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Sardar Patel University
M.Sc. Renewable Energy

Semester : Third

Course Code: PS03CSYT03

Course Title: Advances in Biomass Gasification

Date: Thursday, 27.10.2016

Time: 02:00 PM to 5:00 PM

Total Marks: 70

- Note: 1. All the questions are compulsory
2. Figures on the right bracket indicated marks

Que. 1: Select the correct answer

9 Marks

- i. The conversion of the carbonaceous biomass into gaseous form at high temperature is called
- | | |
|------------------------|-------------------|
| a. Gasification | c. Fermentation |
| b. Anaerobic digestion | d. Photosynthesis |
- ii. Biomass contains.....
- | | |
|--------------|---------------------|
| a. Cellulose | c. Hemicelluloses |
| b. Lignin | d. All of the above |
- iii. Temperature range at which gasification takes place is
- | | |
|---------------|-----------------|
| a. 30-70 °C | c. 1100-1300 °C |
| b. 250-330 °C | d. 380-530 °C |
- iv. The most preferred gasifier design for power generation application is
- | | |
|-------------------------|-----------------------|
| a. Cross draft gasifier | c. Downdraft gasifier |
| b. Updraft gasifier | d. Both b and c |
- v. Producer gas can be utilized in
- | | |
|--------------|-------------------------|
| a) IC engine | c. Furnaces and boilers |
| b) Turbines | d. All of the above |
- vi. The primary goal of fast pyrolysis is to maximize the production of
- | | |
|----------|----------------------|
| a) Char | c. Liquid or Bio-oil |
| b) Gases | d. All of the above |
- vii. The main objective of the torrefaction is to.....
- | | |
|-------------------------------|------------------------------|
| a) Increase O/C ratio of wood | c. Reduce O/C ratio of wood |
| b) Increase C/O ratio of wood | d. Reduced C/O ratio of wood |
- viii. Electrostatic precipitator uses voltage in the range of
- | | |
|--------------|---------------|
| a. 50-100 kV | c. 0-5 kV |
| b. 10-30 kV | d. 150-200 kV |
- ix. Producer gas cooling and cleaning system is used for removal of
- | | |
|--------------------|---------------------|
| a. Tar | c. Moisture |
| b. Solid particles | d. All of the above |

Que. 2: Answer in brief any seven**21 Marks**

- i. Explain in brief biomass formation process
- ii. Define biomass. State the different conversion routes of biomass in brief
- iii. Explain ablative pyrolyser with suitable figure.
- iv. Find the heat of formation of sawdust, the heating value of which is given as 476 kJ/ mol. Assume its chemical formula to be $\text{CH}_{1.35}\text{O}_{0.617}$. Following values are given table-

Compound	H ₂ O	CO ₂	CO	CH ₄	O ₂
Heat of formation at 25 °C (kJ/mole)	-241.5	-393.5	-110.6	-74.8	0

- v. Explain in brief what motivation for biomass conversion
- vi. Give the advantages of torrefaction
- vii. Brief about the producer gas mixture for spark ignition engine
- viii. Explain in brief about the constituents of biomass cells
- ix. Explain working principle of cyclone with suitable diagram
- x. A biomass sample has moisture content 45% on wet basis. Calculate the moisture content of dry basis.

Que. 3: A) What are the different types of biomass gasifier. Explains any one with suitable diagram **5 Marks**

B) Explain different gasification process occurred during gasification **5 Marks**

OR

A biomass company plans to build a commercial torrefaction plant in British Columbia, Canada, to utilize the beetle-infested pine forest. This waste product contains 35% moisture (M) on "as-received" basis. The composition of the feed on "dry basis" is as: Proximate analysis (db): Volatiles: 80.71%, fixed carbon: 16.16%, ash: 3.13%. Ultimate analysis (db): C: 47.99%, H: 6.25%, O: 40.73%, N: 1.31%, S: 0.58%, Ash: 3.13%. Calculate: The lower (LHV) and higher heating value (HHV) of the biomass feed on (a) wet basis, (b) dry basis

Que. 4: A) Explain In-Situ tar reduction methods for reduction of tar in producer gas **5 Marks**

B) Explain in details the principle; operation and application of the baghouse filter **5 Marks**

OR

Explain the principle of the wet scrubber in brief and describe sieve plate scrubber with suitable diagram

Que. 5: A) What are the different methods for increasing power from producer gas fueled engines? **5 Marks**

B) Write about the engine life and engine wear using producer gas **5 Marks**

OR

Write about the engine selection for producer gas

Que. 6: A) Explain the physical aspect of the pyrolysis in details **5 Marks**

B) Explain the following with suitable diagram: **5 Marks**

- a. Circulating fluid bed pyrolyser
- b. Bubbling-Bed Pyrolyzer

OR

What is torrefaction? Explain the mechanism of torrefaction