

Applied chemistry 7th semester (Sp – 1)

Short questions and their answers from previous university past papers

2017

1. What is the role of sweetening process in crude oil refining?

“The process in crude oil refining that refers to the removal of sulfur compounds from crude oil or refined petroleum products to reduce their sulfur content is called sweetening.”

- This process is crucial because sulfur compounds present in crude oil can have detrimental effects on refining equipment, downstream processing units, and the environment.
- Crude oil contains various sulfur compounds i.e hydrogen sulfide (H₂S), mercaptans (also known as thiols), and organic sulfur compounds. These sulfur compounds are undesirable because they can corrode equipment, poison catalysts, and contribute to air pollution when released during processing or combustion. These compounds are removed by applying sweetening process.
- In addition, the sweetening process in crude oil refining plays a critical role in reducing sulfur content to improve product quality, protect equipment and the environment.

2. Explain chemistry of platforming.

“The process which is used in petroleum refining to convert low-octane naphtha into high-octane gasoline blending components is called platforming.”

- The feedstock for platforming is usually a low-octane naphtha.
- The first step in platforming is hydrogenation to removes impurities present in the feedstock.
- The hydrogenated naphtha then enters the reforming reactor, where it is heated and mixed with a catalyst, typically platinum or platinum-rhenium supported on a porous material like alumina.
- Isomerization is one side reaction that occurs concurrently with reforming.
- After the catalytic reactions, the product mixture contains a variety of hydrocarbons, including high-octane aromatics and isomers. These are separated in a fractionation column, where different components are distilled off at their respective boiling points.

3. Name four raw material for paper industry.

The paper industry relies on various raw materials, both natural and synthetic, main raw materials used in the paper industry are as :

- **Wood** : Wood is the primary raw material for paper production.
- **Recycled Paper** : Recycled paper, also known as recovered paper or secondary fiber.
- **Pulp** : Pulp is the fibrous material derived from wood or recycled paper.
- **Non-Wood Fibers** : In addition to wood fibers, paper can also be produced from non-wood fibers, including : Agricultural Residues, Cotton, Bamboo etc.
- **Chemicals** : Various chemicals are used in papermaking processes.
- **Fillers and Additives** : Fillers such as calcium carbonate and kaolin clay are added to paper to improve opacity, brightness, and printing properties. Additives such as sizing agents, wet strength agents, and retention aids are used to enhance paper properties and optimize papermaking processes.

4. Explain phosphorus as a macro nutrient.

Phosphorus is an essential macro-nutrient for plants, playing a crucial role in various physiological processes necessary for growth, development, and reproduction.

- Structural Component of Biomolecules
- Enzyme Activation and Regulation
- Root Development and Nutrient Uptake
- Energy Transfer and Storage
- Cellular Signaling
- Seed and Fruit Development

5. Write applications of potash fertilizers.

Potash fertilizers, which primarily consist of potassium compounds, are widely used in agriculture to provide plants with essential potassium nutrients.

- Improving Plant Growth
- Improving Nutrient Use Efficiency
- Boosting Disease Resistance
- Sustaining Soil Fertility
- Enhancing Root Development
- Enhancing Stress Tolerance
- Balancing Soil pH

6. Explain function of urea as fertilizer.

Urea is a commonly used nitrogenous fertilizer in agriculture, valued for its high nitrogen content and affordability. Its main function as a fertilizer is to provide plants with a readily available source of nitrogen, which is an essential nutrient required for their growth and development.

- **Nitrogen Source** : Urea is primarily used as a nitrogen fertilizer because it contains a high concentration of nitrogen in the form of urea nitrogen.
- **Rapid Nitrogen Release** : Urea is a soluble fertilizer that dissolves quickly in soil moisture, releasing nitrogen in the form of ammonium ions upon hydrolysis.
- **Uniform Nutrient Distribution** : Urea can be easily mixed with other fertilizers, pesticides, or irrigation water, ensuring uniform nutrient distribution in the soil.

- **pH Neutral** : Urea has a neutral pH, which minimizes the risk of soil acidity or alkalinity.
- **Cost-Effectiveness** : Urea is relatively inexpensive compared to some other nitrogen fertilizers.

7. Explain isomerization of light naphtha.

“The process which is used in petroleum refining to convert straight-chain or slightly branched hydrocarbons into their corresponding branched-chain isomers is called Isomerization of light naphtha.”

- Before entering the isomerization unit, the naphtha feedstock may undergo pretreatment steps to remove impurities.
- In the isomerization unit, the light naphtha feedstock is mixed with hydrogen gas and passed over the catalyst bed at elevated temperatures and pressures. Under these conditions, the straight-chain hydrocarbons undergo skeletal rearrangement reactions, resulting in the formation of branched-chain isomers with higher octane ratings.
- After the isomerization reactions, the product mixture contains a blend of branched-chain hydrocarbons with higher octane ratings. This mixture is separated in a fractionation column, where different components are distilled off at their respective boiling points.

