

## Chapter#15

### Common Chemical Industries in Pakistan



#### 1. What are fertilizers?

**Ans:** Fertilizers are the substances added to the soil to make up the deficiency of essential elements like nitrogen, phosphorus and potassium (NPK) required for the proper growth of plants. Fertilizers enhance the natural fertility of the soil or replenish the chemical elements taken up from soil by the previous crops.

#### 2. Classify elements essential for plant growth.

**Ans:** Elements essential for the growth of plants are classified as:

- i. Micro-nutrients
- ii. Macro-nutrients

#### **Micro-nutrients (Trace elements):**

Elements required in very small amount for the growth of plants are considered as micro-nutrients. These include Boron, Copper, Iron, Manganese, Zinc, Molybdenum and Chloride. These are required in range from 6grams to 200grams per acre.

#### **Macro-nutrients:**

Elements required in large amount are considered as macro-nutrients. These include Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Carbon, Hydrogen and Oxygen. These are required in range from 5kg to 200kg per acre.

#### 3. What are micro-nutrients?

**Ans:** The nutrients which are required in a very small amount for the growth of plant are called micro-nutrients. These include Boron, Copper, Iron, Manganese, Zinc, Molybdenum and Chlorine. Only minute amounts of these elements are needed for healthy plant growth and it may be dangerous to add too much quantity because they are poisonous in larger quantities. These are generally required in quantities ranging from 6 grams to 200 grams per acre.

#### 4. What are macro-nutrients?

**Ans:** The nutrients which are required in a large amount for the growth of plants are called macro-nutrients. These include Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Carbon, Hydrogen and Oxygen. These are generally required in quantities ranging from 5 kg to 200 kg per acre.

#### 5. What is meant by the requirement of a fertilizer?

**Ans:** Every compound of the desired elements cannot be a fertilizer. The desired elements should be present in the compound in a water soluble form (so that the plant can take it up) readily available to the plants. The compound employed as fertilizer should be stable in soil as well as in storage e.g., it should not be deliquescent or set to hard stony materials with time. Above all it should be cheap to manufacture.

**6. What are the essential qualities of a good fertilizer?**

**Ans:** The essential requisites of a good fertilizer are:

1. The nutrient elements present in it must be readily available to the plant.
2. It must be fairly soluble in water so that it thoroughly mixes with the soil.
3. It should not be injurious to plant.
4. It should be cheap.
5. It must be stable so that it is available for a longer time to the growing plant.
6. It should not alter the pH of the soil.
7. By rain or water, it should be converted into a form, which the plant can assimilate easily.

**7. Mention any four essential qualities of a good fertilizer.**

**Ans:** The essential requisites of a good fertilizer are:

1. The nutrient elements present in it must be readily available to the plant.
2. It must be fairly soluble in water so that it thoroughly mixes with the soil.
3. It should not be injurious to plant.
4. It should be cheap.

**8. Mention the classification of fertilizers.**

**Ans:** The fertilizers are classified as:

- a. Nitrogenous fertilizers
- b. Phosphatic fertilizers
- c. Potassium fertilizers

**9. What is the importance of nitrogen in plant growth?**

**Ans:** Nitrogen is required during the early stage of plant growth for the development of stems and leaves. It is the main constituent of protein, imparts green colour to the leaves and enhances the yield and quality of the plants.

