National Exams May 2008

04 Agric B11, Principles of Waste Management

3 hours duration

NOTES

1 If doubt exists as to the interpretation of any question the candidate is urged to submit with the answer paper a clear statement of any assumptions made

2 This is an OPEN BOOK EXAM one textbook of your choice Any non communicating calculator is permitted

3 The examination has two parts

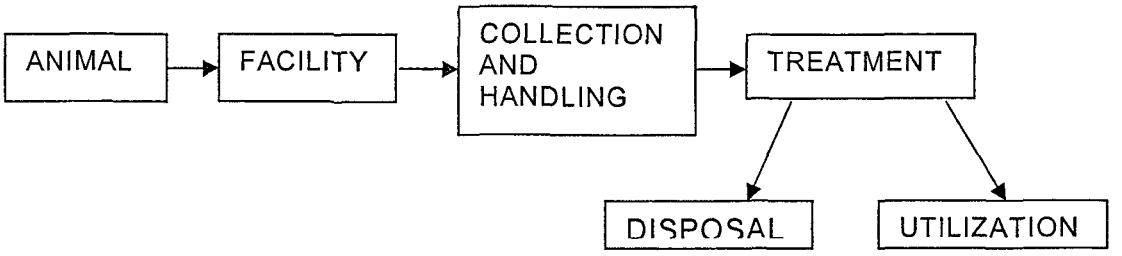
i) PART A has two questions and both must be answered
ii) PART 2 you must answer any four of the five questions listed

Part A will be marked and only the first four questions answered from the remaining five questions (2 3 4 5 6) will be marked Failure to indicate this will result in grading of the first question encountered in the answer book

4 Most questions require an answer in essay format Clarity and organization of the answer are important

PART A – ANSWER QUESTION 1 MANDATORY

1 An integrated approach to an animal production and waste management can be said to consist of the following components



Each of the blocks has a number of components which must be compatible from one block to another Thus if the animal facility produces solid manure then the collection & handling treatment and disposal systems must also be able to handle solid manure

For the purpose of this question assume that there are a large number of animals and that the facility is a total confinement building with a high degree of waste treatment The waste can be in solid liquid or slurry form

a) List or describe (briefly) the alternative animal waste treatment processes under the headings of i) biological treatment chemical treatment and physical treatment with at least two examples of each
b) List or describe (briefly) the alternatives for disposal and utilization of animal wastes resulting from each of those treatments

PART 2 ANSWER ANY FOUR OF THE FOLLOWING FIVE QUESTIONS

2 Anaerobic digestion is receiving renewed attention as an animal waste treatment process and as a means of energy generation Assume that a housed confinement unit has a capacity for 10 000 beef animals with continuous manure delivery to a heated digester The objective is to determine how much electricity can be produced if the digester gas is used to run an engine generator and determine the possibility of maintaining the digester at 35oC with the waste engine heat The following information is available for this preliminary design

Description	Value
average animal weight	360 kg
coldest temperature of the manure dilution water mixture	10°C
coldest environmental temperature around the digester	7°C
overall heat transfer coefficient of the digester walls	9 5 W m^2 °C
digester gas production rate	0 7 m^3/kg of destroyed VS
brake thermal efficiency of the engine	30%
fuel energy recovered from the sludge heat exchanger	50%
conversion efficiency of the generator	85 %
digester diameter not to exceed	30 m
digester liquid depth not to be less than	7 5 m
digester retention time	12 5 days
dilution of beef manure	1 1 32
manure production (per 1000 kg live weight)	
raw manure	60 kg/day
total solids	6 9 kg/day
volatile solids	5 9 kg/day
BOD_5	1 6 kg/day
COD	6 6 kg/day
energy content of the digester gas	2 24x10^7 J/m^3

Calculate

a) Amount of dilution required
b) Digester volume and dimensions
c) Digester heating requirements
d) Daily gas production
e) Daily electrical power production
f) Waste heat available from engine cooling water
g) Is the amount of waste heat enough to satisfy the digester heating requirements?

3 A chicken farm produces manure with a moisture content of 70% and rich in nitrogen (6%) Both the moisture and the nitrogen contents are too high for optimum composting Sawdust is available with a moisture content of 35% a carbon to nitrogen (C/N) ratio of 500 1 and a nitrogen content of 0 11% If the C/N ratio of the chicken manure is 10 1 calculate

a) The amount of sawdust needed per kilogram of manure for a moisture content of the mixture to be 60%?
b) What is the corresponding C/N ratio of the mixture?
c) If a C/N ratio of 25 is desired how much additional sawdust must be added?
d) Is the resulting moisture content of the new mixture suitable for composting?

4 An aerated lagoon is to be used to treat a waste water flow of 0 30 mgd with an average BOD of 600 mg/L The temperature extremes expected for the lagoon contents range from 10°C in winter to 35°C in summer Minimum BOD reduction through the lagoon should be 75% The surface aerators to be installed carry a manufacturer s specification to transfer 2 5 lb of oxygen/hp hr under standard conditions During the laboratory treatability studies the wastewater was shown to have the following characteristics k_{20oC}= BOD removal rate constant 0 68 per dya θ = temperature coefficient = 1 047

a) calculate the critical retention time
b) the amount of oxygen required per hour and
c) the number of 10 hp surface aerators required

5 A dairy wastewater of 0 25 mgd with 1000 mg/L of BOD is treated in an aeration tank and clarifier system without primary settling The volume of the aeration basin is 69 500 ft^3 The MLSS in the aerating liquor is 2000 mg/L and settles to a volume of 200 ml/L in 30 minutes Compute the following

a) hydraulic retention time in the aeration tank
b) BOD loadings
c) BOD sludge age
d) SVI
e) suggested sludge recirculation rate if the solids content of wasted activated sludge is 2 wt%

6 Control of odours is becoming a major problem in managing and treating agricultural wastes In particular composting and anaerobic digestion facilities have become an environmental target by people who have moved from cities to rural areas Describe in detail

a) the odorous compounds that cause complaints
b) the components of the waste that cause odours
c) the measurement of odours
d) the sources of odours in a composting plant
e) methods to reduce odour emissions from composting digestion plants

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MARKING SCHEME

1 a) 10/20 b) 10/20

2 each part is 3/20 except part g) which is 2/20

3 each part is 5/20

4 a) 8/20 b) 7/20 c) 5/20

5 each part is 4/20

6 each part is 4/20