8. Why desalting of crude oil is important ?

Desalting of crude oil is an essential process in petroleum refining that removes salt and water from the crude oil before it undergoes further processing. Desalting is important for several reasons :

- **Prevention of Corrosion** : Crude oil often contains saltwater, which can corrode refining equipment so applying desalting, the risk of corrosion is significantly reduced.
- **Improvement of Product Quality** : Desalting helps improve the quality and purity of refined products.
- **Enhancement of Refinery Efficiency** : By removing salt and water upfront, desalting minimizes the need for maintenance shutdowns and cleaning operations.
- **Compliance with Export Specifications** : Desalting ensures that crude oil meets the specifications, enabling it to be transported safely via pipelines or tankers to refineries.

9. What is the role of beating in pulp refining ?

In pulp and paper manufacturing, refining is a crucial process that involves breaking down raw cellulose fibers to improve their bonding properties, strength, and other physical characteristics. Beating is a specific method within the refining process that plays several important roles :

- Fiber Separation
- Fiber Cutting and Shortening
- Formation of Fines
- Fiber Fibrillation
- Fiber Refinement
- Water Retention

10. Explain abiogenic theory of petroleum origin.

The abiogenic theory of petroleum origin, also known as the abiotic or non-biological theory, proposes that petroleum (crude oil and natural gas) is not solely derived from the fossilized remains of ancient organic matter but is instead formed through abiotic processes deep within the Earth's mantle.

- **Source of Hydrocarbons** : According to the abiogenic theory, hydrocarbons are generated abiotically within the Earth's mantle through different processes.
- **Migration** : Once formed in the mantle, hydrocarbons migrate upward through fractures, faults, and porous rock layers.
- **Reservoir Formation** : As migrating hydrocarbons reach cooler and shallower depths, they can accumulate in porous and permeable reservoir rocks.
- **Maturation and Alteration** : Hydrocarbons undergo further maturation and alteration processes as they migrate and accumulate in reservoir rocks.
- **Trapping Mechanisms** : Hydrocarbons are trapped in reservoir rocks by various geological mechanisms.
- **Evidence** : Proponents of the abiogenic theory cite several pieces of evidence to support their hypothesis, including the discovery of hydrocarbons in igneous rocks, the presence of methane-rich fluids in deep-sea hydrothermal vents, the isotopic composition of hydrocarbons etc.

2018

1. What are the products of refining ?

Refining, particularly in the context of petroleum refining, produces a wide range of products through various processes aimed at separating, converting, and upgrading crude oil into more valuable products. Main products of refining are as :

- Gasoline (Petrol)
- Jet Fuel (Aviation Fuel)
- Liquefied Petroleum Gas (LPG)
- Bitumen (Asphalt)
- Petrochemical Feedstocks
- Diesel Fuel
- Heating Oil (Fuel Oil)
- Petroleum Coke (Petcoke)
- Lubricating Oils
- Specialty Products (solvents, waxes, greases etc.)

2. What are raw materials for normal superphosphate fertilizers ?

Normal superphosphate fertilizer, also known as single superphosphate (SSP), is produced using phosphate rock and sulfuric acid.

- 1) **Phosphate Rock:** Phosphate rock is the primary raw material used in the production of normal superphosphate fertilizers containing P_2O_5 ranging from 27% to 38%.
- 2) **Sulfuric Acid :** It used in various industrial processes, including fertilizer manufacturing. In fertilizer production typically it has concentrations ranging from 93% to 98%.
- 3) **Water :** Water is used as a solvent and a medium for mixing and reacting phosphate rock and sulfuric acid during the production of normal superphosphate fertilizers.
- 4) **Other Additives (Optional) :** In some cases, inert fillers such as gypsum (calcium sulfate) or clay may be added to the fertilizer blend to improve handling characteristics.

3. Name four natural organic fertilizers.

Natural organic fertilizers are derived from natural sources such as plants, animals, and minerals.

- I. **Compost**
- II. **Manure :** Manure is organic matter derived from the excreta of animals.
- III. **Bone Meal :** Bone meal is a natural fertilizer made from finely ground animal bones.
- IV. **Fish Emulsion :** Fish emulsion is a liquid organic fertilizer made from processed fish by-products, such as fish waste and fish remains.
- V. **Seaweed Fertilizer :** Seaweed fertilizer, also known as kelp or seaweed extract, is derived from various species of marine algae.
- VI. **Alfalfa Meal :** Alfalfa meal is a natural fertilizer made from dried and ground alfalfa (*Medicago sativa*) plants.

4. What is soda pulping ?

"A chemical pulping process used to extract cellulose fibers from wood or other plant materials to produce pulp for papermaking is called Soda pulping."

- It is one of the oldest and most widely used methods of pulping due to its simplicity and cost-effectiveness.
- Steps in soda pulping includes
 - Raw Material Preparation
 - Lignin Removal
 - Washing
 - Cooking (Pulping)
 - Cellulose Fiber Separation
 - Bleaching (Optional)
 - Cooking Vessel (digester)
 - Papermaking

5. Explain beating process of soda pulping.

The beating process, also known as refining, is a crucial step in the papermaking process that involves the mechanical treatment of pulp fibers to improve their bonding ability, flexibility, and uniformity.

Purpose : The primary purpose of the beating process is to modify the physical properties of the pulp fibers to achieve the desired characteristics in the final paper product.

