SRM VALLIAMMAI ENGINEERIN COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

V SEMESTER

PME301- BIOENERGY CONVERSION TECHNOLOGIES

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SUBJECT: PME301 – BIOENERGY CONVERSION TECHNOLOGIES

SEM / YEAR : V/ III

UNIT-I INTRODUCTION

Biomass: types – advantages and drawbacks – typical characteristics – proximate & ultimate analysis – comparison with coal - Indian scenario carbon neutrality – biomass assessment studies – typical conversion mechanisms densification technologies

Q.No.	PART-A	BT Level	Competence
1.	What is biomass?	BT-1	Remember
2.	List two types of biomass.	BT-1	Remember
3.	What is carbon neutrality in biomass usage?	BT-1	Remember
4.	What is proximate analysis in biomass?	BT-1	Remember
5.	Define ultimate analysis.	BT-1	Remember
6.	Differentiate between proximate and ultimate analysis.	BT-2	Understand
7.	Why is biomass considered renewable?	BT-2	Understand
8.	Describe one drawback of biomass energy.	BT-2	Understand
9.	What is meant by densification of biomass?	BT-2	Understand
10.	Why is biomass more sustainable than coal?	BT-2	Understand
11.	State one application of biomass in rural energy systems.	BT-1	Remember
12.	How is biomass carbon-neutral in a practical scenario?	BT-1	Remember
13.	Give one example of biomass conversion technology used in India.	BT-1	Remember
14.	How is ultimate analysis helpful in biomass selection?	BT-1	Remember
15.	What type of biomass would be preferred for pelletization? Why?	BT-1	Remember
16.	Compare the calorific value of biomass and coal.	BT-2	Understand
17.	Why is ash content an important parameter in biomass use?	BT-2	Understand
18.	Assess the suitability of rice husk for power generation.	BT-2	Understand
19.	How does Indian biomass potential support rural electrification?	BT-2	Understand

20.	Compare the environmental impacts of biomass vs coal.	BT-1	Remember
21.	Evaluate briquetting as a densification technology.	BT-1	Remember
22.	Assess India's biomass assessment studies.	BT-2	Understand
23.	Justify the use of biomass over fossil fuels in decentralized energy systems.	BT-2	Understand
24.	Recommend a suitable biomass type for urban bioenergy.	BT-2	Understand
25.	Judge the role of biomass in achieving SDG goals.	BT-2	Understand
Q.No.	**PART-B:**	**BT Level**	**Competence**
1.	Define biomass and classify its types. Discuss each type with examples.	BT-2	Understand
2.	Explain the advantages and limitations of using biomass as an energy source.	BT-2	Understand
3.	Describe the typical physical and chemical characteristics of biomass.	BT-2	Understand
4.	Explain proximate and ultimate analysis of biomass. Why are these analyses important?	BT-2	Understand
5.	Compare biomass with coal based on key fuel properties.	BT-4	Analyze
6.	Discuss the concept of carbon neutrality in biomass utilization.	BT-2	Understand
7.	Assess the current biomass energy scenario in India.	BT-1	Remember
8.	Describe any two biomass assessment studies in India. What methodologies are used?	BT-2	Understand
9.	Explain biochemical and thermochemical conversion mechanisms for biomass.	BT-2	Understand
10.	With a neat flow diagram, explain pyrolysis and gasification processes.	BT-2	Understand
11.	Explain various densification technologies for biomass. What are their benefits?	BT-2	Understand
12.	Analyze the barriers in adopting biomass energy in India. Suggest solutions.	BT-3	Apply
13.	Propose a sustainable biomass energy model for a rural Indian village.	BT-3	Apply
14.	Evaluate the environmental and economic impacts of biomass-based power generation.	BT-3	Apply
15.	Write short notes on: (a) Biomass gasifier (b) Torrefaction (c) Pellets (d) Anaerobic Digestion	BT-5	Evaluate
16.	Draw a flow chart for the classification and energy conversion	BT-3	Apply

	pathways of biomass.		
17.	Design a biomass supply chain management system from farm to plant.	BT-5	Evaluate