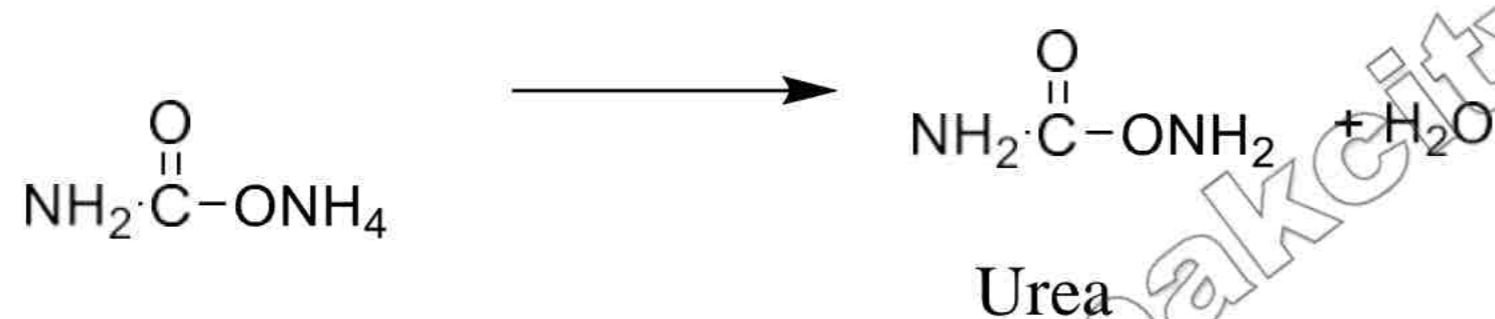
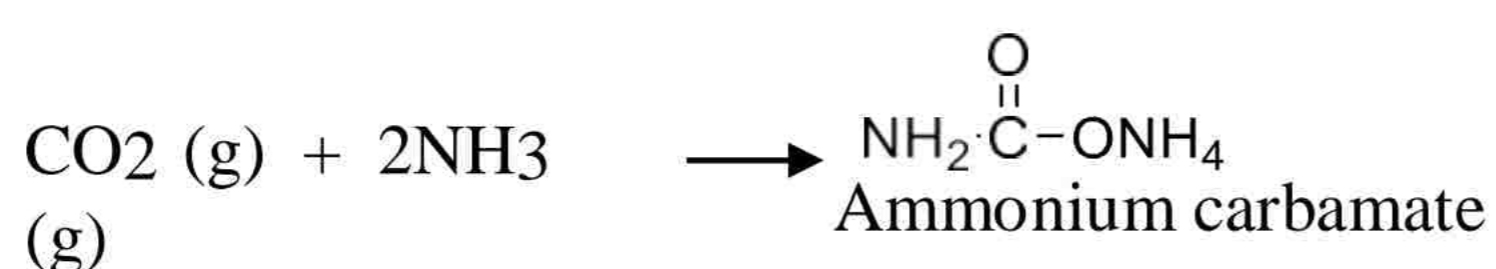
**10. Mention the steps involved in the manufacturing of urea.**

**Ans:** Following are the steps involved in the manufacturing of urea:

- i. Preparation of hydrogen and carbon dioxide
- ii. Preparation of ammonia
- iii. Preparation of ammonium carbamate
- iv. Preparation of urea
- v. Concentration of urea
- vi. Prilling

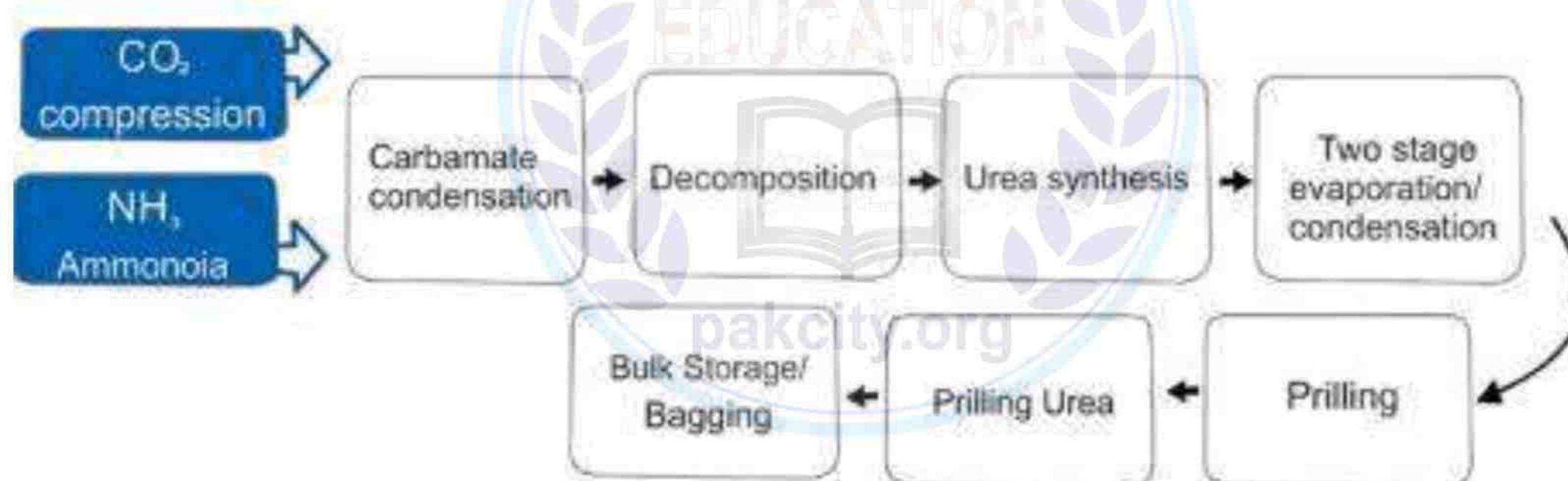
**11. Which reactions are involved in the manufacturing of urea?**