Types of Beaters : Beaters are the equipment used to perform the beating process in paper production. There are two main types of beaters:

- **Hollander Beater**
- **Jordan Beater**

Effects of Beating : The beating process has several effects on the pulp fibers, including :

- Increased Surface Area
- Improved Bonding Ability
- Fiber Shortening
- Enhanced Uniformity

6. Write down the action of calcium cyanide as fertilizer.

Calcium cyanamide, also known as calcium cyanide, is a nitrogenous fertilizer that releases nitrogen through a process known as cyanamide hydrolysis.

Explanation :

- Calcium cyanamide is typically applied to the soil as granules or pellets. It is used primarily as a nitrogen fertilizer to provide readily available nitrogen to plants.
- Upon application to the soil, calcium cyanamide undergoes hydrolysis, a chemical reaction with water, to release ammonia gas (NH_3) and calcium carbonate (CaCO_3).
- The ammonia released from calcium cyanamide hydrolysis provides a direct and readily available source of nitrogen for plant uptake.
- In addition to nitrogen fertilization, calcium cyanamide contributes to soil improvement and amendment.
- Calcium cyanamide provides a rapid and efficient nitrogen supply to plants, promoting vigorous growth, increased biomass production, and higher crop yields.

7. Explain process involved in the chemical treatment of petroleum products.

Chemical treatment of petroleum products involves various processes aimed at improving the quality, stability, and performance of crude oil, refined products, and petrochemicals.

- **Desalting** : Desalting involves mixing crude oil with water and then centrifuging the mixture to remove the impurities.
- **Hydrodesulfurization (HDS)** : Hydrodesulfurization is a catalytic process used to remove sulfur compounds from petroleum products.
- **Hydrocracking** : Hydrocracking is a refining process used to convert heavy hydrocarbon molecules into lighter.
- **Catalytic Reforming** : Catalytic reforming is a process used to improve the octane rating of gasoline blending components.
- **Alkylation** : Alkylation is a process used to produce high-octane gasoline blending components by combining low-molecular-weight hydrocarbons.
- **Sweetening** : Sweetening is a process used to remove acidic or sour compounds, from petroleum products.
- **Fractionation** : It is a fundamental refining process used to separate crude oil into its various components based on their boiling points.

8. What is reforming ?

“The process that refers to a set of processes used to convert hydrocarbons, typically naphtha or other light petroleum fractions, into higher-value products such as gasoline, aromatics, and hydrogen is called Reforming.”

- Reforming processes typically involve the rearrangement and restructuring of hydrocarbon molecules to produce compounds with higher octane ratings.
- Catalytic reforming is the most common type of reforming process used in the petroleum refining industry.
 - The key reactions involved in catalytic reforming include dehydrogenation, isomerization, and cyclization.
 - Catalytic reforming is typically carried out at elevated temperatures (around 500-600°C) and moderate to high pressures (around 3-30 atmospheres) and hydrogen as a reactant.
 - The primary products of catalytic reforming include high-octane reformate gasoline, which is blended with lower-octane gasoline components to improve overall gasoline quality and performance.

9. Define catalytic cracking.

“A refining process used to convert heavy hydrocarbon molecules into lighter, more valuable products such as gasoline and diesel is called catalytic cracking, also known as fluid catalytic cracking (FCC).”

- Catalytic cracking is a refining process used in the petroleum industry to break down large hydrocarbon molecules into smaller, more valuable ones.
- Catalytic cracking involves heating heavy hydrocarbons at high temperatures (typically 500-600°C) in the presence of a catalyst.
- The most commonly used catalysts are zeolites (crystalline aluminosilicates).
- **Mechanism** : The heavy hydrocarbon molecules are adsorbed onto the surface of the catalyst particles. Once adsorbed, the molecules undergo cracking, which involves the breaking of carbon-carbon bonds to form smaller molecules. The cracked products are then desorbed from the catalyst surface.

10. Give examples of phosphate fertilizers ?

Phosphate fertilizers are a type of fertilizer that provides plants with phosphorus, an essential nutrient for growth and development. Some examples of phosphate fertilizers are as :

- I. **Single Superphosphate (SSP)** : It typically contains 16% to 20% P_2O_5
- II. **Triple Superphosphate (TSP)** : It typically contains 44% to 46% P_2O_5
- III. **Diammonium Phosphate (DAP)** : It typically contains 18% nitrogen (N) and 46% P_2O_5 .
- IV. **Monoammonium Phosphate (MAP)** : It typically contains 11% nitrogen (N) and 52% P_2O_5 .

2019

Short questions

1. Name any four fractions with carbon range obtained from fractional distillation of petroleum .

Fractional distillation of petroleum yields various fractions, each with a specific carbon range and unique properties. Some fractions are as :

Name of fraction	Carbon range
Natural Gas	Primarily methane with trace amounts of ethane (C ₂ H ₆) .
Liquefied Petroleum Gas (LPG)	Typically contains propane (C ₃ H ₈) and butane (C ₄ H ₁₀) with small amounts of ethane.
Gasoline (Petrol)	C ₅ to C ₁₂ hydrocarbons
Naphtha	Similar to gasoline but with a slightly broader range, typically C ₅ to C ₁₂ .
Kerosene	C ₁₀ to C ₁₆ hydrocarbons
Diesel Fuel	C ₁₂ to C ₂₀ hydrocarbons.
Heavy Gas Oil	C ₂₀ to C ₃₀ hydrocarbons.
Residual Fuel Oil (RFO)	C ₃₀ + hydrocarbons.

