

Centre for Energy Studies

BIOCONVERSION & PROCESSING OF WASTES, ESL-732

Time : 2 hrs.

(Major Test)

26.11.08

MM : 50

Attempt all questions

1. a) Write down the gaseous components constituting 'Biogas'. Discuss how a large number of microbial species function to produce the above components.

b) Say why :
 - i) an inoculum is added to a biogas digester
 - ii) no biogas digester is operated in the temperature range 42-50°C
 - iii) mixing is needed in the digester
 - iv) the optimum pH range for biogas production is 6.8 - 7.2 .
- c) Differentiate between a 'batch digester' and a 'continuous digester' clearly indicating the advantages and disadvantages of both. (2 + 6 + 4 + 4=16)
2. a) How do you obtain 95% ethanol from a lingo-cellulosic material? Discuss in detail the various problems associated with different steps involved in the conversion process.

b) Justify the statement 'the fermentation process retains most of the energy content of sugar in ethanol'. (10 + 2=12)
3. Give brief answers to the following :-
 - i) In PERC process, nearly half of the total wood is gasified. How and why?
 - ii) What happens to the remaining wood?
 - iii) Which method is followed to prepare wood slurry for liquefaction purpose?
 - iv) Indicate the conditions of liquefaction in the reactor.
 - v) The catalyst recovery is a unique feature of the PERC process. Explain how catalyst is recovered.
 - vi) Discuss the purpose of using 'flash tanks'.
 - vii) Give reason for using a solvent such as xylene in oil separation stage.
 - viii) How oil is separated from the solvent and the catalyst bearing solution? (2 + 6 + 2 =10)
4. a) Using steam in an air-blown gas producer has a number of advantages. Justify.
b) A fluidized bed gasifier produces cleaner gas as compared to a downdraft gasifier with respect to tar content and particulate matter. Say 'True' or 'False'. Give reasons.
c) In a fluidized bed gasifier, temperature is maintained between 800-950°C and also uniform temperature is maintained throughout the bed. Give reason.
d) A gaseous fuel has the following % composition by volume :
 $H_2 = 52$, $CH_4 = 30$, $C_3H_8 = 3.6$, $CO = 8$, $CO_2 = 2$, $O_2 = 0.4$, $N_2 = 4$
Calculate total kmol of air required for combustion/kmol of gaseous fuel. (2 + 2 + 3 + 5=12)

c. Test whether or not all slope coefficients are simultaneously equal to zero (3 points)
(Assume $\sum y_i x_{2i} = 56.7$ and $\sum y_i x_{3i} = 63.4$)

d. Construct a 99% confidence interval for $\hat{\beta}_2$ (2 points)

5. A four variable regression yields the following results

$$\begin{array}{ccccccc} \hat{Y}_i & = & 1.446 & + & 1.9856X_{2i} & + & 2.335X_{3i} & + & 0.568X_{4i} \\ \text{se} & & (0.36) & & (0.98) & & (1.8) & & (0.45) \end{array}$$

The $R^2 = 0.88$ on the above regression. When we regress X_2 on X_3 and X_4 we get the following results,

$$1.9856\hat{X}_{2i} = 5.678X_{3i} + 6.95X_{4i}$$

se (1.45) (3.23) $R^2=0.68$

a. What is the probable phenomenon at work in the regressions above? What in the above regressions is/are indicative of this phenomenon (2 points)

b. Name 2 ways we can attempt to deal with this phenomenon. Can some of these methods cause undesirable effects? Explain briefly (3 points)

6. In a 2 variable regression with 50 we obtain from the residual plot that the error variance is increasing with X_i . We divide the observations into two groups by omitting the 10 central observations. We regress Y on X for the two groups (1 and 2) separately and obtain $RSS_1 = 524.5$ and $RSS_2 = 657.35$. Using this information, can we say that there is significant heteroscedasticity at the 1% level of significance? (3 points) (SHOW YOUR WORKING CLEARLY !!!!)

7. A researcher is studying the effect of X on Y using a time series of 80 observations.

Assuming an Autoregressive relationship of the first order (AR -1 scheme) he models $u_t = \rho u_{t-1} + e_t$ where e_t is a white noise error term.

On regressing u_t on u_{t-1} , he obtains $u_t = .56u_{t-1}$ and $\hat{\sigma}_e^2 = 2.56$

Using the information above construct the Var-Cov matrix of errors assuming that ONLY 1st order serial correlation exists with higher order autocovariances equal to zero. Furthermore assume that the error variance on the original Y on X regression is homoscedastic with $\hat{\sigma}_u^2 = 0.85$. (3 points)

8. An ANOVA table for a 3 variable regression yields the following information:

SOURCE	SS	df
ESS due to X_2	73.89	1
ESS due to X_2 and X_3	249.84	2
RSS (of 3 var. model)	494.50	38

Is the contribution from adding X_3 significant to the model at the 1 % level of significance? (2 points)