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K.S.U aerobic swine-waste handling system (6 years of problems and progress)

Abstract

The Kansas State University Swine research Unit's aerobic-oxidation waste disposal system is functioning satisfactorily with minimum maintenance and supervision. Labor requirements are low. Odor is no problem. Waste fluid can be spread on the fields any time without creating a "public nuisance."? Pigs are performing satisfactorily in the unit. Flies are easily controlled and suitable sanitation is easily maintained.; Swine Day, Manhattan, KS, November 13, 1975

Keywords

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Summary

The Kansas State University Swine research Unit's aerobic-oxidation waste disposal system is functioning satisfactorily with minimum maintenance and supervision. Labor requirements are low. Odor is no problem. Waste fluid can be spread on the fields any time without creating a "public nuisance." Pigs are performing satisfactorily in the unit. Flies are easily controlled and suitable sanitation is easily maintained.

Introduction

Confinement, swine-production research facilities built at Kansas State University in 1968 were designed specifically to accommodate an aerobic waste-oxidation system. Structural details of waste pits and related components are outlined in figure 1 as information only, not recommendations.

Facilities and Equipment

Fairfield, pour-in-place concrete slats are used for flooring in all buildings. Buildings (Butler) are steel and insulated. The farrowing and nursery buildings are completely enclosed. Each is equipped with an overhead furnace that brings in variable amounts (manual control) of outside air. Fans on the furnaces run constantly. An exhaust fan in each "paddle-wheel" room runs constantly. The ceiling of each unit has four intake fans. A separate thermostatic control on each one is manu-

ally adjusted. The farrowing building is equipped with an air-conditioning unit that brings in variable amounts of outside air (manual control) when used. Finishing buildings are open to the south in summer (closed in winter) and each has two exhaust fans on the north wall. Each "paddle-wheel" room has an exhaust fan in the ceiling. Sixteen small propane heaters, (C.S.I. Pro-Pig), one over each pen, supply heat in each finishing unit.

Each pit overflows into a 1500-gallon, outside holding tank. Fluid from the tanks is hauled to nearby fields in a tractor-towed, liquid-manure wagon (Hawkeye Steel).

Fairfield "paddle-wheels," originally used to circulate liquid waste, mix oxygen into the liquid, and to keep solids suspended in five separate pits under farrowing, nursery, and finishing swine pens, were replaced in 1971-72. Their open motors could not withstand high dust and moisture. Their bearings were close to the liquid in pits where foaming was a recurring problem, and odor control was not satisfactory.

All original "paddle-wheels" were replaced by "Aerob-A-Jets" (Fairfield). Each unit consists of

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a nine-inch diameter, three-blade propeller, mounted on a four-foot hollow shaft driven by a three-horsepower sealed motor. The pit under the north finishing barn was drained and cleaned because it had been used as an anaerobic pit several months. The water level in other pits was raised to accommodate the "Aerob-A-Jets" (overflow stand pipes were lengthened). Maintenance problems and time consumed immediately dropped to acceptable levels. Foaming problems were greatly reduced.

All data and information reported here, except references to foam control, were gathered under "Aerob-A-Jet" conditions.

Foaming, Dust, and Odor Problems

We acquired considerable practical experience with foam-control agents while we used the "paddle-wheels." Foaming problems were less spectacular than those others have described, probably because we had ample clearance between liquid and floor. Foam never reached floor-level in any of our pits. The usual problem was a 2 to 4 cm. (2.54 inches equal/cm.) layer of foam that did not circulate and, therefore, dried into a thick crusty layer on the surface of the liquid.

Most of the many additives we used to break up the foam successfully alleviated the immediate problem but none seemed to prevent more foam from forming. Diesel fuel or kerosene would reduce surface foam, but, in our pits, a thick unmanageable scum formed on the liquid surface. We did not study effects of additives on aerobic bacteria but odors indicated poor results. Commercial defoamers were furnished to us by Kemin Industries, Dow-Corning, Rohm & Haas, Feed Flavors, Inc., Arizona

Chemicals, and Kalo Company. All effectively reduced the amount of foam on the liquid surface for a short time. None seemed to have any long-time effect.

By accident, we found that Foremost-Soweena (a milk replacer for baby pigs) is an effective foam disperser, as is Ferma Grow (a fermentation feed additive). Poloxalene (active ingredient in Bloat Guard), also is a valuable foam-controlling agent.

