Management Manure Treatment Plant: The Farm School of Murcia University's Veterinary Science Faculty (Spain)

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ABSTRACT

The new directives set by the production market show that the treatment and appreciation of stockbreeding by-products must be considered from a global standpoint integrating safety, health and respect for the environment. These standards, applicable both to the technology used and to the final product obtained, are vital for maintaining and improving our productivity.

This present work reviews the challenges faced by intensive stockbreeding starting from the traditional problems of manure treatment and compares this situation with a new, more global vision, involving environmental quality, animal health and welfare and productivity, taking as a reference the operation and progress of the first 34 months' running of the manure treatment center facility at the Farm School of Murcia University's Veterinary Science Faculty (Spain).

Modern animal production is an extremely sophisticated business and the management, treatment, purification and appreciation of its by-products should also be so. As the practice of intensive production in stable or pen facilities grows there is an increasingly urgent need for effective and affordable alternatives for management of nutrient by-products. This work presents an integral system for manure treatment designed and installed by SELCO MC at the Farm School of Murcia University Veterinary School (Spain). This system means an undoubted step forward in the technology of manure management and appreciation and vouches for the close inter-relation between production, animal health and welfare and a healthy environment (see Figure 1). We compare the results with another facility in NC (USA) evaluated for Environmental Superior Technology Project Demonstration (AWMP-NCSU) Animal Waste Management Program.

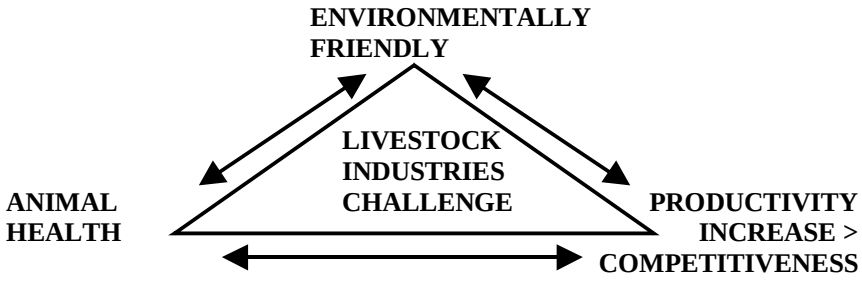

Figure 1. Inter-relation animal production, animal welfare and healthy environment.

1. INTRODUCTION

More efficient and profitable methods for handling stockbreeding by-products, for purifying and storing them, i.e. for their appreciation as a whole, are required. This technology is the polymer technology implemented (SELCO-Ecopurín® Technology) [(1)] at Murcia University Veterinary Faculty Farm School's (Spain) central plant for manure treatment, where fine particulates, most of them colloidal, typical of manures are flocculated, reaching separation efficiencies of over 95%. This extremely high recovery of solids, originally in colloid form, not only makes the use of an advanced purification of the liquid a more economic alternative, but also increases the amount of materials available for the solid processing operation, which generates income.

2. MATERIALS AND METHODS:

2.1 The challenge involved at the facilities of Murcia University Veterinary Faculty Farm School.

Murcia University Veterinary Faculty Farm School is 2.5 km from the Faculty's central building, covering a surface area of 16 Ha, with excellent infrastructures for carrying out practical work with different animal production systems. The land on which the facilities are set is bounded at the north by the Agridulce Residential Estate and the Espinardo Campus of Murcia University, on the east by the town of Guadalupe and on the south and west by the A7 and E15 motorways.

The farm school meant an investment of around 4.5 million Euros. Strict biosecurity principles were observed in its design, the perimeter being divided into two well-differentiated areas going by this concept: clean zone and dirty zone.

The design of the Farm School Manure Treatment centre thus mainly had to tackle these three aspects: reducing-eliminating foul smells, obtaining solid-liquid fractions with biosecurity guarantees, especially the liquid part for use in irrigation by sprinkling and obtaining an effluent with a nutrient content usable in the forage unit with enough nutrient usage guarantees to avoid the use of synthesis fertilisers, at the same time as saving the water necessary for irrigating forage species (oats, barley, alfalfa and white rocket), using the liquid fraction obtained after the process for treating manures.

