Notes

36

BUILDING MATERIALS

In the first four lessons of this module you have learnt about petrochemicals and the synthetic organic chemicals that are derived from petroleum feedstock. In this lesson you will learn about materials produced in industry that are primarily inorganic in nature and are building materials.

Every creature needs a safe place to live in – be it a cave, a burrow or a nest and so on. The prehistoric man took shelter in caves to save himself from the beasts and the fury of nature. Since then different natural resources have been exploited, in native as well as in the modified forms, along with the synthetic materials to make living more comfortable. Today a large number of materials like, cement, steel, glass, ceramics, stone, timber, paints and varnishes etc. are used for making buildings and other structures that are strong, durable and safe. Chemistry has an important role in the development of these materials, their mode of action and newer applications. In this lesson you will learn about some of the building (or construction) materials in terms of their composition, preparation and applications.

Objectives

After reading this lesson you will be able to:

- define cement;
- list the raw materials used for the manufacture of Portland cement;
- discuss the process of setting of cement;
- describe different types of special cements and their applications;
- describe and differentiate between mortar, concrete and R.C.C;
- define glass;
- list the raw materials used for the manufacture of glass and outline their importance;
- describe the process of manufacture of glass;
- discuss general properties of glass;

- describe different types of glass and their uses;
- define the term, 'Ceramics';
- list different types of clay products and
- describe and distinguish between different types of clay products.

36.1 Cement

The word cement means 'to cohere or unite'. Cement can be identified as an inorganic material which when mixed with water gradually sets to give a hard mass. This is used to join (or cement) together bricks, stones, etc. to create different structures. Cement is in use since antiquity. The Egyptian pyramids and many of the ancient Greek structures were constructed by using some kind of cementing material.

There are different types of cements like, natural cement, Puzzolana cement, slag cement and Portland cement, etc. These differ in their composition, mode of preparation and applications. We shall discuss about the Portland cement which is currently the most commonly used cement in the construction works. In India manufacture of Portland cement started about a hundred years ago (1904) by South India Industries Ltd.. Today, Indian cement industry manufactures over 100 million tonnes of cement per year.

36.1.1 Manufacture of Portland Cement

Portland cement was invented in 1824 by calcinating (or burning) argillaceous limestone (limestone containing 20-40 % of clay). It was called as Portland cement because the concrete (a mixture of cement and gravel or sand) obtained from it resembled the building stone from Isle of Portland in England. Today many types of Portland cement with different compositions are available for different applications.

(a) Raw Materials : a number of raw materials are required for the manufacture of Portland cement. These can be broadly put into two categories :

(i) Calcareous (rich in calcium) material : like lime stone ($CaCO_3$), chalk etc. are the principal constituent of cement and need to be used in appropriate amounts. The excess of lime or its deficiency, both reduce the strength of the cement.

(ii) Argillaceous material : These are rich in silica and alumina for example, clay (a mixture of Al_2O_3, and SiO_2) , shale, slate or volcanic material etc. These impart strength to the cement and affect the setting properties of the cement.

In addition to the above, powdered coal or fuel oil and gypsum ($CaSO_4.2H_2O$) are also used in the manufacture of cement. Addition of gypsum controls the setting time of the cement. The amount of gypsum has to be carefully controlled because if it is present in more than required amounts it causes cracks.

(b) Manufacturing process : To prepare cement the raw materials are mixed in appropriate amounts, crushed to powder and then calcinated (burned or fired) There are two types of manufacturing processes **wet process** and **dry process** depending

on whether the mixing and grinding of raw materials is done in wet or in dry conditions.

(i) Wet process : in this method the raw materials are treated with water (about 35-40 % by mass) and then powdered in ball mills. These raw materials can be treated individually or in the form of a mixture. The paste like material so obtained is then sieved and powdered further if necessary. This is then passed through a rotary kiln (Fig. 36.1) for calcination.