The foam dispersers did not overcome a noticeable odor problem (probably hydrogen sulfide), especially in the nursery building. It has been controlled and almost eliminated since April, 1974, by regularly adding small amounts (100 ml. per day) of Puritan Liquid Live Micro-Organisms* to each pit. In November, 1973, a negative ion dispersion unit (Clean Air Systems, Inc.) was installed in the farrowing house and nursery building. It reduced dust so well that part of the air in each building is now being recirculated through the furnace and air conditioner.

Procedures

The swine research unit is primarily for nutritional and management studies with pigs of various ages. The manure disposal system is secondary to overall research planning. Thus, pit loadings fluctuate from month to month.

The farrowing house has crates for 29 sows. We farrow every other month and wean pigs at 4 to 6 weeks of age, so the average loading of the farrowing house is approximately 25 sows plus their pigs.

*Commercially available from Puritan Chemical Company.

All tissue and fluids related to birth drop into the pit (no dead pigs). The septic tank from the headquarters building (as many as four students live there) also drains directly into the pit.

Typical loading over each nursery pit is approximately 100 pigs, averaging 20 kilograms. Pigs go into the nursery averaging approximately 10 kilograms each and are moved out at an average weight of 25 to 35 kilograms.

Most pigs are moved directly from the nursery to the finishing barn, where typical loading over each waste pit is 100 pigs averaging 70 kilograms. Pigs are brought into the barn weighing 30 to 35 kilograms and usually removed when they weigh near 100 kilograms. Time lapse between groups of pigs usually is 2 to 5 days in any house. Floors and walls of pens in all units are cleaned with high-pressure cold water and disinfected between groups of pigs. All cleaning fluid falls into the pits.

Results and Discussion

Data collected during the past year are summarized in tables 34, 35, 36. Objectives outlined in 1968 when the waste control system was built are being met:

1. Reduce labor requirements to a minimum.
2. Reduce "nuisances" to a minimum.
3. Reduce odors in buildings.
4. Furnish pigs a suitable environment.
5. Reduce the "fly" problem.
6. Improve general sanitation.
7. Determine cost of the operation.

Labor related to waste handling is slight. A man with a scraper goes through each farrowing crate daily to see that all fecal material falls into the pits. Other pens are scraped when necessary (related to number of pigs in a pen). Labor required to pump overflow tanks and haul liquid to fields could be reduced by having pits drain directly into a lagoon. Cleaning pens or buildings between groups of pigs is fast and easy as all wash water falls into the pits. Labor required for Aerob-A-Jet maintenance has been low the past year. A new propeller can be put on a unit in an hour or less. The complete unit can be replaced in less time. Propellers wear out and must be replaced.

A new propeller was put on the farrowing house unit March 3, 1974.

August 19, 1974, a new propeller was put on the south nursery unit, it was replaced January 23, 1975, after the flow rate of fluid in the pit slowed noticeably.

Pigs broke a small slat off a feeder over the north nursery pit January 24, 1975. The slat fell into the pit and broke the propeller shear pin. A new propeller was installed when the pin was replaced.

In the south finishing barn pit, a new propeller was put on one unit March 27, 1974, and on the other unit, June 25, 1974. August 6, 1974, one motor burned out and was replaced. Liquid flow was slowing in January so both propellers were replaced January 25, 1975.

New propellers were put on both units in the north finishing barn March 3, 1974. One propeller broke and was lost in the pit May 10, 1974. Both propellers were replaced January 3, 1975, after liquid flow slowed.

The "nuisance" problem is almost completely eliminated. Facilities and fields are close to housing areas and odor from fluid is only slightly noticeable. Fluid is hauled to the fields whenever soil is dry enough regardless of wind direction or humidity.

The overall environment furnished the pigs is conducive to good performance. Twenty-eight sows that farrowed in January, 1975, are raising 240 pigs. One outstanding pig farrowed October 3, 1974, weighed 216 pounds 131 days later (February 11, 1975). Others of similar age exceeded 200 pounds each.

Flies are easily controlled. Reproduction of flies in the unit is essentially zero. Flies that migrate into the buildings are easily destroyed by spraying or fogging.

Health problems have been minimal the past year. Facilities are easily cleaned. We have never had a longstanding siege of illness or infection. Baby pig diarrhea, a problem at times, is not chronic.

Operational costs have been higher than desired. Table 34 shows electrical energy consumed in three different pits. Differences in consumption in the same pit probably reflect differences in condition or location of propellers. Face areas

of some propeller blades removed after long usage were 57 to 72 per cent less than when new. Also, a slight change in location or angle of a propeller will change apparent surface velocity of the fluid in a pit.