The characteristics of this facility are:

- Zootechnics: Swine: 340 mothering sows in closed cycle (5,300 heads fattening); Sheep and Goats: 350 heads; Rabbits: 150 mothers in closed cycle; Laying poultry: 500 laying hens+incubation+fattening; Cows: 24 dairy cows with milking system; Horses: 6 mares and foals.
- Treatment capacity: Solid Separation Unit: 5 m^3/h; Biological Unit: 2.7 m^3/h; Ultrafiltration Unit 2.7 m^3/h.
- Fodder Factory and agronomy: Forage unit 1.60 Ha and Fodder factory.

Technically, the challenge involved in designing the Manure Treatment Centre Facility was the mixture of different types of manures, with very great heterogeneity as regards their biochemical and physical-chemical composition, the variability in the inlet flows to the treatment plant and the use of chemical compounds for cleaning and disinfecting the facilities also being factors to be borne particularly in mind [(3)].

2.2 Brief description of the treatment process

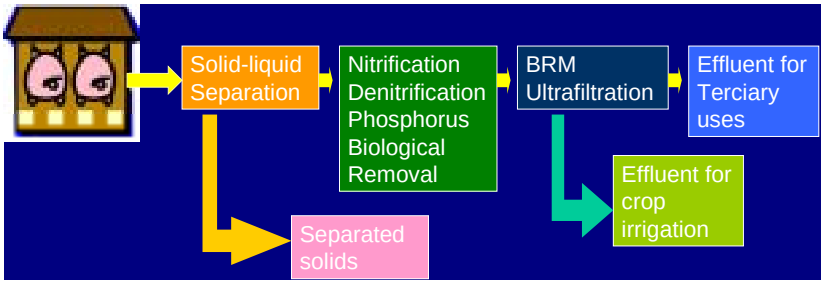

Figure 2. Process Treatment in Murcia Facility (Spain).

2.2.1. Detail of the overall solid-liquid separation process: main ionic transfer reactor. [(1)]

The separation of solids with polymers reduces suspended solids by up to 99.83%, which allows an economical purification of manures by aeration. By capturing suspended particles, most of the volatile organic compounds which require oxygen are also removed from the liquid flow.

2.2.2. Biological treatment for nutrient reduction: phase I biological module

The biological denitrification processes can be combined with a nitrification reactor, in order to totally remove the nitrogen. In this process we also reduce the organic load in the nitrification tank. The suppression of the nitrogen has average efficiencies of 89.55% for total nitrogen and 85,67% for ammonia nitrogen. Nitrification produces acidity and consumes alkalinity, but no supplement is normally required when a pre-denitrification configuration is used.

2.2.3 Reduction of pathogens: phase II biological module

The average reductions are 1 log after the solid-liquid polymeric separation , and 3 logs when the polymeric separation is combined with a system of nitrification-denitrification using aerobic and anoxic conditions. After membrane ultra-filtration by means of BRM, reductions of 5 logs are achieved due to the fact that the membranes filter (permeate) at a membrane spacing under average pore diameter 0.03 μm. (See results in Tables 2 and 3).

2.2.4. Evolution of the results attained

We now express the evolution of the progression and contaminant elimination capacity of the different modules of the manure treatment centre at the Veterinary Faculty of Murcia University.

Table 1. Evolution of the parameters of the Manure Treatment Centre Facility

Parameter	Average analysis inlet manure	Parameters required by the University of Murcia	*M*unicipal Regulations of Murcia wastewater drans service	Limits to pour public channel RDPH-Table 3	Average analyses manure at outlet of whole treatment	Elimination of parameters in % of inlet manure
COD (mg/l)	15.908	1.450	-	160	368	97,69
BOD5	7.138	700	400	40	33	99,54
pH	7,40	8,86	6-9,5	5,5-9	8,14	-
TSS	9.160	1.020	500	80	16	99,83
NH4 (mg/l)	1.065	1.083	-	18,2	153	85,67
Total P (mg/l)	192	-	-	10	27	86,06
TKN	1.473	-	-	-	154	89,55

Average of the analyses made over 38 months from February 2002 until August 2004.