2. Explain the term isomerization.

“A chemical process in which one molecule is transformed into another molecule with the same molecular formula but a different structural arrangement or configuration is called Isomerization.”

- Essentially, isomerization involves rearranging the atoms within a molecule to form one or more isomers—compounds with the same chemical formula but different structural arrangements or spatial orientations of atoms.
- In petroleum refining, isomerization processes are used to convert straight-chain hydrocarbons into branched isomers, which improves the octane rating of gasoline.

Types of Isomerization :

- 1) Structural Isomerization 2) Stereoisomerization

3. Mention different unit operations/process involved in treatment of crude oil.

The treatment of crude oil involves several unit operations and processes to separate, purify, and refine the crude oil into valuable products. The main unit operations and processes involved are as :

- Desalting
- Fractional / atmospheric Distillation
- Vacuum Distillation
- Cracking

- Hydrotreating
- Reforming
- Isomerization
- Alkylation
- Aromatization

4. Briefly explain urea assimilation in soil.

Urea assimilation in soil involves the conversion of urea, a common nitrogen fertilizer, into forms that plants can readily utilize for growth and development.

Explanation :

- **Urea Application** : When applied to soil, urea undergoes various transformations mediated by soil microorganisms.
- **Hydrolysis** : Upon application, urea undergoes hydrolysis. Hydrolysis breaks down urea into NH_3 and CO_2 .
- **Ammonification** : Some of the ammonia is assimilated by soil microorganisms through a process called ammonification.
- **Nitrification** : Another portion of the ammonia may undergo nitrification to oxidize ammonia into nitrite (NO_2^-) and then into nitrate (NO_3^-). Nitrate is the primary form of nitrogen that plants can uptake and use for growth.
- **Plant Uptake** : Plants absorb nitrate and ammonium ions from the soil through their root systems.
- **Microbial Assimilation** : Soil microorganisms assimilate nitrogen from urea, ammonia, and other nitrogen sources to support their growth and metabolism.

5. Name four raw material for paper industry.

See question no.02 part no.03 of 2017

6. What is the role of sweetening process in crude oil refining?

See question no.02 part no.01 of 2017

7. Write down the temperature and catalyst conditions for Haber's process.

Temperature and catalyst conditions for the Haber process are explain as :

- **Temperature** : The Haber process typically operates at high temperatures to facilitate the reaction :
 - The optimal temperature for the Haber process is around 400 to 500°C. Operating at this temperature range balances the rate of reaction with the equilibrium yield of ammonia.
- **Catalyst** : The Haber process utilizes an iron-based catalyst to enhance the rate of reaction without being consumed in the process.
 - The most commonly used catalyst is a mixture of finely divided iron (Fe) and iron oxide (Fe_3O_4), typically promoted with small amounts of other substances such as potassium oxide (K_2O) or aluminum oxide (Al_2O_3).

- **Pressure** : The optimal pressure for the Haber process is around 200 to 300 atmospheres (atm). High pressure ensures that the gaseous reactants remain in close proximity, increasing the likelihood of successful collisions and ammonia formation.

8. What do you understand about migration ?

In the abiogenic theory of petroleum origin, migration refers to the movement of hydrocarbons from their source rocks to reservoir rocks.

- According to this theory, rather than being solely formed from biological material (as in the traditional biogenic theory), hydrocarbons can also originate from deep within the Earth's mantle through abiogenic processes.
- The migration process in abiogenic theory involves several steps :
- Generation
 - Migration
 - Accumulation
 - Trapping
- In abiogenic theory, migration is a crucial step that allows hydrocarbons to reach reservoir rocks where they can accumulate and potentially be extracted.

9. Differentiate between macro and micro nutrients ?

Features	Macro nutrients	Micro nutrients
Definition	Essential nutrients required by plants in relatively large quantities, typically measured in percentage of plant dry weight.	Essential nutrients required by plants in trace amounts, typically measured in ppm or micrograms per gram of plant tissue.
Quantity Required	Plants require macro nutrients in larger quantities.	Plants require micro nutrients in much smaller quantities.
Chemical Form	Include elements such as N, P, K, Ca, Mg and S	Include elements such as Fe, Mn, Zn, Cu, B, Mo and Cl.
Mobility in Plants	Most macro nutrients are mobile within the plant.	Micro nutrients generally exhibit limited mobility within the plant.
Availability in Soil	Typically present in higher concentrations in the soil.	Present in lower concentrations in the soil.

10. Why desalting of crude oil is important ?

See question no.02 part no.08 of 2017

2020

1. Mention different unit operations involved in treatment of crude oil.

See question no.02 part no.03 of 2019

2. What do you understand about migration ?

See question no.02 part no.08 of 2019

3. What is catalytic alkylation ?

“A chemical process in which an alkyl group (a group of atoms derived from an alkane) is introduced into a molecule, typically an organic compound, under the influence of a catalyst is called Catalytic alkylation.”