**Ans:** Following reactions are involved in the manufacturing of urea:



**12. Draw flow sheet diagram for the manufacture of urea.**

**Ans:**



**13. Mention the chemical reaction involved in the manufacturing of ammonium nitrate.**

**Ans:** It is manufactured by the neutralization reaction between ammonia and nitric acid as given below.



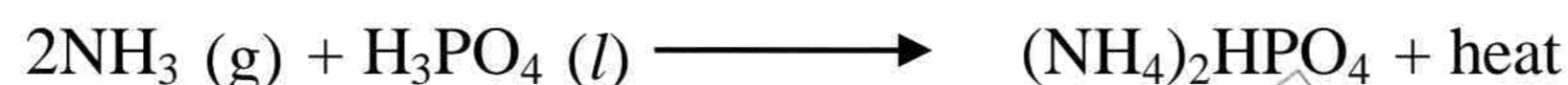
After neutralization, the water is evaporated. The solid ammonium nitrate is melted and then sprayed down from a tall tower. The falling droplets are dried by an upward current of air. The fertilizer solidifies as tiny, hard pellets called prills. Prills of fertilizers are free of dust, easy to handle and easy to spread on the field. Ammonium nitrate contains 33-33.5% nitrogen.

**14. What is the role of phosphorus in plant growth?**

**Ans:** Phosphorus is required to stimulate early growth to accelerate the seed and fruit formation during the later stages of growth. It also increases resistance to diseases.

**15. Mention the chemical reaction for the preparation of diammonium phosphate.**

**Ans:** This compound of fairly high purity is prepared by continuous process that consists of reacting anhydrous ammonia gas and pure phosphoric acid at 60 - 70 °C and pH 5.8 - 6.0.



It is an exothermic reaction. The heat of reaction vaporizes water from the liquor and the crystals of diammonium phosphate are taken out, centrifuged, washed and dried. It contains 16% nitrogen and 48% P<sub>2</sub>O<sub>5</sub>. This product contains about 75% plant nutrients and is deemed suitable for use either alone or in mixed with other fertilizers.

**16. What is the role of potassium in plant growth?**

**Ans:** Potassium is required for the formation of starch, sugar and the fibrous material of the plant. They increase resistance to diseases and make the plants strong by helping in healthy root development. They also help in ripening of seeds, fruits and cereals. Potassium fertilizers are especially useful for tobacco, coffee, potato and corn.

**17. Mention the chemical reaction involved in the manufacturing of potassium nitrate.**

**Ans:** On industrial scale it is prepared by the double decomposition reaction between sodium nitrate and potassium chloride.