UNIT- II BIOMETHANATION

Biomethenation process – influencing parameters – typical feed stocks – Biogas plants: types and design, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

Q.No.	**PART-A**	**BT Level**	**Competence**
1.	Define biomethanation.	BT-1	Remember
2.	List the main stages of biomethanation.	BT-1	Remember
3.	What is methanogenesis?	BT-1	Remember
4.	Name two types of bacteria involved in biomethanation.	BT-1	Remember
5.	State the significance of pH in biomethanation.	BT-1	Remember
6.	Mention any two parameters affecting biogas production.	BT-2	Understand
7.	How does temperature affect biomethanation?	BT-2	Understand
8.	Explain the impact of Carbon/Nitrogen (C/N) ratio.	BT-1	Remember
9.	Why is retention time important in biogas plants?	BT-2	Understand
10.	List any two inhibitors of the biomethanation process.	BT-1	Remember
11.	Give two examples of feedstocks for biogas production.	BT-1	Remember
12.	Classify feedstocks based on origin.	BT-1	Remember
13.	Why is pre-treatment of feedstock necessary?	BT-2	Understand
14.	Compare solid and liquid feedstocks.	BT-1	Remember
15.	Mention a benefit of co-digestion of feedstocks.	BT-3	Apply
16.	Name any two types of biogas plants.	BT-1	Remember
17.	What is a fixed dome type biogas plant?	BT-1	Remember
18.	State one advantage of a floating drum type plant.	BT-1	Remember
19.	Differentiate between batch and continuous biogas plants.	BT-1	Remember
20.	What are the key factors considered in designing a biogas plant?	BT-1	Remember
21.	List two appliances that use biogas.	BT-1	Remember
22.	What is the use of a biogas burner?	BT-1	Remember
23.	How is biogas used in power generation?	BT-2	Understand
24.	State one feature of a biogas luminary.	BT-1	Remember
25.	Name one application of biogas in rural industries.	BT-1	Remember
Q.No.	**PART-B:**	**BT Level**	**Competence**

1.	Define Biomethanation and list its key stages.	BT-1	Remember
2.	Explain the biochemical process involved in Biomethanation.	BT-2	Understand
3.	Discuss the various influencing parameters of the Biomethanation process.	BT-2	Understand
4.	Apply the concept of Biomethanation for municipal solid waste treatment.	BT-3	Apply
5.	Illustrate the design considerations for a fixed dome type biogas plant.	BT-3	Apply
6.	Differentiate between various types of biogas plants based on construction and operation.	BT-4	Analyze
7.	Analyze the influence of temperature and pH on biogas production.	BT-4	Analyze
8.	Examine the role of feedstock selection in the efficiency of biomethanation.	BT-4	Analyze
9.	Evaluate the suitability of different feedstocks for a rural biogas plant.	BT-5	Evaluate
10.	Critically evaluate the performance of industrial effluent-based biogas plants.	BT-5	Evaluate
11.	Compare the performance and efficiency of various biogas plant designs.	BT-5	Evaluate
12.	Design a biogas plant layout for a community with 50 households.	BT-4	Analyze
13.	Propose a system for electricity generation using biogas in a rural setting.	BT-4	Analyze
14.	Develop a maintenance plan for a small-scale biogas plant.	BT-4	Analyze
15.	Create a proposal to integrate industrial effluent and food waste for co-digestion.	BT-4	Analyze
16.	Formulate a biogas-based cooking system using biogas burners and luminaries for a school hostel.	BT-4	Analyze
17.	Design a compact urban biogas unit using kitchen waste.	BT-4	Analyze

UNIT- III COMBUSTION

Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels equivalence ratio – fixed Bed and fluid Bed combustion