Water removed from overflow pits seems excessive at times. Much of it, apparently, is water wasted by pigs playing. Overflow from the farrowing house pit has always exceeded that from other units, but the headquarters building septic tank drains into the farrowing house pit. We routinely remove at least one load (4136 liters) from each overflow pit once each week. Water is added to the manure pit if necessary to force that much fluid into the overflow pit.

Table 34. Selected data from aerobic oxidation pits at K.S.U. Swine Research Unit

Pit No. ¹	January, 1975					January, 1974				
	1	2	3	4	5	1	2	3	4	5
Electricity, K.W.H./Hr.	2.52	1.36	--	2.90	--	2.92	1.75	--	2.94	--
Fluid temp., °C.	20.0	20.0	20.0	18.0	20.0	19.0	21.0	20.0	17.0	20.0
Fluid pH, paper	5.0	8.2	8.2	7.8	8.5	6.5	8.0	8.0	8.0	8.0
Fluid D.M. ² , %	0.55	1.34	1.05	2.15	2.81	0.62	2.21	1.58	2.58	1.86
Crude protein in D.M.,%	27.1	39.6	30.4	31.7	32.8	30.2	35.6	33.8	27.1	24.1
Crude fiber in D.M.,%	7.5	3.2	2.4	1.9	4.5	3.9	5.9	2.6	7.3	6.7
Total ash in D.M.,%	35.2	31.9	42.4	42.6	32.7	39.9	30.3	38.8	38.0	43.7

¹Pit no. 1 = farrowing barn; 2 = south nursery barn; 3 = north nursery barn; 4 = south finishing barn; 5 = north finishing barn.

²D.M. = Dry matter

Temperature of water supply = 12.0° C in January, 1974; 13.0° C in January, 1975.
(C° x 9/5) + 32 = F°.

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Table 35. Partial composition of dry matter ash from pits at K.S.U. Swine Research Unit

Pit No. ¹	January, 1975					January, 1974				
	1	2	3	4	5	1	2	3	4	5
<u>Mineral²</u>	ppm									
Phosphorus	21,590	30,120	36,960	39,690	29,430	27,900	27,400	32,200	35,400	33,700
Calcium	39,950	40,010	37,450	38,010	34,120	46,000	42,100	46,000	41,000	39,200
Iron	4,117	2,930	6,010	3,170	2,750	3,820	1,980	1,810	2,160	1,940
Magnesium	11,290	11,090	15,090	15,960	12,050	13,373	11,660	14,245	13,663	15,388
Manganese	459	798	1,074	773	572	303	400	492	411	378
Zinc	445	683	657	556	600	384	694	536	495	339
Copper	92	118	92	102	107	46	115	100	82	68
Potassium	44,290	46,310	75,560	75,530	59,280	56,164	52,942	71,512	61,404	35,708
Sodium	22,250	19,601	25,950	24,150	19,960	19,323	11,749	19,996	20,920	27,194

¹Pit no. 1 = farrowing barn; no. 2 = south nursery barn; no. 3 = north nursery barn; no. 4 = south finishing barn; no. 5 = north finishing barn.

²Dry matter basis.

Table 36. Fluid removed from overflow tankds at K.S.U. swine research unit.

Month	Farrow	South nursery	North nursery	South finish	North finish
Thousands of liters					
April '74	91.6	37.5	20.8	44.3	16.6
May	60.2	34.4	23.7	54.1	16.3
June	53.7	34.3	34.3	18.5	30.1
July	56.8	41.3	47.3	25.9	15.3
Aug.	80.2	31.0	45.4	9.3	13.4
Sept.	42.6	18.5	17.2	40.3	31.0
Oct.	93.5	30.3	39.7	14.2	8.3
Nov.	17.6	8.3	4.2	33.3	39.4
Dec.	13.8	28.8	20.8	25.9	30.1
Jan. '75	30.1	16.7	20.8	33.3	49.2

¹Transported in a 4136-liter (1,100 gallon) "Hawk-eye" liquid manure wagon (3.785 liters = 1 gallon).

Fig. 1a. Plan View of Waste pits.

