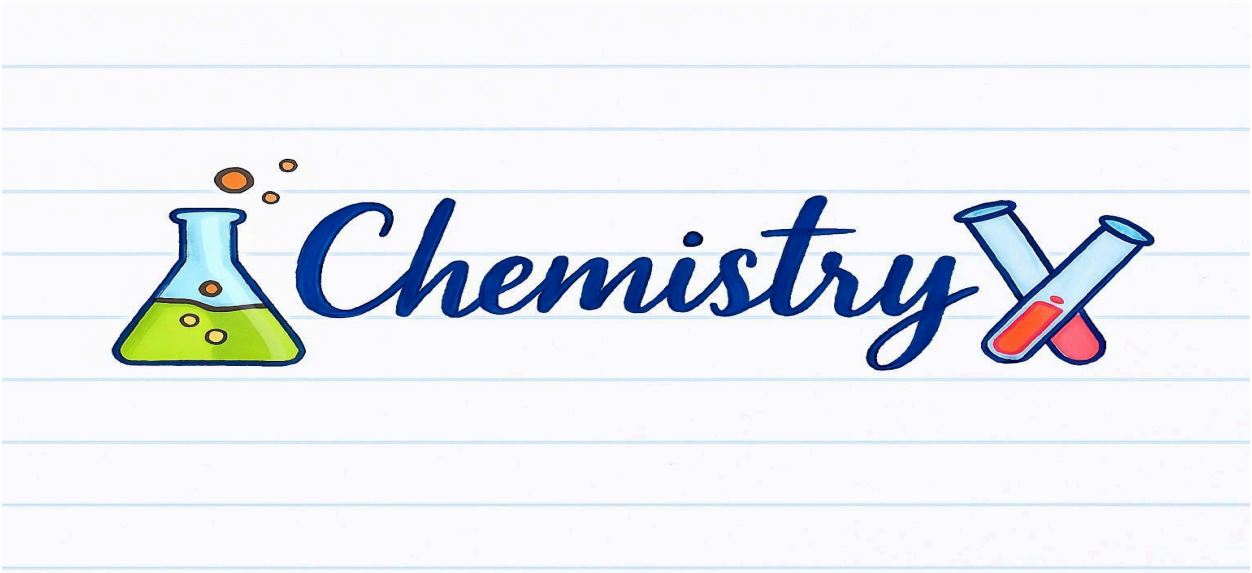

Class: 12th

Subject: Chemistry

Chapter 15: COMMON CHEMICAL INDUSTRIES IN PAKISTAN

🩸 Important MCQs (From Key Points)

1. Agriculture has been an important industry since:

(a) 2000 B.C

(b) 3000 B.C

(c) 5000 B.C ✅

(d) 8000 B.C

2. Chinese began using animal manure in fields around:

(a) 1000 B.C

(b) 5000 B.C ✅

(c) 1500 A.D

(d) 200 A.D

3. Fertilizer is a substance that improves:

(a) Soil colour

(b) Plant taste

(c) Growth and productiveness of plants ✅

(d) Temperature of soil

4. Natural fertilizers are obtained from:

(a) Plastics

(b) Rocks

(c) Plants and animals ✅

(d) Metals

5. Artificial fertilizers include:

(a) Sand and clay

(b) Urea and ammonium nitrate ✅

(c) Wood and coal

(d) Chalk and marble

6. Synthetic fertilizers mainly supply:

(a) Colour to plants

(b) Immediate deficiency of essential nutrients ✅

(c) Water to soil

(d) Heat to roots

7. Nutrients needed in very small amounts are called:

(a) Macro-nutrients

(b) Micro-nutrients ✅

(c) Pro-nutrients

(d) Electrolytes

8. Macro-nutrients are required in:

(a) Very small amount

(b) Variable amount

(c) Very large amount ✅

(d) No amount

9. Major nitrogenous fertilizers include:

(a) Super phosphate only

(b) Urea and ammonium nitrate ✅

(c) Cement and sand

(d) Sodium chloride

10. Important phosphatic fertilizers are:

(a) Urea and ammonia

(b) Super phosphate and triple phosphate ✅

(c) Coal and sulphur

(d) Calcium chloride

11. Cement was first introduced by Joseph Aspdin in:

(a) 1724

(b) 1824 ✅

(c) 1924

(d) 2024

12. Cement is obtained by burning calcarious and argillaceous materials to form:

(a) Slurry

(b) Gypsum

(c) Clinkers ✅

(d) Limestone

13. The commonly used method for cement production in Pakistan is:

(a) Dry process

(b) Wet process ✅

(c) Cold process

(d) Freeze process

14. Paper consists of a network of:

(a) Synthetic fibres

(b) Glass fibres

(c) Natural cellulosic fibres ✅

(d) Metallic fibres

15. The main objective of pulp making is to separate fibres from:

(a) Water

(b) Clay

(c) Lignin, a natural binder ✅

(d) Silica

🩸 Important MCQs:

