FUELS AND COMBUSTION

ENCH 302

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
The objective of this course is to provide concepts of solid, liquid, and gaseous fuels, their properties, combustion characteristics, and thermochemical principles governing combustion processes. By the end of the course students will be able to analyze efficient and sustainable combustion appliances for industrial applications.

1 Energy Resources (2 hours)

1.1 Energy and energy resources
1.2 Conventional energy resources: Oil, natural gas, and coal
1.3 Energy: Consumption and demand

2 Solid Fuels (10 hours)

2.1 Introduction: Biomass-wood and charcoal, bagasse, peat, lignite, sub-bituminous and bituminous coal, semi-anthracite and anthracite
2.2 Coal: Origin, composition, properties: proximate and ultimate analysis, calorific value, volatile matter, caking properties, classification of coal
2.3 Coal cleaning: Dry process - pneumatic table, wet process - jig washer, washer efficiency, storage of coal, coke and briquetting of solid fuels, low and high temperature carbonization, by-product slot-type coke ovens

3 Liquid and Gaseous Fuels (9 hours)

3.1 Liquid fuel: Origin and classification of petroleum, petroleum distillation, stabilization and purification of petroleum
3.2 Important petroleum products: Gasoline, kerosene, jet fuels, diesel fuels, fuel oils and lubricants
3.3 Liquid fuel properties: Viscosity, flash and fire point, cetane number, octane number, and aniline point, storage and handling of liquid fuels
3.4 Gaseous fuel: Types: Natural gas, compressed natural gas (CNG), biogas, liquefied petroleum gas (LPG), cleaning and purification of gaseous fuels, properties of gaseous fuel

4 Stoichiometry of Combustion Process (5 hours)

4.1 Combustion stoichiometry
4.2 Flue gas analysis from fuel analysis and air supply: Solid, liquid and gaseous fuels
4.3 Excess air calculation from flue gas analysis
4.4 Combustion calculations involving loss of combustibles with flue gases and ash
4.5 Fundamental formulae for combustion problems

5 Thermodynamics of Combustion Process (5 hours)

5.1 Heat of combustion
5.2 Enthalpy of combustion system
5.3 Equilibrium constants of combustion reactions
5.4 Calculation methods for adiabatic flame temperature

6 Kinetics of Combustion Process (8 hours)

6.1 Nature of combustion process
6.2 Types of combustion processes
  6.2.1 Combustion with stationary flames
  6.2.2 Surface combustion or flameless combustion
  6.2.3 Combustion with explosion flame
  6.2.4 Slow combustion
6.3 Mechanism of combustion reactions
  6.3.1 Chain reactions
  6.3.2 Thermal mechanism
  6.3.3 Combustion of elementary carbon

7 Combustion Appliances (6 hours)

7.1 Gas burners: Atmospheric gas burner
7.2 Oil burners: Atomizing burners
7.3 Coal burning equipment: Hand firing and mechanical stokers, under-feed stokers, chain- and traveling-grate stokers, pulverized coal firing

Tutorial (15 hours)

1. Dry and wet process of coal cleaning
2. Petroleum distillation and purification processes of liquid and gaseous fuels
3. Calculations on flue gas and excess air for fuel combustion
4. Combustion processes for stationary flames and flameless combustion
5. Chain reactions and thermal mechanism of combustion reactions
6. Chain and traveling-grate stokers and pulverized coal firing processes

Practical (22.5 hours)

1. Determination of flash and fire point of fuels

2. Determination of viscosity of petroleum product
3. Atmospheric distillation of petroleum product
4. Determination of aniline point of petroleum product
5. Determination of cloud and pour point of petroleum product

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	2	2
2	10	12
3	9	12
4	5	8
5	5	8
6	8	10
7	6	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Sarkar, S. (2009). Fuels and combustion. Universities Press (India) Private Limited.
2. Griswold, J. (2006). Fuels, combustion, and furnaces (Latest Edition). McGraw-Hill Book Company, Inc.
3. Gupta, O. P. (2008). Elements of fuels, furnaces and refractories. Khanna Publishers.
4. Gupta, R. C. (2016). Fuels, furnaces, and refractories. PHI Learning Private Limited.
5. Turns, S. R. (2011). An introduction to combustion: Concepts and applications. McGraw-Hill.
6. Perry, R. H. (1997). Perry's chemical engineers' handbook (Latest Edition). McGraw-Hill.