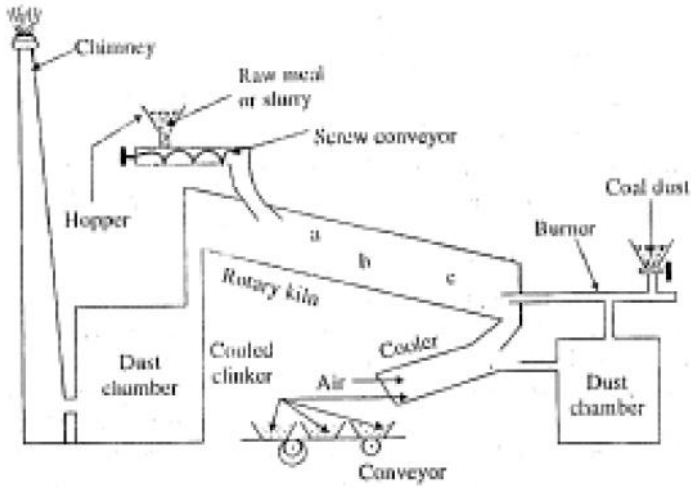


Fig. 36.1 : *Rotary kiln used in the manufacture of cement.*

The furnace consists of a slightly inclined long pipe that revolves slowly around its own axis. The mixture paste is fed into the long pipe through a hopper installed at the top of the pipe. As it moves down it meets the hot gases going upwards. In the high temperature of the kiln, the raw materials undergo a number of chemical reactions to form many new compounds. The mixture comes out of the kiln in the form of small greenish black or grey coloured hard balls known as **clinkers** which falls into a second pipe called cooler. These clinkers are then allowed to cool and powdered. To this powder a small amount (2-3%) of gypsum is added and powdered again to obtain cement.

(ii) Dry method: in this method the raw materials are mixed and powdered in ball mills. This is then placed into rotating panniers whose walls are fitted with water sprays. In the panniers the centrifugal force keeps the material in contact with the wall where it gets somewhat wet and takes the shape of small spheres. These are then passed through the rotary kiln as described above.

(c) Composition of cement

The Portland cement contains calcium aluminum silicates. It contains more than one compound. The approximate percentage of different elements present in Portland cement are expressed as their oxides (Table 36.1).

Table 36.1 : **Approximate percentage composition of Portland cement**

Oxide	Approximate percentage	Average percentage
CaO	60-67	64
SiO_2	17-25	22.5
Al_2O_3	3-8	6.5
Fe_2O_3	0.5-6.0	2.0
MgO	0.1-4.0	2.0
SO_3	1.0-3.0	1.5
K_2O, Na_2O	0.4-1.3	–

The first four of the oxides listed above, provide the basic compounds while the rest are referred to as secondary compounds. The oxides listed above do not exist as such. CaO and MgO absorb moisture and CO_2 from the atmosphere to give hydroxides and carbonates. Chemistry of Portland cement has been well understood. It contains different compounds which are known as **Bogue's compounds**. They are so named because they were identified by R.H.Bogue. The Bogue's compounds, their chemical formulae, and abbreviations and typical percentages are given in Table 36.2.

Table 36.2: Bogue's compounds in Portland cement

Name of the compound	Chemical formula*	Abbreviation	Typical percentage
Tricalcium Silicate	3 CaO SiO_2	C_3S	54.1
Dicalcium Silicate	2 CaO SiO_2	C_2S	16.6
Tricalcium Aluminate	3 CaO Al_2O_3	C_3A	10.8
Tetracalcium Aluminoferrate	4CaO.Al_2O_3 Fe_2O_3	C_4AF	9.1

70-80 % of cement is C_2S and C_3S.

In addition to the four compounds listed in Table 36.2, a number of some other compounds have been discovered in Portland cement but these four compounds are the most important. The amount of these compounds in a sample of cement can vary and determine the properties. of cement.

36.1.2 Setting and Hardening of Cement

In contact with water cement sets to a hard mass and this phenomenon is called setting of cement. The setting and hardening of cement is a process that takes a long time. A number of theories have been proposed for the setting of cement and there is a general agreement that it involves two important processes. These are **hydration** and **crystallisation**. Hydration is the initial stage when water is mixed with cement. It is followed by crystallization of different compounds.

The mixture of cement and water forms a **'cement paste'**. In this paste the constituents of cement get hydrated and form gel and crystalline products. Since the solubility of these

products in water is low, they cause the paste to get stiffened. (harden) This initial stiffening of the paste is called **setting of the cement.** The setting process is complete in about 25 hours. The paste then continues to harden over a long period of time. This process is called hardening and involves further gel formation and gradual crystallisation of the products of hydration. The process of **hardening** is almost complete in about a year, however this process continues for over a decade. The two processes are shown diagrammatically in Fig 36.2.