1. Pakistan at the time of independence had:

(a) Strong industries

(b) Negligible industrial base ✅

(c) Advanced technology

(d) Heavy industries

2. Pakistan has shifted from an agrarian economy to:

(a) Fully industrial state

(b) Semi-chemical industrial state ✅

(c) Service-based economy

(d) Technological economy

3. Which is a heavy industry developing in Pakistan?

(a) Sugar industry

(b) Leather industry

(c) Iron industry ✅

(d) Textile industry

4. Artificial fibres were developed because:

(a) Natural fibres are harmful

(b) Natural fibres cannot meet world clothing needs ✅

(c) Natural fibres are banned

(d) Natural fibres are too colourful

5. Fertilizers and pesticides help to:

(a) Reduce soil fertility

(b) Increase crop yield ✅

(c) Cause soil erosion

(d) Reduce food production

6. Economic development of a country depends on:

(a) Area of agricultural lands

(b) Magnitude of chemical industry ✅

(c) Literacy rate

(d) Tourism

7. Manure consists mainly of:

(a) Minerals

(b) Chemical waste

(c) Faeces and urine of domestic animals ✅

(d) Rocks and stones

8. The first prerequisite for fertilizer use is:

(a) Soil texture

(b) Plant nutrient function understanding ✅

(c) Water supply

(d) Climate

9. The most important nutrients for plant growth are:

(a) Ca, Mg, S

(b) Fe, Cu, Mn

(c) N, P, K ✅

(d) C, H, O

10. Fertilizers are added to soil to:

(a) Reduce soil temperature

(b) Change soil colour

(c) Make up deficiency of essential elements ✅

(d) Remove weeds

11. Micro-nutrients are required in:

(a) Kilograms

(b) Tonnes

(c) Very small amounts (trace amounts) ✅

(d) Quintals

12. Which of the following is NOT a micro-nutrient?

(a) Boron

(b) Manganese

(c) Potassium ✅

(d) Copper

13. Macro-nutrients include:

(a) Molybdenum

(b) Chlorine

(c) Boron

(d) Nitrogen ✅

14. A good fertilizer must be:

(a) Insoluble in water

(b) Harmful to plants

(c) Stable and cheap to manufacture ✅

(d) Highly acidic

15. Elements in a fertilizer must be in:

(a) Solid metallic form

(b) Water-insoluble form

(c) Water-soluble form for easy uptake by plants ✅

(d) Gaseous form

16. Fertilizers are classified on the basis of:

(a) Colour

(b) Elements they provide (N, P, K) ✅

(c) Smell

(d) Soil type

17. Nitrogeneous fertilizers mainly supply:

(a) Phosphorus

(b) Potassium

(c) Nitrogen ✅

(d) Calcium

18. Nitrogen is required for the development of:

(a) Flowers only

(b) Stem and leaves growth ✅

(c) Fruits only

(d) Soil structure

19. A major constituent of protein in plants is:

(a) Carbon

(b) Nitrogen ✅

(c) Sodium

(d) Chlorine

20. Which nitrogen fertilizer is used in liquid form?

(a) Urea

(b) Ammonium sulphate

(c) Ammonia (NH_3) ✅

(d) Calcium nitrate

21. Ammonia contains how much nitrogen?

(a) 46%

(b) 33%

(c) 82% ✅

(d) 16%

22. Urea contains how much nitrogen?

(a) 82%

(b) 33.5%

(c) 46% ✅

(d) 16%

23. Urea is produced by the reaction of:

(a) Ammonia + Nitric acid

(b) Ammonia + Carbon dioxide ✅

(c) Ammonia + Sulphuric acid

(d) Ammonia + Water

24. The compound formed when NH_3 reacts with CO_2 is:

(a) Ammonium sulphate

(b) Ammonium chloride

(c) Ammonium carbamate ✅

(d) Ammonium nitrate

25. Prilling produces:

(a) Liquid fertilizer

(b) Powder fertilizer

(c) Solid prills (small pellets) of urea ✅

(d) Gaseous fertilizer

26. Ammonium nitrate is manufactured by reacting:

(a) $NH_3 + CO_2$

(b) $NH_3 + HNO_3$ ✅

(c) $NH_3 + H_2SO_4$

(d) $NH_3 + H_3PO_4$

27. Ammonium nitrate should not be used for:

(a) Wheat

(b) Tobacco

(c) Rice (paddy fields) ✅

(d) Cotton

28. Phosphatic fertilizers mainly supply:

(a) Nitrogen

(b) Potassium

(c) Phosphorus ✅

(d) Sulphur

29. Diammonium phosphate contains:

(a) 46% N

(b) 48% P_2O_5

(c) 16% N and 48% P_2O_5 ✅

(d) 33% N

30. Potassium fertilizers help in the formation of:

(a) Protein

(b) Starch and sugar ✅

(c) Water

(d) Oxygen

31. Potassium nitrate is produced industrially from:

(a) $NaNO_3$ + KCl reaction ✅

(b) NH_3 + CO_2 reaction

(c) NH_3 + HNO_3 reaction

(d) $CaCl_2$ + K_2CO_3 reaction

32. Potassium nitrate contains:

(a) 46% N

(b) 13% N and 44% potash (K_2O) ✅

(c) 82% N

(d) 16% N

33. Urea has gained great importance in Pakistan because:

(a) It is rarely used

(b) It is an export item

(c) Agricultural soil loses nutrients by repeated cultivation ✅

(d) It changes soil colour

34. The number of fertilizer plants in Pakistan is about:

(a) 5

(b) 8

(c) 14 ✅

(d) 20

35. Total urea production of Pakistan in 2002 was approximately:

(a) 10,00,000 metric tons

(b) 25,00,000 metric tons

(c) 56,30,100 metric tons/annum ✅

(d) 1,00,00,000 metric tons

36. Portland cement was first discovered by:

(a) Michael Faraday

(b) Joseph Aspdin ✅

(c) Dalton

(d) Berzelius

37. Portland cement was named because it resembled:

(a) London rock

(b) Marble

(c) Portland rock of England ✅

(d) Black stone

38. Cement is obtained by burning a mixture of:

(a) Sand and gypsum

(b) Lime, silica, alumina, iron oxide ✅

(c) Chalk and coal

(d) Carbon and clay

39. Calcarious material used in cement manufacturing is mainly:

(a) Clay

(b) Limestone ✅

(c) Gypsum

(d) Sand

40. Argillaceous material mainly provides:

(a) Calcium oxide

(b) Silicates and aluminates ✅

(c) Sodium oxide

(d) Magnesium oxide

41. Gypsum in cement is used as:

(a) Fuel

(b) Setting regulator ✅

(c) Colouring agent

(d) Hardening inhibitor

42. The average percentage of lime (CaO) in Portland cement is:

(a) 22%

(b) 7.5%

(c) 62% ✅

(d) 44%

43. Which process is mostly used in Pakistan for cement manufacturing?

(a) Dry process

(b) Wet process ✅

(c) Semi-dry process

(d) Chemical process

44. The material obtained after mixing limestone (75%) and clay (25%) with water is called:

(a) Cement

(b) Slurry ✅

(c) Paste

(d) Gypsum mix

45. In a rotary kiln, the maximum temperature zone is the:

(a) Drying zone

(b) Decomposition zone

(c) Burning zone ✅

(d) Cooling zone

46. Limestone decomposes at about 900°C to form:

(a) $CaO + CO_2$ ✅

(b) $CaCO_3 + H_2O$

(c) $CaSO_4$

(d) $CaCl_2$

47. The greenish-black balls obtained from the kiln are called:

(a) Gypsum

(b) Slurry

(c) Clinkers ✅

(d) Pellets

48. Gypsum is added to clinkers in cement to:

(a) Reduce colour

(b) Speed up setting

(c) Control the setting of cement (slow down) ✅

(d) Increase hardness immediately

49. In the first 24 hours of setting, tricalcium aluminate reacts with gypsum to form:

(a) Calcium chloride

(b) Calcium silicate

(c) Calcium sulpho-aluminate crystals ✅

(d) Calcium ferrite

50. The hardness of cement between 1 to 7 days is mainly due to:

(a) Water vapour

(b) Formation of needle-shaped crystals of $Ca(OH)_2$ ✅

(c) Presence of CO_2

(d) Colour change

51. At the time of partition (1947), the annual cement production of West Pakistan was:

(a) 130,000 tons

(b) 330,000 tons ✅

(c) 530,000 tons

(d) 930,000 tons

52. In 1954, cement production in Pakistan increased to:

(a) 220,000 tons

(b) 330,000 tons

(c) 660,000 tons ✅

(d) 990,000 tons

53. Cement factories added in 1956 were located at:

(a) Karachi and Quetta

(b) Lahore and Peshawar

(c) Daud Khel and Hyderabad ✅

(d) Multan and Faisalabad

54. Currently, the total number of cement factories in Pakistan is around:

(a) 10

(b) 15

(c) 22 ✅

(d) 40

55. Total cement production of 22 factories is:

(a) 5 million tons/annum

(b) 7 million tons/annum

(c) 9,578,802 metric tons/annum ✅

(d) 12 million tons/annum

56. The word "paper" is derived from:

(a) Cotton plant

(b) Bamboo plant

(c) Papyrus plant ✅

(d) Mulberry tree

57. Modern paper was invented by:

(a) Joseph Aspdin

(b) Ibn-e-Battuta

(c) Ts'ai Lun of China ✅

(d) Leonardo da Vinci