A concentrated hot solution of sodium nitrate is prepared and solid potassium chloride is added into it. On heating, the potassium chloride crystals change into sodium chloride crystals, and the hot potassium nitrate is run through the sodium chloride crystals at the bottom of the kettle. A little water is added to prevent further deposition of sodium chloride as the solution is cooled, which results into a good yield of pale yellow solid potassium nitrate. It contains 13% nitrogen and 44% potash.

**18. What is meant by prilling of urea?**

**Ans:** The molten urea is sprayed at the prilling tower by means of prilling bucket where it is cooled by the air rising upward. Molten droplets solidify into the form of prills.

**19. Give preparation of Portland cement as carried out by Joseph Aspdin. Why it is named so?**

**Ans:** Cement is a very important building material which was first introduced by an English Mason Joseph Aspdin. He found it when strongly heated mixture of limestone and clay was mixed with water and allowed to stand, it hardened to a stone like mass which resembled Portland rock; a famous building stone of England. Since then the name of Portland Cement is given to the mixture of lime (obtained from limestone), silica, iron oxide and alumina.

**20. Define cement.**

**Ans:** Cement is the material obtained by burning an intimate mixture of calcareous and argillaceous materials at sufficiently high temperature to produce clinkers. These clinkers are then ground to a fine powder. The essential constituents are lime (obtained from limestone) silica and alumina (present in clay).

**21. Which raw materials are used for the manufacturing of cement?**

**Ans:** The important raw materials used for the manufacturing of cement are:

1. Calcareous material (limestone, marble, chalks, marine shell) as source of CaO.
2. Argillaceous material (clay, shale, slate, blast furnace slag) They provide acidic components such as aluminates and silicates.
3. Other raw material being used is gypsum.

**22. Give percentage composition of cement/Give percentage composition of Portland cement.**

**Ans:** Following is the percentage composition of cement:

Compound	%age
Lime (CaO)	62
Silica (SiO <sub>2</sub> )	22
Alumina (Al <sub>2</sub> O <sub>3</sub> )	7.5
Magnesia (MgO)	2.5
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> )	2.5
Sulphur trioxide (SO <sub>3</sub> )	1.5
Sodium oxide (Na <sub>2</sub> O)	1.0
Potassium oxide (K <sub>2</sub> O)	1.0

**23. Which factors decide about the manufacturing process of cement?**

**Ans:** The choice of dry or wet process depends on the following factors:

1. Physical condition of the raw materials.
2. Local climatic conditions of the factory.
3. The price of the fuel.

**24. Enlist the steps involved in wet process.**

**Ans:** In this process grinding is done in the presence of water. There are five stages in the manufacture of Portland cement:

1. Crushing and grinding of the raw material.
2. Mixing the material in correct proportion.
3. Heating the prepared mixture in a rotary kiln.
4. Grinding the heated product known as clinker.
5. Mixing and grinding of cement clinker with gypsum.

**25. Give different zones in the rotary kiln and their temperature ranges.**

**Ans:** There four different zones:

**(a) Drying or Pre-heating Zone (Minimum temperature zone):** In this zone the temperature is kept at 500°C, whereby the moisture is removed and the clay is broken into Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, and Fe<sub>2</sub>O<sub>3</sub>.

**(b) Decomposition Zone (Moderate temperature zone):** Here the temperature goes up to 900°C In this zone the limestone (CaCO<sub>3</sub>) decomposes into lime (CaO) and CO<sub>2</sub>



**(c) Burning Zone (Maximum temperature zone):** In this zone, the temperature goes up to 1500°C and the oxides, e.g. CaO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> combine together and form calcium silicate, calcium aluminate and calcium ferrite.