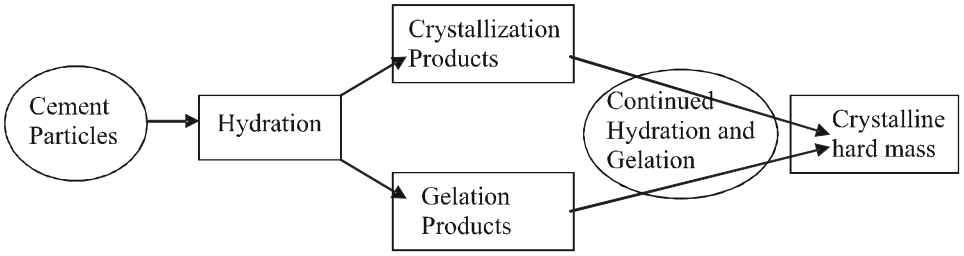


Fig 36.2 : *Setting of Cement*

Different compounds listed in Table 36.2 have different characteristic like rates of hydration, setting time and strength. These 'set' in different time span and contribute to the development of strength of the cement over a long period of time. In terms of chemistry, the first reaction of cement with water is as follows

$$C_3A + 6\,H_2O \longrightarrow C_3A\cdot 6H_2O$$

This reaction proceeds with the evolution of heat. After a few hours of contact with water, the following reaction starts

$$C_3S + H_2O \longrightarrow C_2S + C.\,H_2O$$

These processes cause the initial setting of the cement. In the second stage, i.e., hardening of cement involves the following reactions.

$$C_3A\cdot 6H_2O + C.\,H_2O + 6\,H_2O \longrightarrow C_4A\cdot 13\,H_2O$$

$$C_2S + n\,H_2O \longrightarrow C_2S\,.\,n\,H_2O$$

36.1.3 Special Cements

Portland cement also known as **normal setting** or **ordinary cement** is widely used for most of the construction activity like construction of buildings, roads, bridges and dams, etc.. However, it is unsuitable for application under corrosive conditions. Such applications require special characteristics in the cement. These have lead to the development of special cements. Some of these are given below :

(a) **High alumina cement** : this is prepared by fusing a mixture of lime stone and bauxite (an ore of aluminium containing some impurities of iron oxide, magnesium silicate, etc.) at high temperature. It has high rate of setting and hardening and can achieve full strength in about 24 h. It is also known as **quick setting** cement. It has superior chemical resistance so that it can be used safely, with sea water and water containing sulphates.

(b) White Portland: It is an expensive variety of normal setting Portland cement characterized by the absence of iron compounds. The absence of iron compounds gives it the whiteness. The **white cement** is expensive because its manufacture requires high purity of the raw materials viz. lime stone and clay. It finds applications in the manufacture of tiles and repairing of marble structures. White Portland cement has an added advantage that it can be mixed with different colouring materials (pigments) to give aesthetic applications. Chromium oxide gives it a green coloration, cobalt oxide imparts blue coloration.

(c) Sorel cement(magnesium oxychloride cement) : This cement was discovered by a French Chemist Sorel and is obtained by the addition of 20 % solution of $MgCl_2$ to a finely ground mixture of calcinated magnesite and caustic (NaOH). The main constituent is magnesium oxychloride ($3MgO.\ MgCl_2.\ 12\ H_2O$). Sorel cement is used primarily for flooring and is also used in dental fillings.

(d) Water proof cement : This is obtained by mixing water proof substances like, calcium or aluminium stearate during grinding while making Portland cement. Sometimes substances like soaps, waxes and bitumen etc. are also used to achieve water repelling properties.

36.1.4 Applications of Cement

Cement is generally not used as such, it is normally mixed with certain fillers or additives like sand, crushed stone, gravel, slag, etc. Depending on the nature of the filler or additive and the composition there are three broad types of mixtures. These are

(i) Mortar

(ii) Concrete and

(iii) Reinforced Concrete Construction (R.C.C)

(i) Mortar : It is obtained by adding water to a mixture of cement and sand. The resulting paste is called **cement-mortar.** Mortar finds applications in binding bricks and stones, etc. and also in plastering the walls.

(ii) Concrete : it is formed by making a mixture of cement and fine and coarse inert mineral aggregates like sand, coarse rock, stone, gravel or slag etc. The concrete can be put into any desired shape. Concrete finds applications in making roads, roofs, columns in the building, foundation works etc.