58. Ts'ai Lun invented paper around:

(a) 30 A.D

(b) 105 A.D ✅

(c) 300 A.D

(d) 900 A.D

59. Paper is defined as a sheet made from:

(a) Metallic fibres

(b) Synthetic polymers

(c) Natural cellulosic fibres from aqueous suspension ✅

(d) Artificial fibres

60. The major raw materials for paper in Pakistan are:

(a) Plastics and minerals

(b) Wood only

(c) Non-woody and woody materials both ✅

(d) Metals and fibre glass

61. Wheat straw, rice straw, bagasse and bamboo are:

(a) Woody raw materials

(b) Synthetic materials

(c) Non-woody raw materials ✅

(d) Metallic materials

62. Cotton stalk and eucalyptus are examples of:

(a) Metals

(b) Synthetic fibres

(c) Woody raw materials ✅

(d) Plastic raw materials

63. The pulping process most commonly used in Pakistan is:

(a) Kraft process

(b) Sulphite process

(c) Neutral sulphite semi-chemical process (NSSC) ✅

(d) Mechanical pulping

64. NSSC process uses sodium sulphite buffered with:

(a) NaCl

(b) HCl

(c) Na_2CO_3 or NaOH ✅

(d) KOH

65. The pH maintained during NSSC digestion is:

(a) 3–4

(b) 5–6

(c) 7–9 ✅

(d) 10–12

66. Temperature maintained in the digester during pulping is:

(a) 60–80°C

(b) 100–120°C

(c) 160–180°C ✅

(d) 200–230°C

67. Residual lignin makes paper:

(a) Soft

(b) Elastic

(c) Brittle ✅

(d) Transparent

68. In Pakistan, paper pulp is bleached using:

(a) Bromine

(b) Nitric acid

(c) Chlorine or sodium hypochlorite and hydrogen peroxide ✅

(d) Acetone

69. The machine commonly used for paper making is:

(a) Boiler machine

(b) Dryer machine

(c) Fourdrinier machine ✅

(d) Separator machine

70. Final moisture content of dried paper is:

(a) 1–2%

(b) 3–4%

(c) 6–8% ✅

(d) 15–20%

🩸 Important Short Questions (From Key points)

1. Since when have the Chinese been using animal manure in agriculture fields?

Answer:

👉 The Chinese have been using animal manure in their agriculture fields for several centuries.

2. What is fertilizer?

Answer:

👉 A fertilizer is a substance that provides essential nutrients to plants to improve their growth and yield.

3. Differentiate between natural and artificial fertilizers.

Answer:

👉 Natural fertilizers come from plant and animal sources, while artificial fertilizers are chemically manufactured.

4. Why are synthetic fertilizers used?

Answer:

👉 Synthetic fertilizers are used because they quickly supply essential nutrients to plants and increase crop production.

5. What are micro-nutrients and macro-nutrients?

Answer:

👉 Micro-nutrients are required by plants in small amounts, whereas macro-nutrients are required in large amounts.

6. Name two major nitrogenous fertilizers.

Answer:

👉 Two major nitrogenous fertilizers are ammonium sulphate and urea.

7. Who introduced cement and in which year?

Answer:

👉 Cement was introduced by Joseph Aspdin in 1824.

8. How is cement obtained?

Answer:

👉 Cement is obtained by heating limestone and clay, then grinding the mixture into fine powder with gypsum.

9. On which property of cement is its use in construction based?

Answer:

👉 Its use is based on the property that cement sets and becomes hard when mixed with water.

10. What is paper made of?

Answer:

👉 Paper is made of plant fibres mainly obtained from wood.

🩸 Important Short Questions:

1. What was the industrial base of Pakistan like at the time of its creation in 1947?

Answer:

👉 At the time of its creation in 1947, Pakistan had an almost negligible industrial base and was mainly an agrarian economy.

2. Why have scientists developed artificial fibres?

Answer:

👉 Scientists developed artificial fibres because natural fibres like cotton, silk, and wool could not meet the growing clothing requirements of the world.

3. What is the role of chemical industries in a country's economic development?

Answer:

👉 The magnitude of a country's chemical industry indicates its economic development and progress, as chemical industries produce essential materials like fertilizers, cement, and paper.

4. Since when have the Chinese been using animal manure as fertilizer?

Answer:

👉 The Chinese have been using animal manure as fertilizer since 5000 B.C.

5. Which elements are considered most important for plant growth?

Answer:

👉 Nitrogen (N), Phosphorus (P), and Potassium (K) are considered the most important elements for plant growth.

6. Define fertilizers.

Answer:

👉 Fertilizers are substances added to the soil to make up the deficiency of essential elements like nitrogen, phosphorus, and potassium, enhancing plant growth and soil fertility.

7. What are micro-nutrients? Give examples.

Answer:

👉 Micro-nutrients are nutrients required by plants in very small amounts for healthy growth.

Examples: Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Chlorine (Cl).

8. What are macro-nutrients? Give examples.

Answer:

👉 Macro-nutrients are nutrients required by plants in large amounts for proper growth.

Examples: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulphur (S), Carbon (C), Hydrogen (H), Oxygen (O).

9. What are the essential qualities of a good fertilizer?

Answer:

👉 **Essential qualities of a good fertilizer are:**

- Nutrients must be readily available to plants.
- It should be fairly soluble in water.
- It should not be injurious to plants.

- It should be cheap.
- It should be stable in soil and storage.
- It should not alter soil pH.
- It should convert into a form easily assimilated by plants.

10. Why should fertilizers be water-soluble and stable in soil?

Answer:

👉 Fertilizers must be water-soluble so that plants can absorb the nutrients, and they must be stable in soil to remain effective over time without losing their nutrient value.

11. What are the three main types of fertilizers based on the elements they supply?

Answer:

👉 Nitrogeneous fertilizers, Phosphatic fertilizers, Potassium fertilizers.

12. What is the role of nitrogeneous fertilizers in plant growth?

Answer:

👉 They supply nitrogen, which is required during early plant growth for stem and leaf development, protein formation, green color of leaves, and to enhance yield and quality.

13. Give examples of nitrogeneous fertilizers.

Answer:

👉 Ammonium sulphate, urea, ammonium nitrate, calcium ammonium nitrate, calcium cyanamide, ammonium phosphate, ammonium chloride, ammonia.

14. How is liquid ammonia used as a fertilizer, and why is it injected into the soil?

Answer:

👉 Liquid ammonia (82% nitrogen) is injected about 6 inches under the soil surface to prevent it from seeping out and to provide nitrogen directly to the plant roots.

15. What is urea, and why is it considered a high-quality nitrogen fertilizer?

Answer:

👉 Urea (NH_2CONH_2) contains 46% nitrogen, is the most concentrated solid nitrogen fertilizer, widely used in Pakistan, and provides nitrogen efficiently to plants.

16. Describe the main steps involved in the manufacture of urea.

Answer:

i) Preparation of ammonia and carbon dioxide

ii) Formation of ammonium carbamate ($CO_2 + 2NH_3 \rightarrow NH_2COONH_4$)

iii) Dehydration of ammonium carbamate to urea ($NH_2COONH_4 \rightarrow NH_2CONH_2 + H_2O$)

iv) Concentration of urea solution

v) Prilling to solid urea pellets.

17. How is ammonium nitrate produced, and what is its nitrogen content?

Answer:

👉 By neutralization of ammonia with nitric acid: NH_3 + HNO_3 → NH_4NO_3. It contains 33–33.5% nitrogen.

18. What is the importance of phosphatic fertilizers, and give two examples.

Answer:

👉 They provide phosphorus to stimulate early growth, accelerate seed and fruit formation, and increase disease resistance. Examples: Super phosphate ($Ca(H_2PO_4)_2$) and triple phosphate (Diammonium phosphate, $(NH_4)_2HPO_4$).