- This process is widely used in the synthesis of various organic compounds, including pharmaceuticals, agrochemicals, and polymers.
- Common catalysts for alkylation reactions include :
 - Acids (such as H_2SO_4 or HCl),
 - Lewis acids (such as AlCl_3 or BF_3)
 - Transition metal complexes (such as Pd or Pt catalysts).
- Alkylating agents used in catalytic alkylation reactions can include alkyl halides (such as alkyl chlorides, bromides, or iodides), alkenes, alkynes, and alkyl sulfonates, among others. These agents serve as the source of the alkyl group that is transferred to the substrate molecule.
- Catalytic alkylation is an important tool in organic synthesis and is used in the production of a wide range of chemicals and materials.

4. How prilling is carried out during urea manufacturing ?

Prilling is a key process in the manufacturing of urea, a widely used nitrogen fertilizer. How prilling is carried out during urea manufacturing explain as :

- **Urea Production :** Before prilling, urea is synthesized through the Haber-Bosch process.
- **Preparation of Urea Solution :** The urea melt or solution is pumped to the top of the prilling tower, where it is distributed onto the perforated plate or through the nozzles.
- **Formation of Prills :** As the heated urea solution flows through the perforated plate or nozzles, it is exposed to a stream of cool air or water droplets. The rapid cooling causes the urea solution to solidify into small spherical particles known as prills.
- **Prill Collection :** The newly formed prills fall through the prilling tower and are collected at the bottom.
- **Drying and Coating :** After collection, the prills may undergo further processing steps such as drying to remove any residual moisture and coating to improve their physical properties or add additional nutrients.
- **Packaging and Storage:** Once dried and coated, the urea prills are ready for packaging into bags, bulk containers, or other forms for distribution and storage.

5. What is the role of beating in pulp refining ?

See question no.02 part no.09 of 2017

6. Write down the action of ammonium sulfate as fertilizer.

Ammonium sulfate is a common fertilizer used in agriculture to provide essential nutrients to plants, particularly nitrogen and sulfur.

Explanation :

- **Nitrogen Source** : Ammonium sulfate is a significant source of nitrogen for plants. When applied to the soil, it undergoes a process called mineralization, by which plants can readily uptake and utilize for growth and development.
- **Ammonium Ion Uptake** : In addition to nitrate, plants can also directly uptake NH_4^+ from the soil by plant roots via ion exchange processes.
- **Acidifying Effect** : The nitrification process, also releases hydrogen ions (H^+) into the soil. These hydrogen ions contribute to soil acidification, lowering the soil pH over time which can improve the availability of certain nutrients to plants.
- **Sulfur Supply** : In addition to nitrogen, ammonium sulfate provides sulfur, which is another essential nutrient for plant growth.

7. **Briefly explain Kraft pulping process.**

The Kraft pulping process is a widely used method for converting wood chips into pulp, which is the primary raw material for papermaking.

Explanation :

- **Wood Chip Preparation** : The process begins with the preparation of wood chips.
- **Cooking** : The wood chips are then placed in a large vessel known as a digester, where they are mixed with a solution of NaOH and Na_2S , known as white liquor. The mixture is heated under high pressure for several hours in a process called cooking or pulping.
- **Chemical Reaction** : During cooking, NaOH and Na_2S react with lignin that breaks down the lignin into soluble compounds.
- **Fiber Separation** : As the lignin is dissolved, the wood fibers become separated from each other, forming a fibrous mass known as pulp.
- **Washing and Screening** : After cooking, the pulp is washed to remove residual chemicals, lignin, and other impurities and then screened to remove oversized particles.
- **Bleaching (Optional)** : Depending on the desired brightness and color of the final paper product, the pulp may undergo a bleaching process.
- **Papermaking** : The resulting pulp is ready to be used in the papermaking process. The pulp is diluted with water to form a slurry, which is then formed into sheets or rolls.
- **Drying and Finishing** : The formed paper sheets are dried, pressed, and further processed to achieve the desired paper properties. The finished paper can then be cut, packaged, and distributed for various applications.

8. **Write down the temperature and catalyst conditions for Haber's process.**

See question no.02 part no.07 of 2019

9. **What kind of agriculture waste is used to make papers ?**

Agricultural waste can be used as a valuable resource in papermaking, providing an alternative to traditional wood pulp and helping to reduce the environmental impact of paper production. Following kind of agricultural waste used to make paper :

- Bagasse
- Straw
- Corn Stover
- Bamboo
- Cotton Linters
- Rice Husks
- Other Agricultural residues such as banana stems, pineapple leaves, jute fibers, and kenaf.

10. What is the significance of potash fertilizers ?

Potash fertilizers, which contain potassium in soluble form, play a crucial role in agriculture due to the significance of potassium as an essential nutrient for plant growth and development.

- Improves crop yield
- Enhances quality agricultural products
- Regulates water balance within plant cells
- Boosts resistance to various diseases and pathogens
- Improves nutrient uptake
- Long-term soil fertility productivity

2021

1) Name any four fractions with carbon range obtained from fractional distillation of petroleum .

See question no.02 part no.01 of 2019

2) What is reforming ?

See question no.02 part no.08 of 2018

3) Describe catalytic cracking .

