



**POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY**  
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**DEPARTMENT OF CHEMISTRY**  
**ENGINEERING CHEMISTRY - I**

**UNIT V**

**ENGINEERING MATERIALS**

***PART A***

**1. What is the objective of refractory?**

The main objective of a refractory is to resist heat losses. The refractories also resist the abrasive and corrosion action on the molten metals, slags and gases at higher temperatures without softening or deformation in shape.

**2. Write any two uses of refractories.**

- ❖ Construction of the lining of the furnaces, tanks, kilns, converters, crucibles, ladles etc.,
- ❖ Refractories are also employed for the manufacture of cement, glass, ceramics, paper, metals etc

**3. What are refractories?**

Refractories are any inorganic materials which can withstand high temperature without softening, melting or deformation in shape.

**4. How refractories are classified? Give example.**

Refractories are classified into three types

- ❖ Acidic refractory – fire clay, alumina
- ❖ Basic refractory – dolomite, magnesite
- ❖ Neutral refractory – zirconia, graphite

**5. Name the stages in the manufacture of refractory.**

Grinding → mixing → moulding → drying → firing

**6. What is meant by pyrometric cone equivalent (PCE) of a refractory?**

Pyrometric cone equivalent is the number, which represents the softening temperature of a refractory specimen of standard dimension and composition.

**7. What are the important uses of refractories?**

- ❖ Construction of the lining of the furnaces, tanks, converters, kilns, crucibles, ladles etc.,
- ❖ Manufacture of cement, glass, ceramics, paper, metals (both ferrous and non ferrous) etc.,

**8. Mention the objectives of PCE test.**

- ❖ To determine the softening temperature of attest refractory material
- ❖ To classify the refractories
- ❖ To determine the purity of refractories
- ❖ To check whether the refractory can be used at the particular servicing temperature.

**9. Define porosity of a refractory.**

It is defined as the ratio of its pore volume to the bulk volume. thus,

$$\text{Porosity (P)} = \frac{W-D}{W-A} * 100$$

**10. What is meant by dimensional stability? Mention their types.**

It is the resistance of a refractory to any volume changes, when exposed to high temperature over a prolonged time. These dimensional changes are of two types

- ❖ Reversible
- ❖ Irreversible

**11. What is meant by thermal spalling? How to avoid it?**

Thermal spalling is the property of breaking, cracking or peeling off a refractory material under high temperature.

Thermal spalling can be decreased by

- ❖ Using high porosity, low coefficient of expansion and good thermal conductivity refractory
- ❖ Avoiding sudden temperature changes
- ❖ By modifying the furnace design

**12. What are abrasives? How are they classified?**

Abrasives are hard substances used for polishing, shaping, grinding operations. They are characterized by high melting point, high hardness and chemically inactive.

- ❖ Natural abrasive - diamond, quartz
- ❖ Artificial abrasive – silicon carbide, boron carbide

**13. What are neutral refractories? Give one example.**

Neutral refractories are made from weakly acidic and basic materials like Carbon, Chromite, Zirconia, etc. They are not attacked by both acidic and basic materials.

**Examples:** Graphite, chromite, Zirconia, Carborundum refractories.

**14. Define the term flash point .**

It is the lowest temperatures at which the oil gives off enough vapour that ignites for a moment when a small flame is brought near it.

**15. Define the term fire point.**

It is the lowest temperature at which the vapour of the oil burns continuously for at least 5 seconds when a small flame brought near to it. Generally the fire point is 5-40°C higher than flash point.

**16. Why is graphite used as a lubricant whereas other allotropes of carbon are not?**

Because of the structure of graphite, it has layered structure with easy sliding of the layers over each other with a very low coefficient of friction resulting in effective lubricating action.

**17. Mention any four natural abrasives.**

- ❖ Corundum
- ❖ Quartz
- ❖ Garnets
- ❖ Diamond

**18. How are lubricants classified? Give one example for each class.**

Lubricants are classified on the basis of their physical state as follows.

❖ **Liquid lubricants:**

- Vegetable oil – (e.g) : Palm oil, castor oil, etc.
- Animal oils – (e.g) : Whale oil.

- ❖ **Semi-solid lubricants:** Greases, Vaseline, etc.
- ❖ **Solid lubricants:** Graphite, molybdenum-disulphide, etc.
- ❖ **Emulsions:**
  - Oil in water type – (e.g): Cutting emulsions.
  - Water in oil type – (e.g): Cooling liquids.

**19. What is meant by refractoriness of refractories?**

It is the ability of a material to withstand very high temperature without softening or deformation under particular service condition.

**20. Define cloud point .**

When oil is cooled slowly, the temperature at which the oil becomes cloudy in appearance is called its cloud point.

**21. Define pour point.**

The temperature at which the oil ceases to flow or pour is called its pour point.

**22. Distinguish between acidic and basic refractories.**

**Acidic Refractories:** Acidic refractories consist of acidic materials like alumina ( $\text{Al}_2\text{O}_3$ ) and silica ( $\text{SiO}_2$ ). They are not attacked by acidic materials, but easily attacked by basic materials.

**Examples:** Silica, Alumina, Fire clay refractories.

**Basic Refractories:** Basic refractories consist of basic materials like CaO, MgO, etc. They are not attacked by basic materials, but are easily attacked by acidic materials.

**Examples:** Magnesite, Dolomite refractories.

**23. How to synthesis carbon nanotubes by pyrolysis?**

Carbon nanotubes are synthesized by the pyrolysis of hydrocarbons such as acetylene at about  $700^\circ\text{C}$  in the presence of Fe-silica or Fe-graphite catalyst under inert conditions.