Q.No.	**PART-A**	**BT Level**	**Competence**
1.	Define perfect combustion.	BT-1	Remember
2.	What is complete combustion?	BT-1	Remember
3.	What is incomplete combustion?	BT-1	Remember

4.	Define stoichiometric air.	BT-1	Remember
5.	What is the equivalence ratio?	BT-1	Remember
6.	Name two major products of complete combustion.	BT-1	Remember
7.	State one major product of incomplete combustion.	BT-1	Remember
8.	What is the typical air-fuel ratio for biomass combustion?	BT-1	Remember
9.	List any one drawback of incomplete combustion.	BT-1	Remember
10.	Define fixed bed combustion.	BT-1	Remember
11.	Describe why excess air is used in biomass combustion.	BT-2	Understand
12.	Differentiate between perfect and complete combustion.	BT-2	Understand
13.	Why does incomplete combustion occur in fixed bed combustion?	BT-2	Understand
14.	State how equivalence ratio indicates the combustion condition.	BT-2	Understand
15.	Describe the function of a fluidized bed in combustion.	BT-2	Understand
16.	Calculate the equivalence ratio if actual AFR = 5 and stoichiometric AFR = 6.	BT-3	Apply
17.	Given 1 kg of biomass requiring 6.5 kg of air for complete combustion, how much air is needed for 10 kg of biomass?	BT-3	Apply
18.	A fluidized bed combustor burns wood chips. What improvement does it offer over a fixed bed?	BT-3	Apply
19.	Suggest a way to reduce CO emissions incomplete combustion.	BT-3	Apply
20.	Identify if combustion is complete or incomplete with high CO and low CO_2 in flue gas.	BT-3	Apply
21.	Compare fixed bed and fluid bed combustion in terms of efficiency.	BT-4	Analyze
22.	Analyze the effect of using less air than stoichiometric in biomass combustion.	BT-4	Analyze
23.	Determine why a fluid bed combustion system is more suitable for moist biomass.	BT-4	Analyze
24.	Evaluate the significance of stoichiometric air in combustion control.	BT-4	Analyze
25.	Propose a control method to maintain optimal equivalence ratio in biomass boilers.	BT-4	Analyze
Q.No.	**PART-B:**	**BT Level**	**Competence**
1.	Define perfect, complete, and incomplete combustion with suitable examples.	BT-1	Remember
2.	List the different stages involved in fixed bed and fluidized bed	BT-1	Remember

	combustion processes.		
3.	Explain the stoichiometric air requirement for combustion of biofuels with examples.	BT-2	Understand
4.	Describe the working principle of a fluidized bed combustion system.	BT-2	Understand
5.	Differentiate between complete and incomplete combustion with examples and emission analysis.	BT-2	Understand
6.	Calculate the stoichiometric air required for the combustion of 1 kg of ethanol (C_2H_5OH).	BT-3	Apply
7.	Determine the equivalence ratio for a biomass fuel combusted with 80% of the stoichiometric air requirement.	BT-3	Apply
8.	Compare fixed bed and fluidized bed combustion systems based on operational parameters.	BT-4	Analyze
9.	Analyze the impact of equivalence ratio on combustion efficiency and emissions.	BT-4	Analyze
10.	Examine the factors leading to incomplete combustion in biomass stoves.	BT-4	Analyze
11.	Critically evaluate the advantages and disadvantages of fixed bed combustion systems.	BT-5	Evaluate
12.	Assess the environmental impacts of incomplete combustion of biofuels.	BT-5	Evaluate
13.	Evaluate fluidized bed combustion technology for large-scale biomass utilization.	BT-5	Evaluate
14.	Design a biomass combustion system for rural applications using fixed bed combustion.	BT-5	Evaluate
15.	Propose modifications to improve the efficiency of fixed bed biomass stoves.	BT-5	Evaluate
16.	Develop a mathematical model to calculate excess air required in a biomass combustion process.	BT-5	Evaluate
17.	Construct an experimental plan to compare emissions from complete and incomplete combustion of sawdust.	BT-5	Evaluate

UNIT- IV GASIFICATION, PYROLYSIS AND CARBONISATION

Chemistry of gasification types – comparison – typical application – performance evaluation – economics. Pyrolysis - Classification process governing parameters – Typical yield rates.