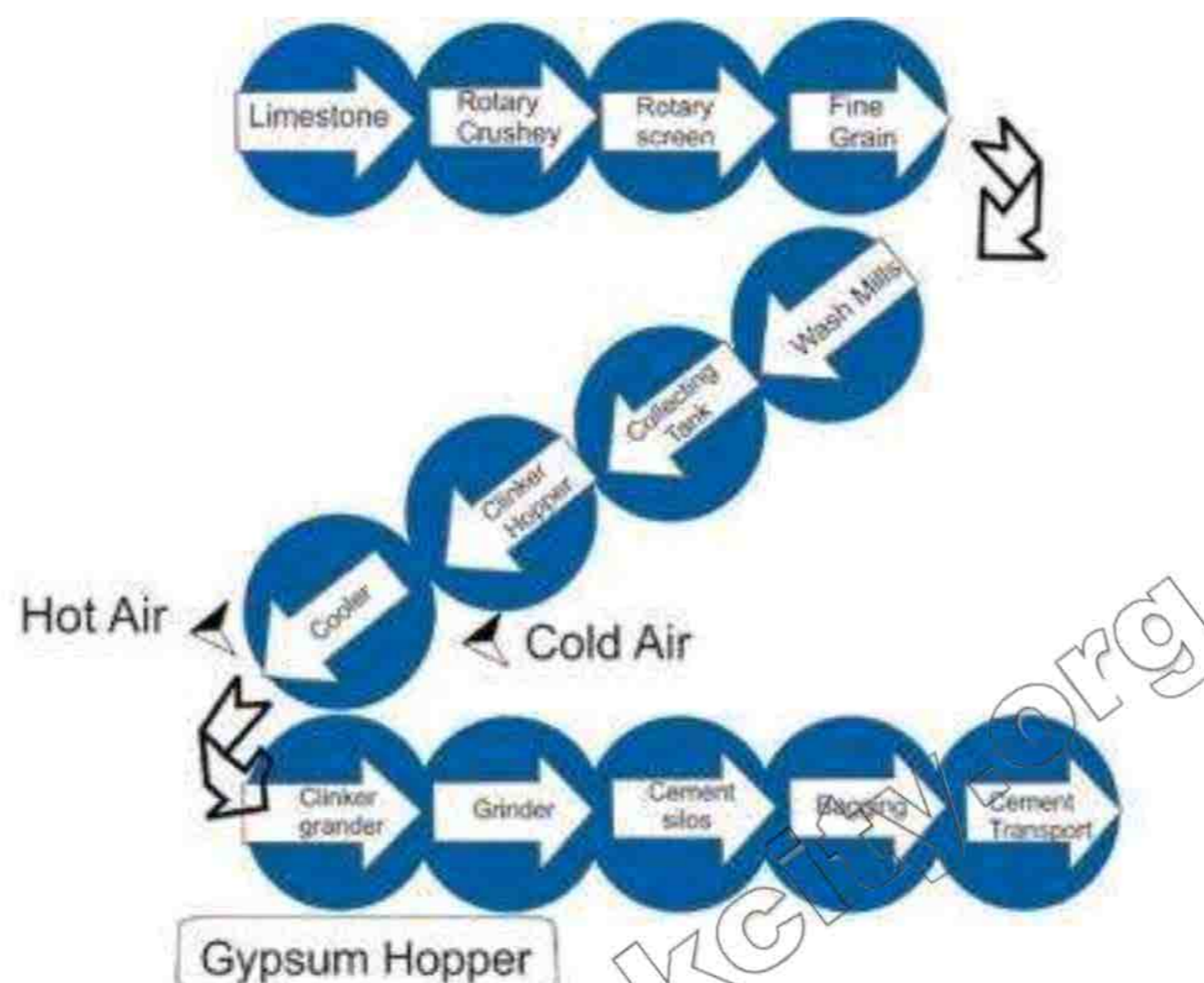
**(d) Cooling Zone:** This is the last stage in the kiln where the charge is cooled up to 150-200°C.

**26. What is clinker formation?**

**Ans:** The resulting product obtained from the kiln is known as cement clinker. This has the appearance of greenish black or grey colored balls varying in size from small nuts to peas.

**27. Draw flow sheet diagram for the manufacturing of cement by wet process.**

**Ans:**



**28. What is meant by setting of cement? Mention the reactions involved in setting of cement.**

**Ans:** When cement is mixed with water it sets to a hard mass when allowed to stand for some time. This is called setting of cement.