(iii) Reinforced Concrete Construction (R.C.C) : sometimes the constructed structure, say a bridge, has to take a lot of load. A plain concrete construction is not appropriate for such an application because concrete has low ability to withstand tension. In such cases, the structure is strengthened (or reinforced) by incorporating a net work of iron or steel rods which helps to take up load. This type of construction is called Reinforced Concrete Construction (R.C.C) and is used in the construction of bridges, arches, roofs girders, floor beams, etc.

Intext Question 36.1

1. What is Portland cement?

   .....

2. What are its main raw materials of Portland cement ?

   .....

3. What do you understand by setting of cement?

   .....

4. List the names of different types of special cements.

   .....

36.2 Glass

Your are familiar with glass and its common applications. Glass is defined as 'a rigid, amorphous transparent or translucent supercooled liquid'. It means that glass is not a solid but a rigid material that may allow light to pass through. Further, it is amorphous which means that it lacks regular three dimensional internal structure characteristic of crystalline solids. Glass has extremely high viscosity and normally does not set over a reasonably long period of time.

Glass is obtained by the fusion of sand, alkali metal carbonates alkaline earth carbonates and some other additives. We can not give it a particular chemical formula, however, glass can be roughly represented as x $M^{I}_{2}O$. y M^{II}_{O} . $6SiO_2$ where M^{I} = refers to an alkali metal like Na, K, etc. while M^{II}, indicates a bivalent metal like Ca, Pb, etc. Glass is a mixture of silicates of alkali and alkaline earth metals with excess of silica. Some verities of glasses may contain small amounts of Al_2O_3, Fe_2O_3 , etc. Some common variety of glasses are given in Table 36.3

Table 36.3 : Types of Glass

Type of glass	M^{I}	M^{II}	Approximate formula
Soda lime glass or Soda glass	Na	Ca	$Na_2O. CaO.6SiO_2$
Potash lead glass	K	Pb	$K_2O. PbO. 6SiO_2$

Nowdays several formulations of glass are known. Silica, soda and lime are main constituents of all glasses. Let us learn about the various raw materials used in manufacture of glass and their roles.

36.2.1 Manufacture of Glass

A large variety of glasses are known today and these are prepared by varying the composition of the raw materials. The basic **raw materials** and their role in determining the properties of a glass are briefly outlined below :

(a) Raw materials

(i) Sand It is the source of silica.- the major component of glass. The sand used for manufacture of glass must be almost pure quartz containing about 99.1-99.7 % SiO_2. The sand particles should be uniform and of moderate size. Larger particles are slow to react while very fine particles cause violent reaction.

(ii) Alkali metal compounds: (Na_2CO_3, K_2CO_3, $NaNO_3$, KNO_3, Na_2SO_4). These are the sources of Na_2O (in soda glass) and K_2O (in hard glass).

(iii) Alkaline earth compounds: (CaO, $CaCO_3$ and $BaCO_3$). These are provided by lime stone and burnt lime from dolomite ($CaCO_3.MgCO_3$). Dolomite also provides MgO which helps in controlling the physical properties of glass. Alkaline Earth compounds contribute towards the high refractive index of glass.

(iv) Heavy metal oxides (ZnO, PbO, Pb_2O_4 and Pb_3O_4). Litharge (PbO) or red lead (Pb_3O_4) are used as a source of lead in flint glass or crystal glass. It provides lusture and high refractive index to the glass.

(v) Feldspar is a cheap source of Al_2O_3. Feldspars have a general formula $M^I_2O.Al_2O_3.6SiO_2$ where M^I represents Na or K or both. Therefore, feldspar has an added advantage as it provides Na_2O, K_2O and silica also. Alumina (Al_2O_3) makes glass resistant to sudden changes in temperature.

(vi) Borax is a minor component and is a source of boron oxide (B_2O_3) and Na_2O. Borax reduces the coefficient of expansion of glass and increases its fusibility, chemical durability and refinement.

(vii) Cullets or pieces of broken glass are generally added to the raw material to increase the fusibility of the glass produced from it. In other words it lowers the temperature of fusion so that we can manufacture glass at a lower temperature. The cullets may contribute from 10% to 80% of the raw material and thus provide a good way of utilising the waste glass.