Table 2. Total and faecal coliforms per mililiter or different liquid samples in the Manure Treatment Facility

Sample	Total Coliforms/ml	Faecal Coliforms/ml	Faecal Coliforms/ct
Raw Manure	$1.70 \cdot 10^4$	$1.70 \cdot 10^4$	100.00
Post flocculation Liquid	$2.70 \cdot 10^3$	$2.70 \cdot 10^3$	100.00
Biologic Reactor	5.00	2.00	40.00
Outlet Filter	0.00	0.00	-

Table 3. Analysis of virical indicators in different samples in the Manure Treatment Facility

Sample	Somatic Coliforms	Salmonella Somatic Coliforms	Pili Spacific Colifagus
Raw Manure	$8.00 \cdot 10^4$	0 (Bacteriofagus in 1 ml of sample)	$1.00 \cdot 10^3$
Post flocculation Liquid	$4.20 \cdot 10^4$	0 (Bacteriofagus in 1 ml of sample)	$1.00 \cdot 10^3$
Biologic Reactor	$1.20 \cdot 10^4$	0 (Bacteriofagus in 1 ml of sample)	$1.00 \cdot 10^1$
Outlet Filter	3.20	0 (Bacteriofagus non detected)	0 (Bacteriofagus non detected)

3. CONCLUSIONS AT THE MANURE TREATMENT CENTER FACILITY AT THE FARM SCHOOL OF MURCIA UNIVERSITY'S VETERINARY SCIENCE FACULTY

38 months after getting under way the Manure Treatment Centre Facility at the Farm School of Murcia University's Veterinary Faculty, the analytical, operational and economic results show that it is possible to tackle the challenges of treatment and appreciation of livestock by-products (waste) with guaranteed success, the main conclusions being as follows:

- Practical reduction of foul smells and emissions of gas.
- The reduction of foul smells is directly connected with the emission of volatile Organic Compounds and thus with the contaminant potential.
- The reduction of the contaminating content on the average of physical-chemical parameters of the inlet (influent) to the treatment plant is between 97.8 and 99.5 %.
- The microbiological quality of the affluent after ultrafiltration, along with the practical non-existence of suspended solids and absence of pathogens (0 pathogens)
- The economic viability for reaching these purification/appreciation levels, estimated as being 1.41 €uro/m^3 (without depreciation) equivalent to 0.01 € per kg of meat produced per animal of 100 kg live weight.
- Obtaining a line of liquid with a 95 % on average of reduction of suspended solids.
- Obtaining a line of solids in the main module with a 25% on average of dry substance (4) (5)
- There is a direct relationship between health and welfare of animals and productivity and proper management and handling of livestock excrement.

4. COMPARISON WITH THE GOSHEN FARMS FACILITY IN NORTH CAROLINA. USA.

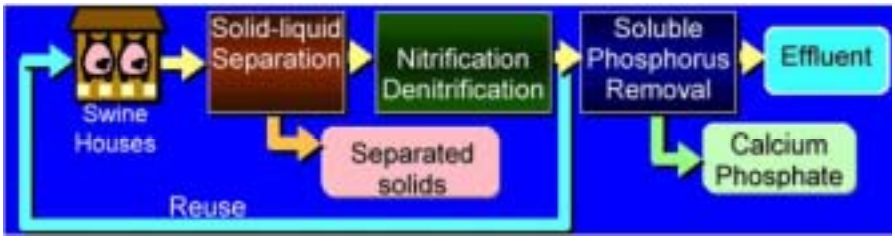

Figure 3 . Process treatment in Goshen Facility (USA).

The main differences between both facilities are the following (7):

- Nitrification Process: In Goshen farms it is made by means of high concentration of bacteria immobilized in pellets(6), while in Murcia highs amount of biomass concentration are allowed due to the use of a combined Nitrification-Denitrification process with an ultrafiltration process (BRM).
- Pathogen Elimination: In Goshen farms pathogens are eliminated by increasing pH at the end of the treatment, during the phosphorous recovery process. In Murcia pathogens are eliminated in the ultrafiltration unit.

- Phosphorous Removal: Goshen Farms facility has a specific P-removal treatment. In Murcia a biological phosphorous process takes place [8].

Table 4.Results Comparison Goshen (USA) Vs Murcia (SPAIN)

Water Quality Parameter	TSS	VSS	COD	BOD5	TKN	NH4-N	TP	PO4-P
Goshen Plant Efficiency	98.8	99.1	95.6	99.8	98.4	99.3	95.0	94.1
Murcia Plant Efficiency	99.8	n/a	97.6	99.5	89.5	85.6	86.0	n/a

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