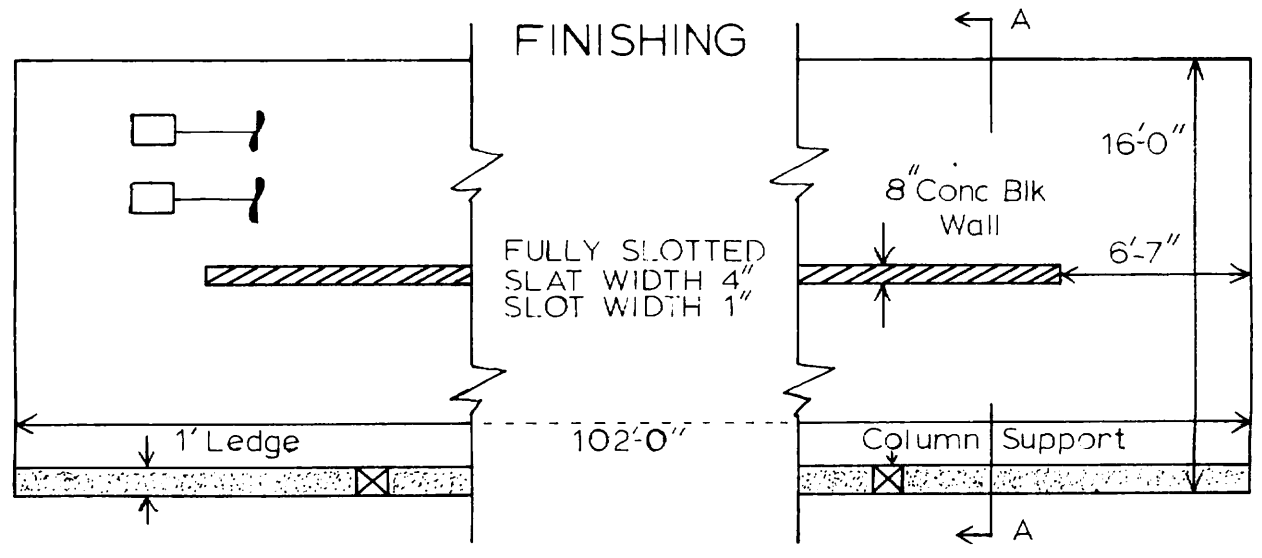
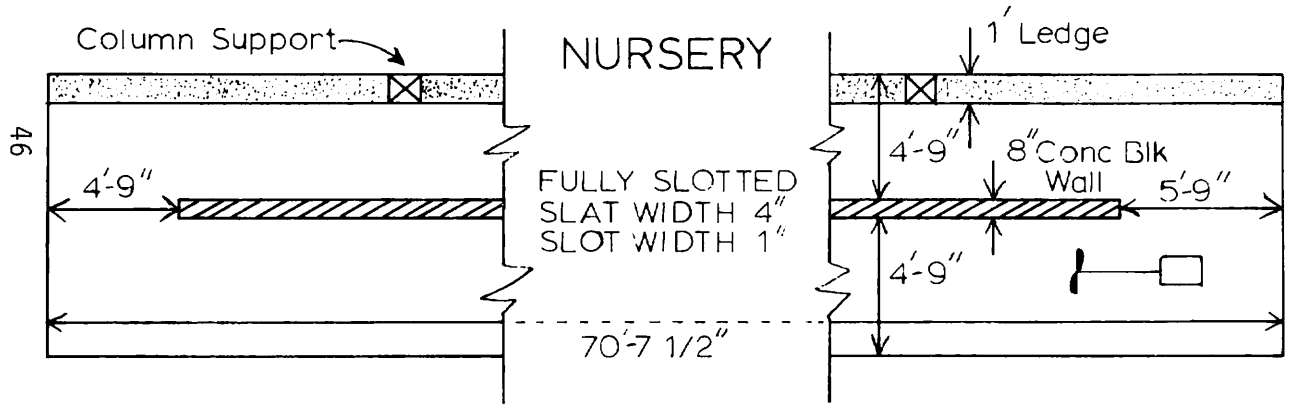
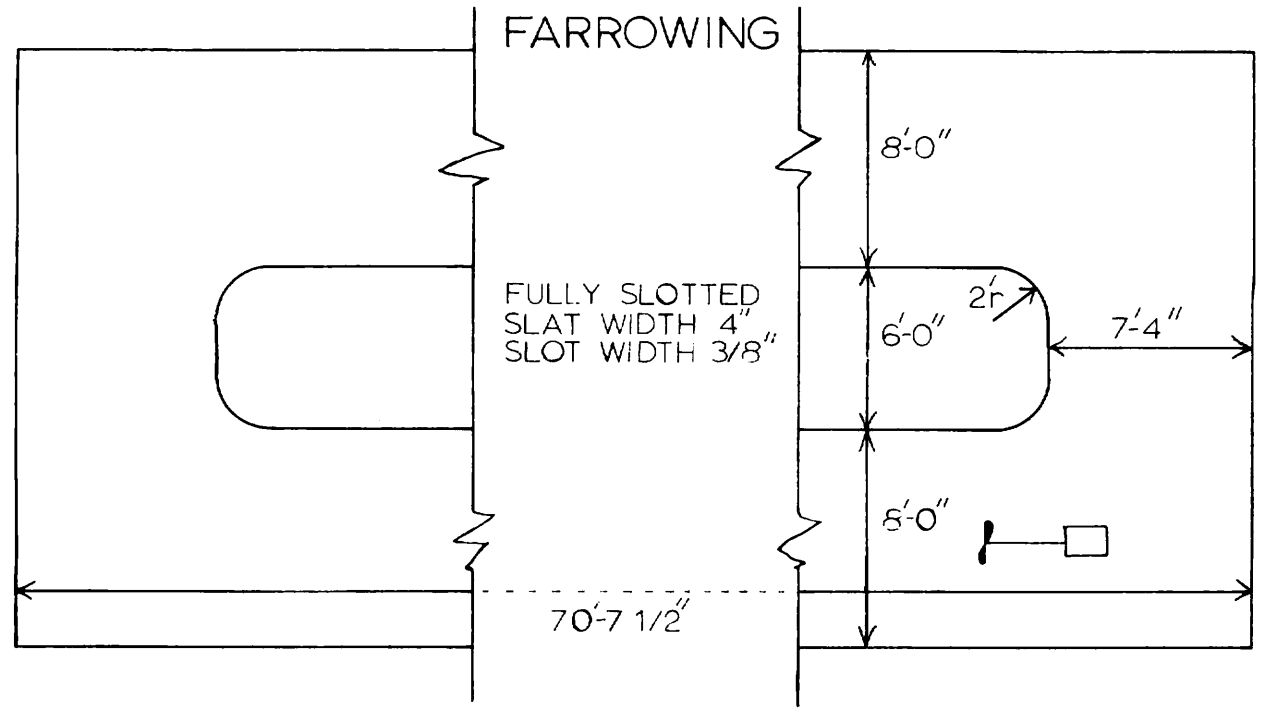