(viii) Besides the above mentioned raw materials certain metallic oxides are also added to impart a colour (if desired) to the glass. Some of the principal glass colorants are given in Table 36.4 .

Table 36.4 : Some common glass colorants

Colorant	Formula	Colour imparted
Oxides of iron	FeO, Fe_2O_3	Light green or bottle green
Chromium compounds	Cr_2O_3, K_2CrO_4	Green tending to yellow
Cobalt oxide	CoO	Blue
Cadmium sulphate	$CdSO_4$	Yellow
Gold powder	Colloidal Au	Shades of ruby

(b) Manufacturing Process: The raw materials including the cullets are powdered in a grinding mill and mixed in proper proportion. This powder is then fused in an open or covered furnace. Certain decolorants like MnO, etc., are added and the heating is

continued till the evolution of gases stops. The coloring material is added at this stage and the heating is continued till a homogenous mass is obtained. It is then gradually cooled to a certain degree of plasticity so that it can be handled easily. The glass so obtained is called **mother glass**. It is then blown or moulded to get the desired shape. The articles are then cooled slowly. This process is called **annealing.**The finished glass product is then obtained after processes like cleaning, cutting , grinding and polishing ,etc.

36.2.2 Properties of Glass

- It is amorphous in nature, having low range of internal order.
- It does not have a sharp melting point. On heating glass gradually becomes softer and softer and eventually starts flowing.
- On cooling, the hot liquid gradually cools to a viscous liquid which can then be transformed into articles of desired shape.
- It may be transparent or translucent.
- It is quite inert and is not readily affected by ordinary chemicals except hydrogen fluoride and some alkalis.
- It has high compressor strength It lacks ordered internal structure.
- It is an insulator of heat and electricity.

36.2.3 Types of Glasses

Commercialy glasses are available in a wide variety. These are used for diverse applications from simple window pane to bullet proof glass. Some types of glasses and their uses are discussed below.

(i) **Soda glass or soft glass :** this is commonly used, low quality, cheap glass. It constitutes about 95% of all the glass manufactured and is prepared by fusing sand (silica), calcium carbonate (lime stone) and soda ash (Na_2CO_3). The approximate composition is $Na_2O.CaO.\ 6SiO_2$. It contain 70 – 74 % SiO_2, 8 to 13% CaO and 13 – 18% Na_2O. About 2% of Al_2O_3 may be present as impurity. It is called soft glass because it soften at a relatively lower temperature. The soda glass also finds application in making electric bulbs, window panes, bottles, jars, etc.

(ii) **Lead Glass or flint glass**: is prepared by fusing litharge (PbO), potassium carbonate, soda ash, lime stone and silica in proper proportions. The approximate composition is $K_2O.PbO.6SiO_2$. It contains about 45% silica and variable amounts of lead oxide, Na_2O, K_2O and CaO. High lead-content glasses are used as shields against x-rays and γ-rays. These are used in the buildings in which x-ray and γ-ray scintillation units are installed. These may even be used in nuclear installations to protect from nuclear radiations. Besides, these applications, lead glass finds extensive use in making optical components like lenses, quality table ware (crystal ware), ornamental or artificial jewellery imitating artificial precious stones and electrical insulations, etc..

(iii) **Toughened (or tempered) glass:** this is not exactly a type of glass but a kind of treatment done to the glass article before annealing. The hot article is dipped in an hot oil both. The outer layer of the article shrinks and hardens whereas the internal layer is in a state of stress or tension. If the surface is broken, it shatters into many

pieces. This procedure is called **tempering** of glass. Such a glass is very strong and tough and can withstand higher mechanical and thermal shock. Such glasses are used in making automatic doors, large showcases. Toughened glass also finds application as wind shields of cars, trucks and aeroplanes.

(iv) Laminated safety glass: is obtained by pressing or bonding together two or three flat glass sheets having a thin layer of polyvinyl butyral plastic or vinyl acute resin and a bonding material (adhesive) between them. These may be cemented with the help of heat and pressure. The glass becomes tough on cooling and can withstand sudden changes in temperature and pressure. On breaking, the glass pieces do not fly off i.e. it is shatter proof. Such a glass is an ideal material to be used for entrance doors, sliding doors, sky lights, sloped looking windows of tall buildings, etc. These also find application as the wind screens of cars and automobiles. If several layers of glass are condensed together with alternating layer of vinyl resin we can get bullet proof glass

(v) Insulated Glass: it is prepared by entrapping insulating materials like anhydrous (or dry) air between two panes of glass thermally sealed along the perimeter. Such glass modules are used in places where inside of the building is to be protected from the drastic climatic conditions outside. In extreme weather conditions a module containing three panes and two layers of insulation may be used. These modules keep the room cool during summer and warm in winters.