19. What is the role of potassium fertilizers in plants, and give one example.

Answer:

👉 They help in starch and sugar formation, strengthen roots, increase disease resistance, and aid in ripening of seeds and fruits. Example: Potassium nitrate (KNO_3).

20. How has the fertilizer industry developed in Pakistan, and how many plants are currently operational?

Answer:

👉 Pakistan has about 14 fertilizer plants in private and public sectors producing various fertilizers, especially urea, to meet agricultural demands.

21. What are nitrogenous fertilizers and why are they important for plants?

Answer:

👉 Nitrogenous fertilizers supply nitrogen to plants, which is essential for the development of stems and leaves, the

formation of proteins, and for giving green color to leaves. They enhance the yield and quality of crops.

22. Name any five examples of nitrogenous fertilizers.

Answer:

👉 Ammonium sulphate, Calcium ammonium nitrate, Ammonia, Ammonium nitrate, Urea.

23. How is liquid ammonia used as a fertilizer and why is it injected under the soil surface?

Answer:

👉 Liquid ammonia contains 82% nitrogen and is injected about 6 inches under the soil surface to avoid it from seeping out. It directly supplies nitrogen to plants and promotes early growth.

24. What is urea and why is it considered a high-quality nitrogenous fertilizer?

Answer:

👉 Urea (NH_2CONH_2) contains 46% nitrogen, making it the most concentrated solid nitrogen fertilizer. It is widely used in Pakistan due to its high quality and efficiency in increasing crop yield.

25. Outline the basic steps involved in the industrial manufacture of urea.

Answer:

1. Preparation of hydrogen and carbon dioxide.

2. Preparation of ammonia.

3. Formation of ammonium carbamate.

4. Dehydration of ammonium carbamate to urea.

5. Concentration of urea solution by evaporation.

6. Prilling to form solid urea pellets.

26. How is ammonium carbamate formed in the urea production process?

Answer:

👉 Ammonium carbamate is formed by reacting gaseous carbon dioxide with ammonia in a 1:2 volume ratio:

$CO_2(g) + 2\ NH_3(g) \longrightarrow NH_2COONH_4$ (Ammonium carbamate)

27. How is ammonium nitrate manufactured and what is its nitrogen content?

Answer:

👉 Ammonium nitrate is made by the neutralization of ammonia with nitric acid:

$NH_3 + HNO_3 \longrightarrow NH_4NO_3$

👉 It contains 33–33.5% nitrogen and solidifies into small prills for easy handling.

28. What are phosphatic fertilizers and why are they important for plants?

Answer:

👉 Phosphatic fertilizers provide phosphorus to plants, which stimulates early growth, accelerates seed and fruit formation, and increases resistance to diseases.

29. How is diammonium phosphate (DAP) prepared and what nutrients does it provide?

Answer:

👉 DAP is prepared by reacting anhydrous ammonia with pure phosphoric acid at 60–70°C and pH 5.8–6.0:

$2\ NH_3 + H_3PO_4 \longrightarrow (NH_4)_2HPO_4 + \text{heat}$

👉 DAP contains 16% nitrogen and 48% phosphorus, providing about 75% plant nutrients.

30. What are potassium fertilizers and how do they benefit plant growth?

Answer:

👉 Potassium fertilizers supply potassium, which helps in starch and sugar formation, strengthens roots, increases disease resistance, and aids in ripening seeds, fruits, and cereals.

31. How is potassium nitrate (KNO_3) prepared on an industrial scale?

Answer:

👉 Potassium nitrate is prepared by double decomposition between sodium nitrate and potassium chloride:

$$NaNO_3(aq) + KCl(aq) \longrightarrow NaCl(aq) + KNO_3(aq)$$

👉 The potassium nitrate is separated, cooled, and solidified as pale yellow crystals containing 13% nitrogen and 44% potash.

32. Why is urea fertilizer particularly important for Pakistan?

Answer:

👉 Pakistan is an agricultural country, and urea fertilizer is essential to maintain crop production and compensate for nutrient depletion caused by repeated cultivation.

33. How many fertilizer plants are currently operating in Pakistan, and which sectors do they belong to?

Answer:

👉 There are about 14 fertilizer plants operating in Pakistan in both private and public sectors.

34. What is the total production of urea fertilizer in Pakistan (as of 2002)?

Answer:

👉 The total production of urea fertilizer in Pakistan in 2002 was about 5,630,100 metric tons per annum.

35. Why is the demand for fertilizers continuously increasing in Pakistan?

Answer:

👉 The demand is increasing due to the growing population, the need for higher agricultural productivity, and repeated cultivation depleting soil nutrients.

36. Who first introduced cement and how was it discovered?

Answer:

👉 Cement was first introduced by an English mason, Joseph Aspdin. He discovered it when a strongly heated mixture of limestone and clay was mixed with water and allowed to stand, which hardened into a stone-like mass resembling Portland rock.

37. What is Portland cement and why is it called so?

Answer:

👉 Portland cement is a mixture of lime (from limestone), silica, iron oxide, and alumina that hardens when mixed with water. It is called Portland cement because its hardened mass resembled Portland stone, a famous building stone of England.

38. Define cement.

Answer:

👉 Cement is the material obtained by burning an intimate mixture of calcarious and argillaceous materials at high temperature to produce clinkers, which are then ground to a fine powder.

39. Name the essential constituents of cement.

Answer:

👉 **The essential constituents are:**

1. Lime (CaO) – from limestone

2. Silica (SiO_2) – from clay

3. Alumina (Al_2O_3) – from clay

40. List the important raw materials used in cement manufacture.

Answer:

👉 **Important raw materials are:**

1. Calcarious materials – limestone, marble, chalk, marine shells

2. Argillaceous materials – clay, shale, slate, blast furnace slag

3. Gypsum – used in small amounts

41. What are the two main processes used in the manufacture of cement?

Answer:

👉 **The two main processes are:**

1. Dry process

2. Wet process

42. Why is the wet process preferred in Pakistan over the dry process?

Answer:

👉 **The wet process is preferred because:**

- It is free from dust
- Grinding is easier
- The composition of cement can be controlled easily
- Suited for soft raw materials

43. What are the main stages involved in the wet process of cement manufacture?

Answer:

👉 The main stages are:

1. Crushing and grinding of raw materials

2. Mixing raw materials in correct proportion

3. Heating the mixture in a rotary kiln

4. Clinker formation

5. Grinding clinker with gypsum

6. Packing or storage of finished cement

44. What is clinker and how is it formed in the cement manufacturing process?

Answer:

👉 Clinker is the product obtained from the rotary kiln. It is formed when heated raw materials react at high temperature

to produce calcium silicate, calcium aluminate, and calcium ferrite. Clinker appears as greenish-black or grey balls.

45. Explain the setting of cement and the reactions taking place in the first 24 hours.

Answer:

👉 When cement is mixed with water, tri-calcium aluminate ($3CaO \cdot Al_2O_3$) absorbs water and forms a colloidal gel ($3CaO \cdot Al_2O_3 \cdot 6H_2O$). This gel reacts with gypsum ($CaSO_4 \cdot 2H_2O$) to form calcium sulpho-aluminate crystals, which start crystallizing slowly and give the cement paste its initial hardness.

