



FACULTY OF ENGINEERING & TECHNOLOGY

Second Year Master of Technology

Branch: Renewable Energy

Course Code: 102450301

Course Title: ADVANCES IN BIOMASS GASIFICATION

Type of Course: Professional Elective Course

Course Objectives: To understand biomass gasification systems.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Internal		External		Total
				Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	40/16	20/08	60/24	30/12	150/60

* J: Jury; V: Viva; P: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	BIOMASS GASIFICATION: Historical background, Biomass and Its Products, Biomass Conversion-Bio-chemical and thermo-chemical conversion, Motivation for Biomass Conversion, Commercial Attraction of Gasification, Comparison of Gasification and Combustion, constituents of biomass cell, properties of biomass, Ultimate and proximate analysis of biomass and its importance in gasification, Gasification and reaction involved, gasifying medium, The Gasification reaction Process, Design of Biomass Gasifiers, Gasifier Types- Fixed-Bed/Moving-Bed Gasifiers, Fluidized-Bed Gasifiers- Entrained-Flow Gasifiers, Plasma Gasification, Process Design-Mass Balance, Energy Balance, hydrothermal gasification of biomass, Performance evaluation of biomass gasifier, advances in biomass gasification technology	12
2	GAS CLEANING AND CONDITIONING: Basics of tar, acceptable limits for tar, Tar formation, tar composition, tar reduction, In-Situ tar reduction, post-gasification—secondary reduction of tar, The power theory of gas cleanup, gas cleanup goals-gas contaminant characteristics-typical dirty gas- gas cleanup-cleanup design target, classification of particles, particle movement and capture mechanisms , dry collectors-gravity settling chambers-cyclone separators-bag house filter- electrostatic precipitators, wet scrubbers-principles of wet scrubbers -scrubber – auxiliary equipment, disposal of captured contaminants-char-ash- tar- condensate.	10



3	POWER FROM PRODUCER GAS: Burners for producer gas, Operation with diesel engines, Efficiency and energy distribution, Emissions, operation with gas engines, performance on lubrication, emissions, test on small gas engines and load variations, large gas engines, independent power plants, tri-generation possibilities, gas turbines, manufacture and commercial status of fuel cells	07
4	PYROLYSIS AND TORREFACTION: Introduction, historical background, pyrolysis, pyrolysis products, types of pyrolysis, pyrolysis product yield, effect of biomass composition on pyrolysis, effect of pyrolysis temperature, effect of heating rate, pyrolysis kinetics-physical aspects-chemical aspects, heat transfer in a pyrolyzer-mass transfer effect, pyrolyzer types: fixed-bed pyrolyzer-bubbling-bed pyrolyzer-circulating fluidized-bed pyrolyzer-ultra-rapid pyrolyzer-ablative pyrolyzer-rotating-cone pyrolyzer-vacuum pyrolyzer, pyrolyzer design considerations, torrefaction, advantages of torrefaction, mechanism of torrefaction, design considerations for torrefaction	10

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						R: Remembering; U: Understanding; A: Application, N: Analyze; E: Evaluate; C: Create
R	U	A	N	E	C	
10%	20%	20%	20%	20%	10%	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1	Biomass for Renewable Energy, Fuels, and Chemicals, Donald L. Klass, Reed Private Limited.
2	Biomass gasification and Pyrolysis - Practical designs and theory by Prabir Basu, Elsevier
3	Understanding clean energy and fuel from biomass. Dr. H S Mukunda, Wiley-India
4	Biomass- Application, technology & production, N.C. Cheremisenoff, P.N. Cheremisenoff & F. Ellurbrush, Marcel Dekker, New York
5	Handbook on biomass downdraft gasifier engine system. Thomas B Reed and Agua Das, Solar Energy Research Institute

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understanding of Biomass Gasification.	40
CO-2	Understanding of gas cooling and cleaning system.	30
CO-3	Understanding of Pyrolysis and torrefaction.	30



List of Practicals / Tutorials:

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1	To study different types of biomass gasification systems.
2	To perform analysis of biomass gasification in downdraft gasification system.
3	To investigate the effect of variation in Equivalence Ratio on the biomass gasification.
4	To perform analysis of biomass gasification in Fluidized Bed Gasification system.
5	To investigate the effect of catalyst on tar content.
6	To investigate the effect of heating rate during Pyrolysis.
7	To investigate the effect of pyrolysis temperature on oil yields.
8	To perform analysis of biomass cookstove.
9	To study plasma gasification process.
10	To perform numerical analysis of the biomass gasification process.

Supplementary learning Material:

1	http://nptel.ac.in
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Curriculum Revision:

Version:	1
Drafted on (Month-Year):	Apr-21
Last Reviewed on (Month-Year):	Jul-21
Next Review on (Month-Year):	Apr-23