Thus says the Lord:

"Let not the wise man glory in his wisdom,
Let not the mighty man glory in his might,
Let not the rich man glory in his riches;
But let him who glories glory in this,
That he knows and understands me,
That I am the Lord who practise
Steadfast love, justice, and righteousness in the earth;
For in these things I delight."

Jeremiah 9 v 23, 24

STUDIES IN ANAEROBIC/AEROBIC TREATMENT

OF

DAIRY SHED EFFLUENT

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DAVID JOHN WARBURTON

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ABSTRACT

Increases in herd size and enforcement of water quality regulations have created an effluent disposal problem for the New Zealand dairy industry. Spray disposal to land and lagooning are commonly used but mechanical failures, management requirements and pressure on land have limited their suitability in many situations. This project was established to consider an alternative system.

Initial studies revealed that anaerobic treatment in unmixed, non-insulated tanks, followed by trickling filter aeration, might be suitable. Two laboratory scale and one field treatment plant (1/15 - 1/20 full scale) were constructed to investigate the system. A factorial experimental design allowed investigation into three anaerobic treatment levels with a 3 x 3 aerobic treatment interaction nested within each anaerobic treatment.

Anaerobic residence times of 5, 7.5 and 10 days provided loading rates of 1.35 - 0.63 kg COD/m^3-day and 1.36 - 0.67 kg TS/m^3-day. Removals between inlet and outlet averaged 71% and were insensitive to loading rate. Total solids accumulation rates of 40-50% TS input rate suggests that anaerobic tank design should be based on solids accumulation rate and cleaning frequency.

The stone media trickling filter was loaded at approximately 0.61 kg COD/m^3-day. Aeration periods of 1, 2 and 3 days and hydraulic loads of 2.8, 10.1 and 18.2 m^3/m^2-day were studied to determine their influence on treatment efficiency. Multiple regression analysis indicated that the longer residence times and higher recycle rates improved treatment efficiency. Removals varied with the measured parameters but ranged from 42-66% for COD. Design alterations to allow the final discharge to be taken from the bottom of the filter, after settling, would increase aerobic treatment efficiency above 75% COD removal. Prediction of treatment efficiencies beyond the monitored operating conditions suggested that only marginal improvements could be made. The TS accumulation rate in the aerobic phase was approximately 13% of the TS input rate or 56% of the BOD removal rate.

Overall plant treatment efficiencies of 80-89% were obtained. Removals in excess of 92% could be achieved with minor design alterations. Maintenance and operational requirements were minimal. The only problem with the system was an average 15 fold increase in NO_3-N and 4 fold increase in DIP under conditions for optimum removal of the other parameters. Intermittent land disposal could reduce this problem.

Treatment comparison between similar laboratory plants, and between laboratory and field plants which varied by a scale factor of 56, suggests that identically designed plants would give a similar performance and that there is little scale effect. Increasing the scale only improved treatment efficiencies under unstable aerobic conditions, i.e., high recycle rates and low residence times. Increasing scale gave some decrease in maintenance and operational problems.

Design of a full scale plant, based on daily pollution loads from a 250 cow dairy shed, suggests that the system is a viable proposition.

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A B B R E V I A T I O N S

BOD = biochemical oxygen demand

C = carbon

^oC = degrees Celsius

Ca = calcium

CH_4 = methane

CMD = coefficient of multiple determination

CO_2 = carbon dioxide

COD = chemical oxygen demand

DIP = dissolved inorganic phosphate

DKN = dissolved Kjeldahl nitrogen

DM = dry matter

DO = dissolved oxygen

DOP = dissolved organic phosphate

F/M = food to microorganism ratio

g = gram

h = hour

ha = hectare

I.D. = internal diameter

K = potassium

kg = kilogram

kW = kilowatt

l = litre

m = metre

max. = maximum

mg = milligram

Mg = magnesium

ml = millilitre

MLVSS = mixed liquor volatile suspended solids

mm = millimetre

mV = millivolt

N = nitrogen

Na = sodium

Na_2O_2 = sodium peroxide

NaOH = sodium hydroxide

NH_4-N = ammoniacal nitrogen

NO_3-N = nitrate nitrogen

O_2 = oxygen

P = phosphorus

ppm = parts per million

RBD = rotating biological disc

rpm = revolutions per minute

s = second

S.T.P. = standard temperature and pressure

TDN = total dissolved nitrogen

TDP = total dissolved phosphate

TEMP = temperature

TKN = total Kjeldahl nitrogen

TN = total nitrogen

TP = total phosphate

TPN = total particulate nitrogen

TPP = total particulate phosphate

TS	= total solids	VS	= volatile solids
VFA	= volatile fatty acids	yr	= year