See question no.02 part no.09 of 2018

4) What are the products of refining ?

See question no.02 part no.01 of 2018

5) Why desalting of crude oil is important ?

See question no.02 part no.10 of 2019

6) Explain bleaching of paper pulp.

Bleaching of paper pulp is a process used in papermaking to remove color, impurities, and residual lignin from the pulp, resulting in a brighter and whiter final paper product.

Explanation :

- The primary purpose of bleaching paper pulp is to improve the appearance and quality of the paper by removing substances that can cause discoloration and affect its properties.

Types of Bleaching Agents : There are several types of bleaching agents used in the pulp and paper industry, each with its own mechanism of action and suitability for different pulp types :

- Chlorine-based bleaching
- Oxygen-based bleaching
- Hydrosulfite (sodium dithionite)
- Chlorine dioxide (ClO₂)
- Ozone (O₃)

- The bleaching process typically consists of multiple stages, each using a different bleaching agent or combination of agents to achieve the desired level of brightness and purity :

7) What is soda pulping ?

See question no.02 part no.04 of 2018

8) Why is straw wheat is preferred over rice straw for paper pulp ?

Straw, particularly wheat straw, is often preferred over rice straw for paper pulp production due to several factors related to its chemical composition, physical characteristics, and availability.

Explanation :

- **Chemical Composition :**
 - **Cellulose Content :** Wheat straw generally has a higher cellulose content compared to rice straw.
 - **Lignin Content :** Rice straw typically contains higher levels of lignin compared to wheat straw.
- **Physical Characteristics :**
 - **Fiber Length and Strength :** Wheat straw fibers are generally longer and stronger compared to rice straw fibers.
 - **Pulp Bleaching :** Rice straw fibers tend to be darker in color compared to wheat straw fibers due to higher lignin content.
- **Availability and Cultivation :**
 - **Cultivation Area :** Wheat is cultivated on a larger scale worldwide compared to rice

9) What is beating process of paper production ?

See question no.02 part no.05 of 2018

10) How paper pulp manufacturing cause water pollution ?

Paper pulp manufacturing can contribute to water pollution through various stages of the production process, including wood preparation, pulping, bleaching, and wastewater treatment.

Explanation :

- The debarking of wood logs can release tannins, resins, and extractives into the water used for soaking or washing the logs contribute to organic pollution.
- Spills, leaks, or discharges of pulping liquor during chemical pulping process can release harmful chemicals and organic pollutants into water bodies, affecting aquatic ecosystems.
- Water used in mechanical pulping may contain suspended solids, fine fibers, and wood residues, contributing to turbidity and organic pollution in wastewater.

- Discharges of bleaching effluents containing chlorinated organic compounds can lead to water pollution.

11) Write down the action of calcium cyanide as fertilizer.

See question no.02 part no.06 of 2018

12) Give two examples of phosphate fertilizers ?

See question no.02 part no.10 of 2018

13) What are raw materials for normal superphosphate fertilizers ?

See question no.02 part no.02 of 2018

14) Name four natural organic fertilizers.

See question no.02 part no.03 of 2018

15) Differentiate between micro and macro nutrients ?

See question no.02 part no.07 of 2019

2022

1. Mention different unit process involved in treatment of crude oil.

See question no.02 part no.03 of 2019

2. What do you understand about migration ?

See question no.02 part no.08 of 2019

3. Explain the term isomerization.

See question no.02 part no.02 of 2019

4. What are the products of refining ?

See question no.02 part no.01 of 2018

5. What is octane no. of fuel ?

The **octane number** (or **octane rating**) of a fuel is a measure of its resistance to **knocking** or **pinging** during combustion in a gasoline engine. It reflects the fuel's ability to withstand compression before igniting prematurely. Higher octane fuels resist knocking better and are suited for high-performance or high-compression engines.

- The **octane number** is explained as the percentage by volume of **iso-octane** (2,2,4-trimethylpentane) in a mixture with **n-heptane** that matches the knocking characteristics of the fuel under standardized conditions.

For example :

- A fuel with an octane number of 87 behaves like a mixture of 87% iso-octane and 13% n-heptane in terms of knocking resistance.
- Octane numbers are measured using standardized tests in a **CFR engine** (Cooperative Fuel Research engine). Two common methods included as
- Research Octane Number (RON)
 - Motor Octane Number (MON)
 - Pump Octane Number (PON)

6. Briefly explain the soda pulping.

See question no.02 part no.04 of 2018

7. What do you know about acidic digestion process ?

“The chemical process which is used to break down organic materials, such as food or biomass, into simpler compounds using acidic solutions is called acidic digestion process, also known as acidic hydrolysis.”

➤ This process involves the use of strong mineral acids, typically HCl or H₂SO₄, to hydrolyze complex organic molecules into their constituent components.

• **Process Steps :**

- Sample Preparation • Acid Addition • Hydrolysis Reaction
- Heating or Digestion • Neutralization

• **Purpose :** The acidic digestion process is employed in various industries and laboratory settings for different purposes :

- Chemical Analysis • Waste Treatment • Biofuel Production etc.

8. What are the environmental problems associated with pulp manufacturing ?

Pulp manufacturing, particularly in paper mills, can lead to several environmental problems due to the release of various pollutants and the consumption of natural resources.

