GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Branch: Chemical Engineering (Green Technology and Sustainability Engineering)

Course/Subject Code: BE04044021

Course/Subject Name: Fuel and Combustion

W. E. F. Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core

Prerequisite:	None
Rationale:	Fuels and combustion course introduces basic knowledge about solid, liquid and gaseous fuels, their origin, classification, preparation procedure and characterization in terms of physico-chemical properties. Coal being the main solid fossil fuels, its mining, cleaning and combustion processes covered in detail. Petroleum is the liquid fuel which is elaborated in terms of exploration, evaluation, distillation and secondary processing. Different important gaseous fuels are also included. It also covers fundamentals of combustion along with and combustion appliances. Emphasis is given to combustion of various fuels considering thermodynamics. Combustion appliances are discussed in Combustion technology section. Basic knowledge of advance topics like continuous industrial furnaces and oxy-rich combustion is also incorporated for wide exposure and realizing importance of the subject.

Course Outcome:

After Completion of the Course, Student will able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Summarize the significance of solid, liquid, and gaseous fuels	20
CO-2	Summarize the basic processing techniques for different types of fuels.	25
CO-3	Identify and select proper equipment used for combustion and fuel applications	25
CO-4	Apply stoichiometric calculations to analyze combustion processes	30

Teaching and Examination Scheme:

Teaching /Learning Scheme in Hours Per Semester					Total Credits = TH/30	Examination Marks					Total Marks
						Theory Marks		Practical Marks			
L	T	P	PBL*	TH	04	ESE (E)	PA (M)	PA (I)	PBL	ESE (V)	
45	15	0	60	120		70	30	0	30	0	130

Course Content:

Sr. No.	Content	Total Hrs
1	**Classification and Properties of Fuels:** Definition of Fuels, Types and characteristics of fuels, Determination of properties of fuels, Fuel analysis Proximate and ultimate analysis, Calorific value (CV)-Gross and net calorific values (GCV,NCV), Bomb Calorimetry-empirical equations for CV estimation.	6
2	**Solid fuels:** Coal origin, its classification, composition, and properties. Coal mining, preparation, and washing. Combustion of coal and coke making, different types of coal combustion techniques, coal tar distillation, coal liquefaction: direct and Indirect liquefaction, coal gasification, oxidation and hydrogenation. Efficient use of solid fuels.	7
3	**Liquid Fuels:** Origin and classification of petroleum, refining, properties & testing of petroleum products, various petroleum products, petroleum refining in India, liquid fuels from other sources, storage and handling of liquid fuels.	6
4	**Gaseous Fuels:** Types of gaseous fuels: natural gases, methane from coal mines, manufactured gases, producer gas, water gas, biogas and refinery gas, LPG, hydrogen, acetylene, other fuel gases. Cleaning, purification and quality enhancement of gaseous fuels, study of Solid, liquid and gaseous fuels-selection of coal for different industrial applications.	8
5	**Stoichiometry of combustion:** General principles of combustion-types of combustion processes, Estimation of minimum amount of air required for a fuel of known composition, theoretical and actual combustion processes - Air fuel ratio, estimation of dry flue gases for known fuel composition, calculation of the composition of fuel and excess air supplied from exhaust gas analysis, dew point of products. Calorific value of fuels, adiabatic flame temperature, mechanism and kinetics of combustion.	9
6	**Combustion Equipment:** Combustion of oil, combustion of coal, combustion of gas, calculation of heat of formation and heat of combustion, Analysis of flue gases by Orsat apparatus, Combustion of solid fuels, grate firing and pulverized fuel firing system, Fluidized bed combustion, Circulating fluidized bed boiler, Burners, Factors affecting burners and combustion. **Introduction to different types of furnaces:** Heat treatment furnaces, industrial furnaces, process furnaces, and kilns. Applications of batch and continuous furnaces, oxy-rich combustion.	9

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**25**	**10**	**10**	**5**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Irvin Glassman, "Combustion" 2nd ed., Academic Press.
2. John Griswold, "Fuels Combustion and Furnaces" Mc-Graw Hill Book Company Inc.
3. S.P. Sharma & Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co. Ltd.
4. Dr. Samir Sarkar, "Fuels & Combustion", 2nd ed., Orient Longman.
5. B. I Bhatt & S. B. Thakore, "Stoichiometry", 5th ed., Tata McGraw Hill Publishing Co. Ltd.
6. James G, "Chemistry and Technology of Petroleum", Marcel Dekker, NY
7. B. K. Sharma, "Fuels and Petroleum Processing" , 1st ed., Goel publishing, Meerut.

Open source software and website:

1. Students can refer to video lectures available on the websites including NPTEL
2. Students can refer website of FurnXpert "https://www.furnxpert.com/casestudy" for case studies of furnace simulation and analysis.

Activities suggested under Problem Based learning:

Sl. No.	Name of the activity	No. of hours	Total Hours
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h	10
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h	10
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each.	10
4.	Self learning on-line course	Minimum duration of the course should be 10h.	10
5.	Videos on Industrial safety aspects	Duration of video = 5h	10

	based on subject	Report preparation = 5h	
6.	Poster/chart/power point preparation on technical topics		6
7.	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	20
8.	Group Discussion on emerging/trending technical topics based on subject		1 hr each

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