46. Who first introduced cement and how was it discovered?

Answer:

👉 Cement was first introduced by an English mason, Joseph Aspdin. He discovered it when a strongly heated mixture of limestone and clay was mixed with water and allowed to stand, which hardened into a stone-like mass resembling Portland rock.

47. What is Portland cement and why is it called so?

Answer:

👉 Portland cement is a mixture of lime (from limestone), silica, iron oxide, and alumina that hardens when mixed with water. It is called Portland cement because its hardened mass resembled Portland stone, a famous building stone of England.

48. Define cement.

Answer:

👉 Cement is the material obtained by burning an intimate mixture of calcarious and argillaceous materials at high temperature to produce clinkers, which are then ground to a fine powder.

49. Name the essential constituents of cement.

Answer:

👉 **The essential constituents are:**

1. Lime (CaO) – from limestone

2. Silica (SiO_2) – from clay

3. Alumina (Al_2O_3) – from clay

50. List the important raw materials used in cement manufacture.

Answer:

👉 **Important raw materials are:**

1. Calcarious materials – limestone, marble, chalk, marine shells

2. Argillaceous materials – clay, shale, slate, blast furnace slag

3. Gypsum – used in small amounts

51. What are the two main processes used in the manufacture of cement?

Answer:

👉 The two main processes are:

1. Dry process

2. Wet process

52. Why is the wet process preferred in Pakistan over the dry process?

Answer:

👉 **The wet process is preferred because:**

- It is free from dust
- Grinding is easier
- The composition of cement can be controlled easily
- Suited for soft raw materials

53. What are the main stages involved in the wet process of cement manufacture?

Answer:

👉 **The main stages are:**

1. Crushing and grinding of raw materials

2. Mixing raw materials in correct proportion

3. Heating the mixture in a rotary kiln

4. Clinker formation

5. Grinding clinker with gypsum

6. Packing or storage of finished cement

54. What is clinker and how is it formed in the cement manufacturing process?

Answer:

👉 Clinker is the product obtained from the rotary kiln. It is formed when heated raw materials react at high temperature to produce calcium silicate, calcium aluminate, and calcium ferrite. Clinker appears as greenish-black or grey balls.

55. Explain the setting of cement and the reactions taking place in the first 24 hours.

Answer:

👉 When cement is mixed with water, tri-calcium aluminate ($3CaO \cdot Al_2O_3$) absorbs water and forms a colloidal gel ($3CaO \cdot Al_2O_3 \cdot 6H_2O$). This gel reacts with gypsum ($CaSO_4 \cdot 2H_2O$) to form calcium sulpho-aluminate crystals, which start crystallizing slowly and give the cement paste its initial hardness.

56. How many cement plants existed in West Pakistan at the time of partition in 1947, and what was their annual production?

Answer:

👉 There were four cement plants, producing about 330,000 tons of cement per year.

57. How many cement factories were operating in Pakistan in 1956, and what were their locations?

Answer:

👉 Two more factories were set up in Daud Khel and Hyderabad in 1956.

58. How many cement factories are currently operating in Pakistan, and what is their total annual production?

Answer:

👉 About 22 cement factories are operating in private and public sectors, producing 9,578,802 metric tons per year.

59. From which plant is the word “paper” derived, and where did it grow abundantly?

Answer:

👉 The word “paper” is derived from Papyrus, which grew along the marshy delta of the River Nile in Egypt around 3000 B.C.

60. Who is credited with the invention of modern paper and when?

Answer:

👉 Ts’ai Lun of China is credited with the invention of modern paper in 105 A.D.

61. Define paper in terms of its method of production.

Answer:

👉 Paper is a sheet material made of a network of natural cellulosic fibres deposited from an aqueous suspension.

62. Name the two types of raw materials used in paper production in Pakistan.

Answer:

👉 **1. Non-woody raw materials** – wheat straw, rice straw, bagasse, bamboo, rag

👉 **2. Woody raw materials** – poplar, eucalyptus, douglas fir, cotton stalk, cotton linter, kahi grass, grasses

63. Name the three principal chemical pulping methods used for paper production.

Answer:

👉 1. Kraft process (Alkaline)

2. Sulphite process (Acidic)

3. Neutral sulphite semi-chemical process (NSSC)

64. What are the essential steps in the Neutral Sulphite Semi-Chemical (NSSC) pulping process?

Answer:

👉 **The steps are:**

1. Cutting of raw materials

2. Dry cleaning

3. Wet cleaning

4. Screening

5. Digestion

6. Blow tank

7. Pulp washing

8. Bleaching

9. Stock preparation plant

10. Paper making machine

64. What is the current status of the paper industry in Pakistan?

Answer:

👉 At present, more than 30 pulp and paper industries operate in private and public sectors, producing pulp and paperboard. Pakistan has enough non-woody raw materials to meet future industry requirements.

🩸 EXERCISE

Q. 1 Fill in the blanks with suitable words.

1. Fertilizers enhance the natural ----- of the soil.

Answer: fertility ✅

2. Micro-nutrients are required in quantity ranging from ------ per acre.

Answer: 1–5 kg ✅

3. Ammonia contains ------- % nitrogen.

Answer: 82% ✅

4. Manure is an ------ material used to fertilize land.

Answer: organic ✅

5. Cement was first introduced by an English mason ------.

Answer: Joseph Aspdin ✅

6. Phosphorus is required to stimulate ------- of plant.

Answer: early growth ✅

7. In Pakistan, bleaching of pulp is carried out with-------.

Answer: chlorine, sodium hypochlorite, or hydrogen peroxide ✅

8. Cement is generally manufactured using ------- process.

Answer: wet or dry ✅

9. The use of cement in the construction of building is based on its property of ------- when its paste with water is allowed to stand for sometime.

Answer: setting/hardening ✅

10. Lignin is an -------- polymer and cause paper to become brittle.

Answer: aromatic ✅

Q. 2 Indicate True or False.

1. Potassium fertilizers are especially used for tobacco and corn.

Answer: ✅ True

Reason: Potassium fertilizers help in healthy root development and increase resistance to diseases in crops like tobacco and corn.

2. Ammonia is used in gaseous state while all other fertilizers are used in the solid form.

Answer: ❌ False

Reason: Ammonia is used in liquid state, not gaseous state, for direct soil application.

3. In wet process for the manufacture of cement, grinding of raw material is done in the presence of water.

Answer: ✅ True

Reason: Wet process involves grinding raw materials in water to form a slurry.

4. The total production of cement in Pakistan is 56,30,100 metric tons/annum.

Answer: ❌ False

Reason: This figure (56,30,100 metric tons) refers to urea fertilizer, not cement. Cement production is about 9,578,802 metric tons/annum.

5. In neutral sulphite semi-chemical process, sodium sulphite is used buffered with sodium carbonate.

Answer: ✅ True

Reason: Buffering maintains pH 7-9 during pulping.

6. Lignin is an inorganic binder.

Answer: ❌ False

Reason: Lignin is an aromatic polymer and causes paper to become brittle.

7. Paper consumption in Pakistan is around 5kg per person per year.

Answer: ✅ True

Reason: Due to limited availability and high prices, per capita consumption is low.

8. Urea contains 90% nitrogen.

Answer: ❌ False

Reason: Urea contains 46% nitrogen, making it a high-quality nitrogenous fertilizer.

9. The temperature of the digester in paper industry should be around 160-180°C.

Answer: ✅ True

Reason: This temperature ensures proper digestion of raw materials to produce pulp.