- **Water Pollution :** Pulp manufacturing processes generate large volumes of wastewater containing organic compounds, lignin, suspended solids, and chemicals.
- **Air Pollution :** VOCs contribute to air pollution and may react with other pollutants to form smog and ozone.
- **Deforestation and Habitat Destruction :** Unsustainable logging practices during Pulp manufacturing can result in loss of biodiversity, soil erosion etc.
- **Chemical Pollution :** Chlorine-based bleaching processes used in pulp manufacturing can produce chlorinated organic compounds, that can harm human health and the environment.

9. Name four raw materials for paper industry.

See question no.02 part no.03 of 2017

10. Why lignin is removed from pulp ?

Lignin is removed from pulp during the papermaking process for several reasons, primarily to improve the quality and properties of the final paper product.

➤ By minimizing lignin content, papermakers can produce higher-quality papers with enhanced optical and mechanical properties, as well as reduced environmental impact.

Lignin is removed from pulp to :

- Enhanced Brightness and Whiteness
- Improved Strength and Durability
- Reduced Chemical Reactivity
- Enhanced Printability and Ink Absorption
- Improved Pulp Bleachability

11. What are the main raw materials for ammonia production ?

Ammonia production typically involves the Haber-Bosch process, which combines nitrogen gas (N_2) from the air with hydrogen gas (H_2) derived from natural gas or other hydrocarbon feedstocks.

- Nitrogen (N_2)
- Hydrogen (H_2)
- Natural Gas (Methane, CH_4)
- Water (H_2O)

12. Write down the action of calcium cyanide as fertilizer.

See question no.02 part no.06 of 2018

13. Give examples of phosphate fertilizers.

See question no.02 part no.10 of 2018

14. What are the raw materials for normal superphosphate fertilizer ?

See question no.02 part no.02 of 2018

15. Name four natural organic fertilizers.

See question no.02 part no.03 of 2018

2023

1. What do you know about abiogenic theory of petroleum ?

See question no.02 part no.10 of 2017

2. Write two examples of fractional distillation.

See question no.02 part no.01 of 2019

3. What is catalytic cracking ?

See question no.02 part no.09 of 2018

4. What are the products of refining ?

See question no.02 part no.01 of 2018

5. What is catalytic alkylation ?

See question no.02 part no.03 of 2020

6. Briefly explain sulphide pulping process.

The sulfite pulping process is a method of producing paper pulp from wood by breaking down the lignin that binds cellulose fibers. It uses a mixture of sulfur dioxide (SO_2) and a base to create an acidic or neutral cooking liquor.

Steps in Sulfite Pulping :

- Preparation of Raw Material
- Preparation of Cooking Liquor
- Cooking

- Pulp Washing
- Bleaching (Optional)
- Drying and Finishing

7. What is meant by calendaring in paper manufacturing ?

Calendaring is the final finishing process in paper manufacturing, where the paper or board is passed through a series of rollers (called calender rolls) to improve its **surface properties**. These rollers apply pressure, heat, and sometimes friction to enhance the paper's smoothness, gloss, and uniform thickness.

Types of Calendaring :

- i. Soft Calendaring
- ii. Hard Calendaring
- iii. Supercalendering

How Calendaring Works :

- The paper web is fed into the **calendering machine**.
- The rolls apply **pressure** and sometimes **heat** to compress and smooth the paper.
- The number of **passes** through the rolls determines the degree of smoothness and gloss.
- The final product is wound onto rolls or cut into sheets.

8. Write at least two examples of agriculture wastes for paper manufacturing ?

See question no.02 part no.09 of 2020

9. Why debarking is important for pulp manufacturing ?

Debarking is an essential step in pulp manufacturing because it removes the bark from wood logs before they are processed into pulp. Bark is considered undesirable in the pulping process due to its high impurities and low fiber content.

Importance of Debarking :

- Improves Pulp Quality
- Reduces Chemical Consumption
- Prevents Contamination
- Increases Process Efficiency
- Facilitates Bark Utilization

10. How paper industry causes water pollution ?

See question no.02 part no.10 of 2021

11. What are indirect fertilizers, give two examples.

Indirect fertilizers are substances that do not directly provide essential nutrients (like nitrogen, phosphorus, or potassium) to plants but improve soil conditions to enhance nutrient availability and plant growth.

- They work by modifying the chemical, physical, or biological properties of the soil.
- They improve the soil structure, pH, or microbial activity, making nutrients more accessible.

Examples of Indirect Fertilizers :

- Lime (Calcium Carbonate - CaCO_3)
- Gypsum (Calcium Sulfate - CaSO_4)
- Sulfur (S)
- Organic Matter (e.g., Compost or Manure)

12. Write down the temperature and catalyst conditions for Haber's process.

See question no.02 part no.07 of 2019

13. Briefly explain urea assimilation in soil.

See question no.02 part no.02 of 2018

14. What are potash fertilizers, give two examples.

Potash fertilizers are a group of fertilizers that provide **potassium (K)** as the primary nutrient, which is one of the essential macronutrients for plant growth. Potassium helps plants in processes like photosynthesis, water regulation, disease resistance, and improving the quality of fruits and seeds.