Carbonization – merits of carbonized fuels – techniques adopted for carbonisation

Q.No.	**PART-A**	**BT Level**	**Competence**

1.	What is gasification?	BT-1	Remember
2.	List any two types of gasifiers.	BT-1	Remember
3.	Define pyrolysis.	BT-1	Remember
4.	What is carbonization?	BT-1	Remember
5.	Mention any one merit of carbonized fuels.	BT-1	Remember
6.	State any one governing parameter in pyrolysis.	BT-1	Remember
7.	Give one example of feedstock for pyrolysis.	BT-1	Remember
8.	What is producer gas?	BT-1	Remember
9.	Name two main products of pyrolysis.	BT-1	Remember
10.	What is the typical temperature range for pyrolysis?	BT-1	Remember
11.	Differentiate between gasification and pyrolysis.	BT-2	Understand
12.	Why is gasification considered more efficient than direct combustion?	BT-2	Understand
13.	State the term ‘slow pyrolysis’.	BT-2	Understand
14.	State the role of temperature in pyrolysis.	BT-2	Understand
15.	Compare fixed bed and fluidized bed gasifiers.	BT-2	Understand
16.	How will you calculate the performance of a gasifier?	BT-3	Apply
17.	Suggest an application for pyrolysis oil.	BT-3	Apply
18.	How can carbonized fuels be applied in rural energy systems?	BT-3	Apply
19.	Identify the advantage of fluidized bed gasifiers over fixed bed types.	BT-3	Apply
20.	Analyze how moisture content affects pyrolysis yield.	BT-3	Apply
21.	Why is tar formation an issue in gasification?	BT-4	Analyze
22.	Evaluate the economic advantage of gasification over diesel generators.	BT-4	Analyze
23.	Assess the environmental benefit of pyrolysis.	BT-4	Analyze
24.	Design a flow diagram for a pyrolysis unit.	BT-4	Analyze
25.	Propose an integrated biomass conversion system using pyrolysis and gasification.	BT-4	Analyze
Q.No.	**PART-B:**	**BT Level**	**Competence**
1.	Define gasification and describe its chemical reactions.	BT-1	Remember
2.	Explain the stages involved in the gasification process of biomass.	BT-2	Understand
3.	Describe the chemistry and heat balance of biomass gasification.	BT-2	Understand
4.	Illustrate with a diagram the working of a fixed-bed updraft gasifier.	BT-3	Apply

5.	Calculate the stoichiometric air requirement for gasification of 1 kg of biomass with 40% carbon.	BT-3	Apply
6.	Differentiate between fixed-bed and fluidized-bed gasifiers in terms of efficiency and operation.	BT-4	Analyze
7.	Compare the gasification of biomass with coal.	BT-4	Analyze
8.	Evaluate the performance of downdraft gasifiers for engine applications.	BT-5	Evaluate
9.	Assess the economic feasibility of biomass gasification in rural India.	BT-5	Evaluate
10.	Explain the main products of biomass pyrolysis.	BT-4	Analyze
11.	Explain the classification of pyrolysis based on heating rate and temperature.	BT-2	Understand
12.	Describe the parameters governing pyrolysis process efficiency.	BT-2	Understand
13.	Suggest suitable reactor types for bio-oil production through pyrolysis.	BT-3	Apply
14.	Analyze the effect of pyrolysis temperature on product yield.	BT-4	Analyze
15.	Define carbonization and mention its main benefits.	BT-1	Remember
16.	Compare traditional and modern techniques of carbonization.	BT-4	Analyze
17.	Design a basic carbonization unit for rural application and justify the choice of materials.	BT-3	Apply

UNIT- V LIQUIFIED BIOFUELS

Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae Process and chemistry Biodiesel Vs. Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