10. Potassium fertilizers increase the capability of plants to resist diseases.

Answer: ✅ True

Reason: Potassium improves plant strength, disease resistance, and fruit ripening.

Q. 3 Multiple choice questions. Encircle the correct answer.

(i) Which three elements are needed for the healthy growth of plants?

(a) N, S, P ✅

(b) N, Ca, P

(c) N, P, K

(d) N, K, C

(ii) Which woody raw material is used for the manufacture of paper pulp?

(a) Cotton

(b) Bagasse

(c) Poplar ✅

(d) Rice straw

(iii) The nitrogen present in some fertilizers helps plants

(a) to fight against diseases

(b) to produce fat

(c) to undergo photosynthesis

(d) to produce protein ✅

(iv) Phosphorus helps the growth of

(a) root ✅

(b) leave

(c) stem

(d) seed

(v) Micro-nutrients are required in quantity ranging from

(a) 4–40g ✅

(b) 6–200g

(c) 6–200kg

(d) 4–40kg

(vi) During the manufacturing process of cement the temperature of the decomposition zone goes up to

(a) 600°C

(b) 800°C

(c) 1000°C

(d) 1200°C ✅

(vii) The word paper is derived from the name of which reedy plant

(a) Rose

(b) Sunflower

(c) Papyrus ✅

(d) Water Hyacinth

(viii) Which is not a calcareous material?

(a) lime

(b) clay ✅

(c) marble

(d) marine shell

(ix) How many zones through which the charge passes in a rotary kiln?

(a) 4

(b) 3 ✅

(c) 2

(d) 5

(x) Ammonium nitrate fertilizer is not used for which crop?

(a) Cotton

(b) Wheat

(c) Sugar cane

(d) Paddy rice ✅

🌟 Q. 4 What are phosphatic fertilizers? How are they prepared? Mention the role of phosphorus in the growth of plants.

❖ **Answer:**

1. Definition of Phosphatic Fertilizers:

Phosphatic fertilizers are those fertilizers that supply phosphorus (P) to the plants or soil. Phosphorus is an essential nutrient required by plants for healthy growth, especially during the early stages of development and during flowering and seed formation. These fertilizers are important for stimulating early growth, accelerating seed and fruit formation, and increasing resistance to diseases.

2. Importance of Phosphorus in Plants:

Phosphorus plays a vital role in the growth and development of plants. Its key roles include:

- **Root Development**: Phosphorus helps in the development of strong and healthy roots.
- **Energy Transfer:** It is a component of ATP (adenosine triphosphate), which provides energy for various biochemical reactions in the plant.
- **Flowering and Fruit Formation:** Phosphorus promotes early flowering, seed formation, and fruit development.
- **Disease Resistance:** It increases plant resistance to various diseases.
- **Photosynthesis and Growth:** Phosphorus helps in efficient photosynthesis and overall plant growth.

3. Preparation of Phosphatic Fertilizers:

There are different phosphatic fertilizers, but one of the most important and widely used is Diammonium Phosphate (DAP). The preparation process is as follows:

Diammonium Phosphate (DAP) Preparation:

- DAP is a compound of fairly high purity.
- It is prepared by reacting anhydrous ammonia (NH_3) gas with pure phosphoric acid (H_3PO_4) under controlled conditions.
- The reaction is carried out at a temperature of 60-70°C and a pH of 5.8-6.0.

Chemical Reaction:

2NH_3 (g) + H_3PO_4 (l) → (NH_4)_2HPO_4 + heat

- The resulting crystals of DAP are then taken out, centrifuged, washed, and dried.
- **Nutrient Content:** DAP contains about 16% nitrogen (N) and 48% phosphorus pentoxide (P_2O_5), providing

approximately 75% plant nutrients. It can be used alone or mixed with other fertilizers.

Other Phosphatic Fertilizers:

- **Single Super Phosphate (SSP):** Calcium super phosphate, commonly used, provides phosphorus in soluble form for plant absorption.
- **Triple Super Phosphate (TSP):** Contains a higher concentration of phosphorus than SSP.

4. Role of Phosphorus in Fertilizers:

- **Provides essential** nutrient for early growth and flowering.
- **Enhances** the quality of fruits and seeds.
- **Helps in energy** transfer in plants.
- **Improves plant** resistance to diseases.
- **Strengthens root** development for better nutrient and water absorption.

✦ **Summary:**

Phosphatic fertilizers are fertilizers that supply phosphorus to plants, essential for root development, flowering, seed

formation, and disease resistance. Diammonium phosphate (DAP) is a major phosphatic fertilizer, prepared by reacting ammonia with phosphoric acid, and contains both nitrogen and phosphorus nutrients. Phosphorus in fertilizers accelerates plant growth, improves yield, and strengthens plants.

🌟 Q. 5 (a) What are fertilizers? Why are they needed?

❖ **Definition:**

Fertilizers are substances added to soil or plants to supply essential nutrients required for growth and development. They are usually rich in elements like nitrogen (N), phosphorus (P), and potassium (K).

Need for Fertilizers:

1. Enhance Soil Fertility: Fertilizers replenish nutrients that are depleted due to repeated cultivation.

2. Promote Plant Growth: Provide essential nutrients required for stems, leaves, roots, flowers, and fruits.

3. Increase Crop Yield: Improve both the quantity and quality of crops.

4. Correct Nutrient Deficiency: Specific fertilizers supply specific nutrients (e.g., nitrogen for green leaves, phosphorus for flowering).

5. Support Modern Agriculture: Essential for meeting the food demands of a growing population.

✅ Fertilizers are essential to maintain soil fertility and to enhance plant growth and productivity.

🌟 (b) Classification of Fertilizers and Their Uses

Fertilizers are classified based on the nutrients they provide to the soil. The main types are:

1. Nitrogenous Fertilizers:

Provide: Nitrogen (N)

Importance: Required for early growth, development of leaves and stems, protein formation, and green color of plants.

Examples: Urea, Ammonium sulphate, Ammonium nitrate, Ammonium phosphate.

Uses: Increase growth, enhance yield, promote leafy vegetables.

2. Phosphatic Fertilizers:

Provide: Phosphorus (P)

Importance: Stimulates early growth, flowering, seed and fruit formation, and increases resistance to diseases.

Examples: Diammonium phosphate (DAP), Single super phosphate (SSP), Triple super phosphate (TSP).

Uses: Improves root development, flowering, and seed quality.

3. Potassium Fertilizers:

Provide: Potassium (K)

Importance: Formation of starch, sugar, and fibrous material; enhances disease resistance; strengthens roots.

Examples: Potassium chloride (KCl), Potassium nitrate (KNO_3)

Uses: Beneficial for tobacco, coffee, potato, corn, and fruit crops.

✦ **Summary of Uses:**

- **Nitrogen:** Leaf growth and green color.
- **Phosphorus:** Roots, flowers, seeds, disease resistance.
- **Potassium:** Fruits, starch formation, disease resistance, strong roots.

🌟 **(c) How is urea manufactured in Pakistan? Describe the process.**

Urea (NH_2CONH_2):

Definition: Urea is a high-quality, concentrated nitrogenous fertilizer containing about 46% nitrogen. It is the most widely used fertilizer in Pakistan.

Industrial Manufacture of Urea:

1. Preparation of Ammonia (NH_3):

- Ammonia is produced from natural gas (methane) and water through the Haber process.

