JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Year & Sem. – B. Tech I year, Sem.-I
Subject –Engineering Chemistry
Unit – II
Presented by – Dr. Seema Joshi
Designation - Professor
Department - Chemistry

VISION OF INSTITUTE

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

MISSION OF INSTITUTE

❖**Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.**

❖**Identify, based on informed perception of Indian, regional and global needs, the areas of focus and provide platform to gain knowledge and solutions.**

❖**Offer opportunities for interaction between academia and industry.**

❖**Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders may emerge.**

Engineering Chemistry: Course Outcomes

Students will be able to:

CO1: Explain the impurities of water (mainly hardness) and boiler troubles.

CO2: Describe processing technologies of fuel with numerical aspects of combustion of fuel.

CO3: Describe the engineering material (cement, glass and lubricant) with respect to their manufacturing, composition, classification & properties.

CO4: Explain corrosion with its controlling measures, organic reaction mechanism and synthesis of drugs (Aspirin & Paracetamol) with their properties and uses.

JECRC
Department of Applied Sciences
Lecture Plan (Session- 2020-2021)

Course Name: Engineering Chemistry **Year/Semester: 1st Year/ Semester- I**

Course code: 1FY2-03 **No. of Lecture Req. /(Avl.): /(40/44)**

Semester starting: 21 Sept. 2020 **Semester Ending: 24 Dec. 2020**

Unit No./ Total Lect. Req.	Topics	Lect. No.	Date of Delivery	Book Referred	Pg. No.
Unit-I 10	Introduction to syllabus, Common natural impurities, hardness, Degree of hardness,	1		Engg. Chemistry (New Age International)	2-12
	Units of hardness, Determination of hardness by complexometric (EDTA method).	2		Engg. Chemistry (Jain & Jain)	
	Municipal water supply, Requisite of drinking water, purification of water, Sedimentation,	3			
	Filtration, disinfection, Breakpoint chlorination.	4			
	Boiler troubles: Scale and Sludge formation, Internal treatment Methods	5			
	Priming and Foaming, Boiler corrosion and caustic embrittlement	6			
	Water softening: Lime-Soda process	7			
	Water softening: Zeolite (Permutit) process, Demineralization process.	8			
	Numerical problems based on Hardness, EDTA,	9			
	Numerical problems based on Lime-Soda and Zeolite process.	10			

Unit-II 10	**2.Organic Fuels: Solids fuels: Coal, Classification of Coal, Proximate analyses of coal and its significance**	11		Engg. Chemistry (Jain & Jain)	116 -117
	Ultimate analyses of coal and its significance,	12		Engg. Chemistry (Jain & Jain)	117 -118
	Gross and Net Calorific value, Determination of Calorific value of coal by Bomb Calorimeter.	13			
	Metallurgical coke, Carbonization processes; Otto-Hoffmann byproduct oven method.	14			
	Liquid fuels : Advantages of liquid fuels, Mining, Refining and Composition of petroleum, Cracking	15			
	Synthetic petrol, Reforming, Knocking, Octane number, Anti-knocking agents, Cetane number	16			
	Gaseous fuels; Advantages, manufacturing, composition and Calorific value of coal gas and oil gas	17			
	Determination of calorific value of gaseous fuels by Junker's calorimeter, Numerical problems based on Junkers calorimeter	18			
	Numerical problems based on determination of calorific value bomb calorimeter, /Dulongs formula, proximate & ultimate Analysis.	19			
	Numerical problems based on combustion of fuel.	20			

Unit-III 3	**3.Corrosion and its control: Definition and significance of corrosion, Mechanism of chemical (dry) corrosion**	**21**			
	Mechanism of electrochemical (wet) corrosion, galvanic corrosion, concentration corrosion and pitting corrosion.	22			
	Protection from corrosion; protective coatings-galvanization and tinning, cathodic protection, sacrificial anode and modifications in design.	23			

Unit-IV 10	**4.Engineering Materials: Portland Cement; Definition, Manufacturing by Rotary kiln.**	**24**			
	Chemistry of setting and hardening of cement. Role of Gypsum.	25			
	Glass: Definition, Manufacturing by tank furnace, significance of Annealing	26			
	Types and properties of soft glass, hard glass	27			
	Borosilicate glass, glass wool, safety glass.	28			
	Lubricants: Classification	29			
	Lubricants: Mechanism	30			
	Properties; Viscosity and viscosity index	31			
	Flash and fire point, cloud and pour point.	32			
	Emulsification and steam emulsion number.	33			

Unit-V 7	**5. Organic reaction mechanism and introduction of drugs: Organic reaction mechanism: Substitution; SN1, SN2.**	**34**			
	Electrophilic aromatic substitution in benzene, free radical halogenations of alkanes,	35			
	Elimination: elimination in alkyl halides, dehydration of alcohols,	36			
	Addition: electrophilic and free radical addition in alkenes, nucleophilic addition in aldehyde and ketones	37			
	Rearrangement: Carbocation and free radical rearrangements	38			
	Drugs : Introduction, Synthesis, properties and uses of Aspirin	39			
	Drugs : Introduction, Synthesis, properties and uses of Paracetamol, Revision	40			

Lecture-11(Unit-II)Organic Fuels

CONTENTS:

- Solids fuels: Coal
- Classification of Coal
- Proximate analyses of coal and its significance

Fuels:

Fuels are naturally occurring source of heat energy which includes combustible substance that combines with oxygen from the atmosphere with evolution of large amount of heat that can be used economically for domestic and industrial purposes.

