. Re-evaluating the project goals and process flow directed GRRO that if the hog manure could be combined with previously dried material and the total daily production of manure is processed through the Tempest, the nutrients in the manure could be almost totally reclaimed without the addition of other processes or chemicals.

GRRO has developed the Recycler Tempest where the raw materials are blended with a portion of the processed material to increase the efficiency and production rates through the Tempest unit. The blending of the materials greatly enhances the ability of the Tempest to process the material by reducing the adhesive tendency of the wet manure and increasing the flowability.

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