2. Preparation of Carbon Dioxide (CO_2):

- CO_2 is obtained as a by-product from ammonia production or from lime kilns.

3. Formation of Ammonium Carbamate:

- Ammonia reacts with carbon dioxide in a 2:1 volume ratio in a reactor to form ammonium carbamate.

CO_2 + 2NH_3 → NH_2COONH_4

4. Conversion to Urea:

- Ammonium carbamate is dehydrated to produce urea and water:

$$NH_2COONH_4 \rightarrow NH_2CONH_2 + H_2O$$

5. Concentration:

- The urea solution is concentrated in evaporation units under vacuum to obtain 99.7% urea melt.

6. Prilling:

- Molten urea is sprayed in a prilling tower where air cooling solidifies the droplets into tiny beads called prills.
- Prills are easy to handle, transport, and apply on fields.

✦ **Summary of Urea Manufacturing Process:**

Ammonia + CO_2 ⟶ Ammonium carbamate ⟶ Urea + Water ⟶ Concentrated ⟶ Prilled Urea ✅

Importance of Urea in Pakistan:

- Most widely used nitrogenous fertilizer.
- Supports high crop yield.
- Helps in maintaining soil fertility and meeting agricultural demands.

✦ **Overall Summary:**

- Fertilizers are essential for supplying nutrients and increasing soil fertility.
- **Classification:** Nitrogenous (leaf growth), Phosphatic (roots and seeds), Potassium (fruit quality and disease resistance).
- **Urea:** A concentrated nitrogenous fertilizer, manufactured by reacting ammonia with CO_2, forming ammonium carbamate, then dehydrating and prilling.

Fertilizers, especially urea, are vital for agriculture in Pakistan. ✅

🌟 Q. 6 (a) What are the prospects of fertilizer industry in Pakistan?

Prospects of Fertilizer Industry in Pakistan:

1. Agricultural Country: Pakistan's economy heavily depends on agriculture, which needs fertilizers for high crop yields.

2. Increasing Demand: With growing population, the demand for food and hence fertilizers continues to rise.

3. Urea Fertilizer: Urea has gained high importance due to its concentrated nitrogen content and effectiveness in crop production.

4. Government Support: The government encourages the establishment of fertilizer plants to reduce import dependency.

5. Existing Industry: Currently, Pakistan has about 14 fertilizer plants in both private and public sectors producing different types of fertilizers.

6. Future Potential: Expansion in production and development of new fertilizers can make the country self-sufficient and support export opportunities.

✅ The fertilizer industry has a bright future in Pakistan due to growing agricultural needs and government initiatives.

🌟 **(b) What are essential nutrient elements and why are they needed for plant growth?**

❖ **Definition:**

Essential nutrient elements are those chemical elements that are necessary for the healthy growth and development of plants and cannot be substituted by other elements.

✦ **Types and Role:**

1. Macronutrients: Needed in large amounts

Nitrogen (N): Formation of proteins, leaves, chlorophyll; promotes vegetative growth.

Phosphorus (P): Root development, flowering, seed and fruit formation, disease resistance.

Potassium (K): Formation of starch, sugar, fibrous material; strengthens roots and stems; enhances disease resistance.

Calcium (Ca), Magnesium (Mg), Sulfur (S): Essential for enzyme activity, cell wall formation, and chlorophyll production.

2. Micronutrients: Needed in very small amounts (mg/kg)

Examples: Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Boron (B), Molybdenum (Mo)

Role: Act as cofactors in enzymes, aid chlorophyll synthesis, and regulate growth processes.

Importance:

Essential nutrient elements are needed to maintain soil fertility, ensure healthy growth, and maximize crop yield and quality.

🌟 (c) Essential Qualities of a Good Fertilizer

1. High Nutrient Content: Should contain sufficient quantity of essential nutrients.

2. Solubility: Nutrients must be soluble in water for easy absorption by plants.

3. Non-Toxic: Should not harm soil, plants, or microorganisms.

4. Easy to Handle and Store: Should have uniform size, low dust, and resistance to caking.

5. Economical: Cost-effective for farmers to use on large scale.

6. Stable: Should maintain its chemical composition during storage and transport.

7. Balanced Composition: Must provide nutrients in proper ratios for different crops.

✅ A good fertilizer ensures effective, safe, and economical supply of nutrients to crops.

✦ **Summary:**

Prospects: Fertilizer industry in Pakistan has a bright future due to agriculture reliance and growing demand.

Essential Nutrients: Macronutrients (N, P, K, Ca, Mg, S) and micronutrients (Fe, Zn, B, etc.) are vital for healthy plant growth.

Qualities of Good Fertilizer: High nutrient content, soluble, safe, stable, economical, and balanced. ✅

🌟 Q. 7 (a) Composition of a Good Portland Cement

A good sample of Portland cement contains the following essential compounds in approximate percentages:

Compound	Percentage (%)
Lime (CaO)	62
Silica (SiO_2)	22
Alumina (Al_2O_3)	7.5
Magnesia (MgO)	2.5

Iron oxide (Fe_2O_3)	2.5
Sulphur trioxide (SO_3)	1.5
Sodium oxide (Na_2O)	1.0
Potassium oxide (K_2O)	1.0

Explanation of Components:

Lime (CaO): Provides strength and hardness to cement.

Silica (SiO_2): Contributes to strength and controls setting time.

Alumina (Al_2O_3): Helps in the formation of cement clinker and reduces the burning temperature.

Magnesia (MgO): Provides durability.

Iron oxide (Fe_2O_3): Helps in the formation of clinker compounds.

SO_3, Na_2O, K_2O: Small quantities improve setting and workability.

✅ Essential constituents for good quality cement are lime, silica, and alumina.

🌟 (b) Wet Process for the Manufacture of Cement

❖ **Definition:**

The wet process involves grinding the raw materials in the presence of water to form a slurry, which is then heated in a rotary kiln to form clinker.

✦ **Steps of Wet Process:**

1. Crushing and Grinding:

- Soft raw materials like limestone and clay are crushed and ground into fine particles with water to form a slurry.

2. Mixing:

- **Limestone** slurry is mixed with clay paste in proper proportion (75% limestone, 25% clay).

- **Homogenized** slurry contains 35–45% water.

3. Heating in Rotary Kiln:

- Slurry is fed into a rotary kiln (8–15 feet diameter, 300–500 feet length) that rotates slowly.

Temperature zones in kiln:

- **Preheating zone (≈500°C):** Moisture is removed; clay decomposes.
- **Decomposition zone (≈900°C):** Limestone decomposes into $CaO + CO_2$.
- **Burning zone (≈1500°C):** Oxides combine to form clinker (calcium silicate, aluminate, ferrite).
- **Cooling zone (≈150–200°C):** Clinker cools down.

4. Clinker Formation:

- The solid product obtained is called cement clinker, greenish-black or grey balls.

5. Grinding with Gypsum:

- Clinkers are air-cooled.
- About 2% gypsum is added and ground into fine powder to control the setting time.
- Finished cement is stored in silos or packed in bags.

Flow Sheet Diagram of Wet Process:

Crushing & Grinding ⟶ Mixing (Slurry) ⟶ Rotary Kiln Heating ⟶ Clinker Formation ⟶ Grinding with Gypsum ⟶ Storage/Packaging

🌟 (c) Setting of Cement

❖ Definition:

Setting of cement is the process by which cement paste mixed with water hardens over time, forming a solid mass that gains strength.