Organic Fuels: Definition

"Fuel may be defined as any combustible substance containing carbon as the major constituent which on burning liberates large amount of energy in the form of heat that can be used for the beneficial purposes." For example coal, wood, charcoal, petrol, diesel, CNG etc.

Mechanism of combustion:

$$C + O_2 \longrightarrow CO_2 + 97.644 \text{ kcal}$$

$$2H_2 + O_2 \longrightarrow 2H_2O + 69.000 \text{ kcal}$$

Characteristics of a good fuel

- High calorific value
- Moderate ignition temperature
- Low non combustible matter content
- Low moisture content
- No harmful products of combustion
- Moderate velocity of combustion
- Easy to transport & store
- Efficient burning
- Size
- Should not undergo spontaneous combustion
- Easily controllable combustion
- Cheaper cost

Classification of Fuel:

- On the basis of occurrence or origin
- On the basis of state of aggregation

Classification of Fuel:

On the basis of occurrence or origin

- **Natural (primary) fuel:** Fuels which are directly obtained from the nature ex. wood, coal, petroleum, natural gas.
- **Artificial or derived (secondary) Fuels:** Fuels which are obtained after the modification and treatment of primary fuels. ex .Coke, diesel, kerosene etc.

Classification of Fuel:

On the basis of state of aggregation :

On the basis of their physical state fuels are classified into following:

- **Solid fuels:** wood, coal, coke, charcoal etc.
- **Liquid fuel:** Kerosene, petroleum, diesel etc
- **Gaseous fuel:** coal gas, oil gas, water gas etc.

Solids fuels: Coal

Coal is a carbonaceous matter consisting of **C,H,N** and **O** besides non combustible matter.

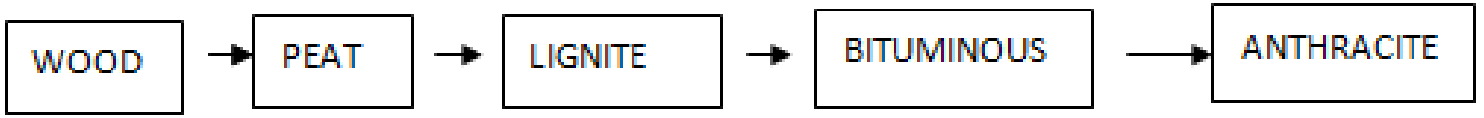
Characteristics of a better coal

- Moisture content should be low.
- Calorific value should be high.
- Ash or non combustible matter should be low.
- Calorific intensity should be high.
- S & P content should be low.
- Uniform size.
- Coking quality should be high.

Classification of Coal

Classification of Coal

Coals are classified according to their degree of coalification from wood to anthracite.



C content, calorific value and hardness increases

Moisture content, H, O,N, S content and volatile matter decreases

Classification of Coal

Average composition from wood to anthracite on coalification

S. No.	Fuel	Moisture at 40°C and 60% relative humidity	Volatile matter	C	H	N	O	Calorific value (KCal/ Kg
1.	Wood	25	75	50	6	0.5	43.5	4600
2.	Peat	25	65	57	5.7	2.0	35.3	5400
3.	Lignite	18	50–56	67	5.0	1.5	26.5	6600
4.	Sub-bituminous	11	45–50	77	5.0	1.8	16.2	7200
5.	Bituninous coal	4	20–45	83	5.0	2.0	10.0	8500
6.	Semi-bituminous coal	1	9–20	90	4.5	1.5	4.0	8600
7.	An thracite	1.5	5–6	93	3.0	0.7	3.0	8750

Analysis of Coal

Coal Analysis techniques are specific analytical methods designed to measure the particular physical and chemical properties of coals. There are two methods to analyze coal.

- Proximate analysis and
- Ultimate analysis.

The proximate analysis determines only the fixed carbon, volatile matter, moisture and ash percentages and it can be determined with a simple apparatus.
The ultimate analysis determines all coal component elements, solid or gaseous and it needs properly equipped laboratory with skilled chemists. It is useful in determining the quantity of air required for combustion and the volume and composition of the combustion gases.

Proximate analysis of coal

Proximate analysis of coal:

Proximate analysis is quantitative analysis. It involves the determination of

- Moisture,
- Volatile matter,
- Ash and
- Fixed carbon.

This analysis provides data necessary to assessment of quality and type of coal.

1.Determination of Moisture content:

A known amount of accurately weighed powdered coal sample is taken in a dry and accurately weighed silica crucible (w1). Crucible is then heated for about one hour at 105°C-110 °C into an electric oven. The crucible is then placed in a desiccator and allowed to cool down to room temperature then it's weight is measured (w3). The loss in weight corresponds to the moisture.