The reactions involved in the setting of cement are described as follows:

**(i) Reactions Taking Place in First 24 Hours.**

A short time after the cement is mixed with water, tri-calcium aluminate absorbs water (hydration) and forms a colloidal gel of the composition,  $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$ , (hydrated tricalcium aluminate). This gel starts crystallizing slowly, reacts with gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) to form the crystals of calcium sulfo-aluminate ( $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ).

**(ii) Reactions Taking Place Between 1 to 7 Days**

Tricalcium silicate ( $3\text{CaO} \cdot \text{SiO}_2$ ) and tri-calcium aluminate ( $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ ) get hydrolyzed to produce calcium hydroxide and aluminium hydroxide. The calcium hydroxide, thus formed, starts changing into needle-shaped crystals, which get studded in the colloidal gel and impart strength to it. Aluminium hydroxide, on the other hand,

fills the interstices resulting in hardening the mass. The gel formed starts losing water partly by evaporation and sets to a hard mass.

**29. Define paper.**

**Ans:** Paper is defined in term of its method of production that is a sheet material made up of a network of natural cellulosic fibres which have been deposited from an aqueous suspension. The product obtained is a network of intertwining fibres.

**30. Mention non-woody raw materials used in paper industry.**

**Ans:** Names of the non-woody materials are:

- i. Wheat straw
- ii. Cotton stalk
- iii. Rice straw
- iv. Cotton linter
- v. Bagasse
- vi. Kahi grass
- vii. Bamboo
- viii. Grasses
- ix. Rag

**31. Mention woody raw materials used in paper industry.**

**Ans:** Names of the woody materials are:

- (i) Poplar (hard wood)
- (ii) Eucalyptus (hard wood)
- (iii) Douglas fir (soft wood)

**32. Write down two woody and two non-woody raw materials for paper pulp manufacture.**



**Ans:** Woody Raw materials

- (i) Poplar
- (ii) Eucalyptus (hard wood)

Non-Woody Raw materials

- (i) Wheat straw
- (ii) Bagasse

**33. What is meant by NSSC? Why it is commonly used in Pakistan?**

**Ans:** The term NSSC stands for neutral sulphite semi chemical process. The neutral sulphite semi chemical process has come to occupy the dominant position because of the advantages in chemical recovery and pulp strength.

**34. Briefly describe process of neutral sulphite semi chemical process.**

**Ans:** The process utilizes sodium sulphite cooking liquor which is buffered with sodium carbonate or NaOH to neutralize the organic acid liberated from the raw materials.

**35. Mention the steps involved in neutral sulphite semi chemical process.**

**Ans:** The steps involved in neutral sulphite semi chemical process are:

- i. Cutting of the raw materials
- ii. Dry cleaning
- iii. Wet cleaning
- iv. Screening
- v. Digestion
- vi. Blow tank
- vii. Pulp washing
- viii. Bleaching
- ix. Paper making machine
- x. Stock preparation plant

**36. Write down digestion process for the preparation of pulp.**

**Ans:** As the raw material enters into the digester, steam is introduced at the bottom and a liquor containing sodium sulphite is injected simultaneously to cover the raw material. Sodium sulphite used is buffered with sodium carbonate or sodium hydroxide to maintain its pH 7-9. The digester is closed carefully. It is revolved at 2.5 RPM and a temperature of 160- 180°C is maintained. The digester takes 45 minutes to attain the desired temperature after which it gets switched off automatically and pressure is released.

**37. Why lignin is removed from pulp?**

**Ans:** Lignin is an aromatic polymer and causes paper to become brittle. That is why it is removed from pulp.

**38. What are the common bleaching agents used in paper industry in Pakistan?**

**Ans:** In Pakistan, bleaching is done with chlorine or sodium hypochlorite and hydrogen peroxide.

**39. Mention the parts of paper making machine.**

**Ans:** Following are the parts of paper making machine:

- (a) Flow Spreader
- (b) Head Box
- (c) Fourdrinier Table
- (d) Press Section
- (e) Dryer Section
- (f) Calendar Stock
- (g) Reel