- These fertilizers are derived from potash minerals or salts.
- These enhance drought resistance by regulating water uptake.
- These promote enzyme activation and nutrient transport.

Examples of Potash Fertilizers :

- Potassium Chloride (Muriate of Potash)
- Potassium Sulfate (K_2SO_4)
- Potassium Nitrate (KNO_3)
- Potassium Magnesium Sulfate ($\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4$)

15. What is the role of macro nutrients ?

Macronutrients are essential nutrients required by plants in relatively large amounts for growth, development, and physiological processes. These nutrients are divided into **primary macronutrients** (Nitrogen, Phosphorus, Potassium) and **secondary macronutrients** (Calcium, Magnesium, Sulfur). Each plays a unique and vital role in plant health.

Importance of Macronutrients :

- Promote overall plant growth and health.
- Enhance productivity, yield, and quality of crops.
- Aid in physiological processes like photosynthesis, energy transfer, and protein synthesis.
- Balanced macronutrient availability is crucial for optimal plant growth and sustainable agriculture.

Spring 2023

1. Name any four different unit operations treatment of crude oil.

See question no.02 part no.03 of 2019

2. What do you understand about migration?

See question no.02 part no.08 of 2019

3. Explain the term isomerization.

See question no.02 part no.02 of 2019

4. Define octane number of fuel?

See question no.02 part no.05 of 2022

5. What are the products of catalytic cracking?

Catalytic cracking is a key process in petroleum refining that breaks down heavy hydrocarbon molecules into lighter, more valuable products using a catalyst. The process typically involves high temperatures and pressures in the presence of a catalyst, such as zeolites. The primary products of catalytic cracking are as follows :

- Gaseous Products (Hydrogen (H₂), Methane, Ethane, Propane, Ethylene and Propylene)
- Gasoline
- Heavy Cycle Oil (HCO)
- Liquefied Petroleum Gas (LPG)
- Light Cycle Oil (LCO)
- Coke
- Intermediate Hydrocarbons

6. Write any four fractions with carbon range obtained from fractional distillation.

See question no.02 part no.01 of 2019

7. What are environmental problems associated with pulp manufacturing.

See question no.02 part no.08 of 2022

8. Why non-fibrous materials are removed in paper manufacturing?

In paper manufacturing, non-fibrous materials are removed during the preparation of raw materials because they are impurities that can negatively impact the quality, strength, and appearance of the paper. These materials do not contribute to the formation of a strong, cohesive paper sheet and can introduce defects or inefficiencies in the production process.

Reasons for Removing Non-Fibrous Materials :

- Improves Paper Quality
- Prevents Equipment Damage
- Enhances Strength and Uniformity
- Improves Appearance
- Reduces Chemical Consumption
- Prevents Operational Issues
- Promotes Environmental Compliance

9. Which agriculture waste is used in paper manufacturing?

See question no.02 part no.09 of 2020

10. What is the role of beating process in paper manufacturing?

See question no.02 part no.09 of 2017

11. Write down applications of potash fertilizers.

Potash fertilizers, rich in potassium (K), play a critical role in improving plant growth, yield, and quality. They are used in a wide variety of agricultural and horticultural settings due to potassium's essential functions in plant physiology.

- Enhancing Crop Quality

- Improving Stress Tolerance
- Boosting Plant Health and Growth
- Specialty Applications
- Soil Fertility Management

12. What are raw materials for ammonia synthesis?

See question no.02 part no.11 of 2022

13. Give two examples of micro and macro nutrients for soil.

Examples of Macronutrients for Soil :

- Nitrogen (N)
- Potassium (K)
- Phosphorus (P)
- Calcium (Ca)

Examples of Micronutrients for Soil :

- Iron (Fe)
- Zinc (Zn)
- Manganese (Mn)
- Copper (Cu)

14. What are natural organic fertilizers, give examples.

Natural organic fertilizers are derived from plant, animal, or mineral sources and are used to improve soil fertility and provide nutrients to plants. Unlike synthetic fertilizers, organic fertilizers release nutrients slowly and improve soil structure over time. They also enhance soil microbial activity, improve moisture retention, and reduce environmental impact by avoiding chemical runoff.

Examples of Natural Organic Fertilizers :

- Compost
- Bone Meal
- Blood Meal
- Manure
- Fish Meal
- Seaweed or Kelp Meal

15. What is the difference between normal superphosphate and triple superphosphate fertilizers?

Normal superphosphate	Triple superphosphate
Contains about 16-20% phosphorus as monocalcium phosphate ($\text{Ca}(\text{H}_2\text{PO}_4)_2$), with sulfur as a byproduct.	Contains about 44-48% phosphorus as monocalcium phosphate or dicalcium phosphate.
Made by reacting phosphate rock with sulfuric acid.	Made by reacting phosphate rock with phosphoric acid.
Less effective for plants with higher phosphorus requirements due to lower phosphorus content.	More effective for phosphorus-demanding crops due to its higher phosphorus concentration.
Usually comes in larger, coarser granules.	Comes in finer, more concentrated granules.
Typically less expensive than TSP due to the lower phosphorus content and simpler production process.	More expensive because it is more concentrated and involves a more complex production process.