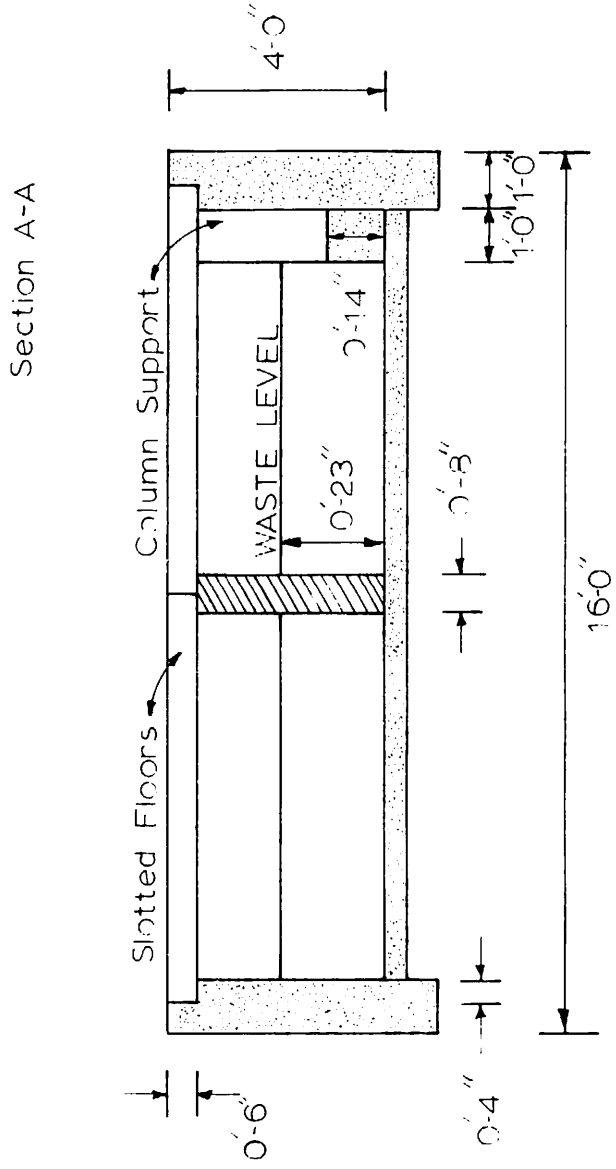


Fig. 1b. Cross section with corner detail.



Corner Fillet