Q.No.	**PART-A**	**BT Level**	**Competence**
1.	Define Straight Vegetable Oil (SVO).	BT-1	Remember
2.	List two limitations of using SVO as fuel.	BT-1	Remember
3.	What engine modification is needed for SVO use?	BT-2	Understand
4.	Why SVO cannot directly replace diesel in cold climates?	BT-2	Understand
5.	Compare SVO and diesel in terms of viscosity.	BT-3	Apply
6.	Define transesterification.	BT-1	Remember
7.	Name two feedstocks for biodiesel production.	BT-1	Remember
8.	List two advantages of using algae for biodiesel production.	BT-2	Understand
9.	Why is methanol used in biodiesel production?	BT-2	Understand
10.	Differentiate between oilseed and algae-based biodiesel production.	BT-2	Understand

11.	What is the byproduct of transesterification?	BT-1	Remember
12.	List the catalysts used in biodiesel production.	BT-1	Remember
13.	State the chemical reaction involved in biodiesel production.	BT-2	Understand
14.	What is the purpose of washing biodiesel after production?	BT-2	Understand
15.	Identify the key process parameters affecting biodiesel yield.	BT-1	Remember
16.	Mention any two emission benefits of biodiesel over diesel.	BT-1	Remember
17.	Why does biodiesel reduce greenhouse gas emissions?	BT-2	Understand
18.	List any two performance drawbacks of biodiesel.	BT-2	Understand
19.	Compare cetane number of biodiesel and diesel.	BT-1	Remember
20.	Evaluate the impact of biodiesel on engine lubrication.	BT-2	Understand
21.	List of two alcoholic fuels derived from biomass.	BT-1	Remember
22.	What is the fermentation feedstock for ethanol production?	BT-1	Remember
23.	What process is used to produce methanol from biomass?	BT-1	Remember
24.	List one major challenge in using alcohol fuels in engines.	BT-2	Understand
25.	What engine modification is needed for alcohol fuels?	BT-1	Remember
Q.No.	**PART-B:**	**BT Level**	**Competence**
1.	Define Straight Vegetable Oil (SVO). List the types of oils used in SVO fuel applications.	BT-1	Remember
2.	Explain the basic process of biodiesel production from oil seeds.	BT-2	Understand
3.	Illustrate the transesterification reaction involved in biodiesel production. Provide a schematic diagram.	BT-3	Apply
4.	Analyze the suitability of waste cooking oil for biodiesel production. Include advantages and challenges.	BT-4	Analyze
5.	Compare the emission characteristics of biodiesel and petroleum diesel in CI engines.	BT-5	Evaluate
6.	Design a small-scale biodiesel production setup for rural use. Explain the components and operation.	BT-1	Remember
7.	List the main steps involved in alcohol fuel production from biomass.	BT-2	Understand
8.	Explain the chemical process of ethanol production from lignocellulosic biomass.	BT-2	Understand
9.	Apply the concept of dual-fuel operation in diesel engines using methanol or ethanol.	BT-3	Apply
10.	Analyze the comparative performance of biodiesel blends (B10, B20,	BT-4	Analyze

	B100) in CI engines.		
11.	Evaluate the advantages and disadvantages of algae as a source for biodiesel production.	BT-5	Evaluate
12.	Propose a strategy for integrating waste oil collection and biodiesel production in an urban setting.	BT-3	Apply
13.	Describe the necessary engine modifications to use ethanol/methanol in SI and CI engines.	BT-2	Understand
14.	Demonstrate how calorific value differences affect engine performance in alcohol fuels vs. diesel.	BT-2	Understand
15.	Compare the lifecycle greenhouse gas emissions of biodiesel and diesel.	BT-4	Analyze
16.	Critically evaluate the economic viability of biodiesel production from oil seeds vs. algae.	BT-2	Understand
17.	Design a roadmap for sustainable alcohol fuel production in India using agro-waste.	BT-2	Understand