✦ Reactions in the First 24 Hours:

1. Hydration of Tri-Calcium Aluminate ($3CaO \cdot Al_2O_3$):

Absorbs water to form a colloidal gel:

$3CaO \cdot Al_2O_3 + 6H_2O \longrightarrow 3CaO \cdot Al_2O_3 \cdot 6H_2O$

2. Reaction with Gypsum ($CaSO_4 \cdot 2H_2O$):

Forms calcium sulpho-aluminate crystals:

$3CaO \cdot Al_2O_3 + 3CaSO_4 \cdot 2H_2O \longrightarrow 3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot H_2O$

Importance:

- This **early** reaction prevents flash setting and ensures controlled hardening.
- **Provides** strength development in first few hours after mixing with water.

✦ **Summary:**

Composition: Portland cement mainly contains lime, silica, and alumina.

Wet Process: Involves grinding raw materials with water, rotary kiln heating, clinker formation, and grinding with gypsum.

Setting of Cement: Hardening occurs due to hydration of tri-calcium aluminate and reaction with gypsum forming interlocking crystals.

🌟 (Q.8): Essential Non-Woody Raw Materials in Pulp and Paper Production in Pakistan

❖ **Answer**

The non-woody raw materials are plant-based materials that do not come from trees but are used for making pulp and paper. These are important because Pakistan has abundant sources of these materials, making the paper industry feasible and cost-effective.

Essential Non-Woody Raw Materials:

1. Wheat Straw – Collected after harvesting wheat; used as a major source of cellulose.

2. Rice Straw – Abundant agricultural residue; provides fiber for paper pulp.

3. Bagasse – Fibrous residue left after extracting juice from sugarcane; rich in cellulose.

4. Bamboo – Fast-growing plant; used in pulp production for stronger paper.

5. Rags – Used cloth materials; provide high-quality cellulose fibers.

✦ **Summary:**

Non-woody raw materials like wheat straw, rice straw, bagasse, bamboo, and rags are essential for the pulp and paper industry in Pakistan because they are readily available, renewable, and rich in cellulose, which is required for paper production.

🌟 **Q. 9 (a) Principal Methods of Chemical Pulping**

Chemical pulping is used to separate cellulose fibers from lignin and other components in raw materials to produce pulp for paper. The three principal methods are:

1. Kraft Process (Alkaline Process)

- Uses sodium hydroxide (NaOH) and sodium sulfide (Na_2S) as cooking chemicals.
- Produces strong and durable paper pulp.

2. Sulphite Process (Acidic Process)

- Uses sulfurous acid (H_2SO_3) and its salts (calcium, sodium, magnesium, or ammonium).
- Produces pulp that is easier to bleach but weaker than kraft pulp.

3. Neutral Sulphite Semi-Chemical Process (NSSC)

- Uses **sodium sulphite** (Na_2SO_3) buffered with sodium carbonate (Na_2CO_3) or NaOH.
- **Combines chemical** and mechanical treatment.
- **Dominant method** in Pakistan due to good pulp strength and efficient chemical recovery.

🌟 Q. 9 (b) Neutral Sulphite Semi-Chemical Process (NSSC)

❖ **Answer:**

This is the most widely used method in Pakistan for producing paper pulp, especially from non-woody raw materials like wheat straw, rice straw, bagasse, cotton linter, and rags.

✦ Steps involved:

1. Cutting of Raw Materials

- Raw materials are cut into small pieces for easy processing.

2. Dry Cleaning

- Air is blown to remove dust, sand, and unwanted particles.

3. Wet Cleaning

- Remaining dirt and soluble impurities are removed by water.

4. Screening

- Oversized particles and metal pieces are removed using vibratory, centrifugal, or gravity screens.

5. Digestion

- Raw materials are cooked in a digester with sodium sulphite solution buffered with sodium carbonate or NaOH.

Temperature: 160–180°C, pH: 7–9.

Steam is applied, and the material is softened to separate fibers from lignin.

6. Blow Tank

- Cooked material is blown into a tank to separate uncooked residues.

7. Pulp Washing

- Pulp is washed with water to remove residual lignin and colored compounds.

8. Bleaching

- Pulp is whitened using chlorine, sodium hypochlorite, or hydrogen peroxide.
- Chlorination is done under controlled temperature and pressure to achieve desired brightness.

9. Stock Preparation Plant

- Pulp is dispersed in water to make slurry.
- Mechanical refining or beating improves fiber quality.
- Chemical additives and recycled fibers may be added.

10. Paper Making Machine

- Pulp is formed into sheets on Fourdrinier type machines, pressed, dried, calendered, and wound into reels.

✦ **Summary:**

- The neutral sulphite semi-chemical (NSSC) process is a combination of chemical and mechanical pulping, ideal for non-woody raw materials.
- It ensures strong pulp, good bleaching efficiency, and effective chemical recovery.

Main raw materials: wheat straw, rice straw, bagasse, cotton linter, rags.

Steps include cutting, cleaning, screening, digestion, washing, bleaching, stock preparation, and paper making.

🌟Q. 10 (a) Common Bleaching Agents and Bleaching Process

1. Common Bleaching Agents Used in Pakistan:

In the paper industry, bleaching is carried out to remove residual lignin from pulp and to achieve a bright white color suitable for printing and writing papers. The main bleaching agents are:

- Chlorine (Cl_2)
- Sodium hypochlorite (NaOCl)
- Hydrogen peroxide (H_2O_2)

2. Bleaching Process (Stepwise Description):

1. Initial Pulp:

The pulp obtained from the chemical pulping process is brown due to residual lignin.

2. Chlorination:

- **Pulp** is treated with **chlorine** at 45 bar pressure and about 45°C for 45–60 minutes.
- **Chlorine reacts** with lignin, breaking it down to soluble compounds.

3. Washing:

- After **chlorination**, pulp is washed with hot water to remove chlorine and soluble compounds.

- **Residual** chlorine is neutralized using water as an antichlor.

4. Additional Bleaching (Optional):

- Sodium hypochlorite or hydrogen peroxide may be used for further whitening and achieving the required brightness.

5. Final Pulp:

- The bleached pulp is now white and ready for paper production.

Note: Correct dosage of bleaching agents is essential to prevent over-bleaching, which can damage fibers.

🌟 Q. 10 (b) Prospects of Paper Industry in Pakistan

1. Historical Background:

- At independence in 1947, Pakistan had no paper industry and consumed ~25,000 tons/year, all imported.

2. Current Scenario:

- More than 30 pulp and paper industries are now operating in private and public sectors.
- **Raw materials** are mainly non-woody (wheat straw, bagasse, rice straw, rags, cotton linter) and some woody (poplar, eucalyptus).

3. Prospects:

- **High domestic** demand due to population growth and education expansion.
- **Efforts** are being made to increase self-sufficiency by utilizing available raw materials.
- **Potential** for export of paper and paper products in the future.
- **Government** and private sector support can expand production capacity.

✦ **Summary:**

Bleaching Agents: Chlorine, sodium hypochlorite, hydrogen peroxide.

Bleaching Purpose: Removal of residual lignin, whitening pulp, preparing paper for printing/writing.

Paper Industry in Pakistan: Growing sector with over 30 industries, high demand, potential for self-sufficiency and export.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.