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1.Determination of Moisture content:

$$\% \text{ of moisture} = \frac{\text{Loss in weight due to removal of volatile matter x 100}}{\text{Weight of coal sample taken}}$$

$$\% \text{ of moisture} = \frac{(w2 - w3) \times 100}{(w2 - w1)}$$

where w1=weight of the empty crucible

w2= weight of the crucible + sample of coal

w3= weight of the crucible + sample of coal (after heating in oven)

2.Determination of Volatile Matter

After step one, the crucible is now covered with a lid and placed in an electric furnace maintained at 950±20 °C for about 7 minutes. It is again cooled into a desiccator and weighed (w4). Loss in weight is represented as volatile matter.

2.Determination of Volatile Matter

$$\% \text{ of Volatile matter} = \frac{\text{Loss in weight due to removal of volatile matter x 100}}{\text{Weight of coal sample taken}}$$

$$\% \text{ of Volatile matter} = \frac{(w3 - w4)\text{ x } 100}{(w2 - w1)}$$

Where w3= weight of the crucible + sample of coal (after heating in oven),

w4= weight of crucible + sample (after heating in electric furnace)

Determination of Ash content

Silica crucible+ coal sample (w4) after step 2 is burnt in an open crucible (lid is removed) at 700±50 °C in a muffle furnace for about 30 min and then cooled into a desiccators and weighed. This is repeated again and again until a constant weight of residue (w5) is obtained. The residue is reported as ash content on percentage basis.

Determination of Ash content

% of ash= Weight of ash formed x 100/ weight of sample taken

= (w5) x 100/ (w2-w1)

where w1= weight of empty crucible,

w2= weight of the crucible + sample

w5= weight of the crucible + ash

4.Determination of Fixed Carbon

The fixed-carbon content of a coal is determined by subtracting the percentages of moisture, volatile matter, and ash from a sample.

The % of fixed carbon is calculated as

% of fixed carbon

= 100-[% of moisture+ % of volatile matter+% of ash]

Significance of Proximate analysis of coal:

- **Moisture content:** Moisture content is an important parameter in coal analysis. It is needed for determining the calorific (heating) value and handling properties of a coal. Moisture absorbs heat, so high moisture content in coal reduces the relative efficiency of heating when a coal is combusted. Moisture adds weight to coal, and also contributes to spontaneous combustion in low-rank coals, and as such, affects handling and transport. So it is undesirable in coal.

Significance of Proximate analysis of coal:

- **Volatile Matter:** Volatile matter is essentially a measure of the non water gases formed from a coal sample during heating. Most volatile matter comes from the organic components in coal, but some elements from minerals in coal, can also combine to form volatile oxides. The most common volatile matter in coal is water, carbon dioxide, and sulfur dioxide. As it does not contributes towards calorific value, so it is undesirable in coal. Volatile matter is directly related to coal rank, as rank increases, volatile matter content decreases .

Significance of Proximate analysis of coal:

- **Ash content:** Coal ash is the waste that is left after coal is combusted (burned). It is actually the non-combustible inorganic remains that are left after burning of coal. Higher amount of ash content reduces the calorific value of coal, causes health and environmental damages and lowers the efficiency. Thus ash content is important parameter to determine the coal quality as coal's purity and efficiency greatly depend on ash content. As it does not contributes towards calorific value, so it is undesirable in coal.

Significance of Proximate analysis of coal:

Fixed carbon: The % of fixed carbon increases the ranking of coal because the more is the amount of fixed carbon higher will be the calorific value of coal and quality of coal will also be better. At the same time it helps in designing of furnace and fire box.

Question Bank

Q1. Explain the term fuel?
Q2. Define calorific value of coal?
Q3. Write 5 characteristics of an ideal fuel?
Q4. Discuss different methods of classification of fuel?
Q5 How many types of coal are there?
Q6.Write the reactions involved in mechanism of combustion of fuel.
Q7. Write down all the formulae of proximate analysis in proper sequence.
Q8.Describe proximate analysis of coal and its significance .
Q9.What is proximate analysis of coal?
Q10. What is ultimate analysis of coal?

Practice Questions contd……

Q1. Name the type of method used for proximate analysis of coal.

Q2. What is analysed in proximate analysis of fuel?

Q3. What are the characteristics of good fuel ?

Q4. What are the characteristics of good coal?

Q5. Write down formula for determination of moisture content .

Q6. Write down formula for determination of volatile matter content ?

Q7. Write formulae for calculating ash content in proximate analysis.
Q8. Write down formula for determination of fixed carbon content .

Q9. Write down names of all the apparatus used in proximate analysis of coal?
Q10. Define fuel.

Suggested links from NPTEL & other Platforms:

- https://nptel.ac.in/content/storage2/courses/113104058/mme_pdf/Lecture2.pdf
- https://nptel.ac.in/courses/103/105/103105110/

- (Video Lecture By Dr. Seema Joshi)

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