**24. Give any two applications of carbon nanotubes.**

***Drug delivery vessels:***

CNTs can be effectively used inside the body for drug delivery by placing the drugs within the tubes.

***Used in Microscope:***

CNTs attached to the tips of scanning probe microscope have been used to image biological and industrial specimens.

## **25. Explain RUL test.**

RUL test is conducted by applying a constant load of 3.5 or 1.75 kg/cm<sup>2</sup> to the test refractory specimen of size base 5cm<sup>2</sup> and height 75 cm and heating in a furnace at a standard rate of 10°C per minute.

A good refractory should have high RUL value.

## **26. Write notes on basic refractories.**

Basic refractories consist of basic materials like CaO, MgO, etc. They are not attacked by basic materials, but are easily attacked by acidic materials.

**Examples:** Magnesite, Dolomite refractories

## **27. What are carbon nanotubes?**

Carbon nanotubes are allotropes of carbon with a nanostructure having a length-to-diameter ratio greater than 1,00,000.

## **28. How to Manufacture Zirconium bricks?**

They are prepared by mixing zirconite mineral (ZrO<sub>2</sub>) with colloidal zirconia or alumina as binder and finally heated to 1700°C. Small amount of MgO or CaO is added a stabilizer because mineral zirconite undergoes volume changes on heating and cooling

## **29. What are types of carbon nano tubes?**

1. Single- walled nanotubes (SWNTs)
2. Multi-walled nanotubes (MWNTs)

## **30. What is a soft abrasive?**

Abrasives, having their hardness 1-4 in Moh's a scale, are known as soft abrasives.

## **31. What is abrasives power?**

It is the strength of an abrasive to grind away another material. It depends on hardness, toughness and refractoriness.

## **32. Mention some important applications of abrasives.**

- ❖ To clean the surface prior to coating abrasive powders are used Ex: uartz, garnet.
- ❖ To prepare smooth wood, metal and plastic surfaces, abrasives paper is used Ex: alumina, SiC
- ❖ To remove the scales from iron surfaces, grinding wheels are used.

**33. Mention some important characteristics of abrasives.**

- ❖ It should be very hard
- ❖ It should resist the abrading action
- ❖ It should be chemically inactive
- ❖ It should possess high refractoriness
- ❖ It should have high melting point

**34. What is emery?**

It is a fine grained, opaque, and black in color. It consists of 55 – 75 % crystalline alumina, 20-40 % magnetite and 12% other minerals. Its hardness is 8 on Moh's scale.

**35. What are the types of lubrication?**

- ❖ Fluid film / hydrodynamic lubrication
- ❖ Boundary lubrication
- ❖ Extreme pressure lubrication

**36. What are greases? How they are prepared?**

Greases are semi solid lubricants, obtained by thickening of lubricating oil by the addition of metallic soap.

**37. Define viscosity index.**

Viscosity index is defined as the average decrease in viscosity of an oil per degree rise in temperature between 100 °F and 200 °F.

**38. What is softening temperature?**

The minimum temperature at which a solid begins to soften and lose its shape and size is known as softening temperatures.

**39. What are the methods employed to produce carbon nanotubes?**

- ❖ Laser evaporation method
- ❖ Carbon arc method
- ❖ Chemical vapour deposition method

**40. Give two examples of synthetic lubrication oils.**

Silicones, polyglycol ethers, fluolubes

## ***PART –B***

1. What are the characteristics of a good refractory? Name the stages in the manufacture of a refractory.
2. How are refractories classified? Explain with examples.
3. Classify the refractories based on their chemical composition. Write about the manufacture of fire clay brick.
4. Discuss the preparation properties & uses of high alumina & zirconia bricks.
5. Bring out a detailed discussion on magnesite bricks.
6. Explain thermal spalling & porosity of refractories.
7. Discuss in detail about any three properties of refractories
8. Write note on PCE test (OR) what is meant by refractoriness of refractories. How is it determined.
9. Discuss RUL strength
10. Write a brief note on dimensional stability.
11. What are the different types of abrasives. Describe a process of manufacture of carborundum. Mention its uses.
12. How are artificial abrasives prepared? Explain the different types of abrasives.
13. How are abrasives manufactured? Mention their uses.
14. Write a note on natural abrasives.
15. How is silicon carbide manufactured? Give its important properties & uses.
16. How is boron carbide prepared?
17. What are the applications of abrasives?
18. What are garnets and carborundum? Give the properties of carborundum.
19. How are lubricants classified? Explain with examples.
20. Discuss the importance of viscosity, flash point in selecting lubricating oil for a particular use.
21. Write notes on flash & fire point of a lubricant.
22. Explain cloud and pour point. Give their significance.
23. Name any four additives for lubricating oils. Indicate their functions.
24. Give an account of the important properties of lubricating oil.
25. Compare the structure of graphite & molybdenum disulphide and their uses. (or) Write a note on solid lubricants.
26. Write a note on semisolid lubricant (or) Write a note on greases.
27. What are carbon nano tubes? Explain two types of nanotubes.
28. Explain the structure of CNTs.
29. How is carbon nanotube synthesized?
30. Give an account of properties & applications of CNT.
31. Write notes on the following with examples i) the role of CNT in catalyst ii) CNT in storage devices.
32. How are solid lubricants produced? Mention its advantages and uses.
33. What are carbon nanotubes? Explain its method of production and its applications.