In addition to the above mentioned, a number of other types of glass are known that find applications in making tableware, chemical containers and apparatus, optical lenses, goggles, neon signs, cathode ray tubes and many more.

Intext Question 36.2

1. List different raw materials used in the manufacture of glass.

   .....

2. What is the chemical composition of soda glass?

   .....

3. What do you understand by tampering of glass?

   .....

4. Give two examples of substances used as colourants for glass.

   .....

36.3 Ceramics

The term ceramics originated from the Greek word, keramos meaning ' burnt stuff'. It refers to a broad class of chemically inorganic materials that are prepared by high temperature processes or are used at high temperatures. These are broadly grouped into following classes :

- Clay products
- Refractories

In this section we shall discuss about clay products.

Clay Products

The clay products are sub divided into the following types.

(i) **Structural clay products**: these contain iron oxide as one of the important constituents and are used for making bricks, terra cotta, sewer pipes and tiles, etc..

(ii) **White wares or white pottery :** these are prepared from **china clay** (or Kaoline) mixed with some fusible silicates. These include products like chinaware, porcelain stoneware and vitreous ware.

(iii) **Chemical stoneware:** these are prepared from refractory clays mixed with crushed stones and pottery, etc. which are then glazed. These are generally quite strong and non-porous products. These find applications in making sanitary fixtures like bath tubs, wash basins, sinks and drainage pipes, etc.

Before proceeding with the details of these clay products let us learn about clay.

36.3.1 What is Clay?

Geographically, clays are the products obtained by the disintegration of rocks over long periods of time due to the effects of weather. These consist mainly of aluminium silicates along with other substances like, mica, quartz and sand, etc. some of the common clays and their chemical formulae are :

(i) Beidellite $Al_2O_3.\ 2SiO_2.H_2O$

(ii) Kaolinite $Al_2O_3.\ 2SiO_2.2H_2O$

(iii) Halloysite $Al_2O_3.\ 2SiO_2.3H_2O$

These differ only in terms of the number of water molecules of hydration. Clays have an important property called plasticity because of which on mixing with water these form a plastic like mass which can be easily moulded into desired shape. You would have observed pottery makers turning clays into various shapes. The wet clay has sufficient rigidity so that it does not get deformed on standing.

36.3.2 Structural Clay Products

The structural clay products like bricks and tiles are prepared from common clay containing iron oxide and other impurities.

(i) Bricks: these are one of the oldest and extensively used construction material. These are cheap, locally available (other than on hilly areas) and have good strength. The main raw materials used for preparing bricks are clay (alumina) and sand (silica). Small amounts of lime (to reduce shrinkage and give strength) and iron oxide (to help in the fusion of the brick particles and for giving colour to the bricks) are also added. Manufacture of bricks involves the following steps:

- Kneading of clay with water till homogenous
- Moulding and drying of bricks
- Baking of dry bricks

Now a days bricks are being prepared from fly ash- the waste product of thermal power stations.

(ii) Tiles: these are prepared from better quality clay (free from pebbles, grit and other impurities) and are used in flooring, making pavements and roofs, etc.. Superior quality tiles are used for decorative purposes. Finely ground mixture of glass and pottery are also added to the clay while preparing tiles, this provides strength to the tiles.

36.3.3 Whitewares and White Pottery

These are clay products having white or pale-cream colour. Whitewares are prepared from china clay, feldspar ($K_2O.\ Al_2O_3.\ SiO_2$.) and sand or flint(SiO_2). These are used in varying amounts to get different products. The raw materials contain none or negligible amounts of iron oxides.

To prepare whitewares the raw materials are ground to a fine powder and mixed with water. The wet clay is moulded into desired shape, dried, baked and glazed. During glazing the pores of the clay are plugged (closed) so as to make it water proof and shining. Glazing is done in a number of ways depending on requirement. Glazing materials used are glass forming materials like quartz, feldspar, lead and boro-silicates, etc. along with some coloring components. These are mixed with water to form a colloidal solution (called slip-glaze). The ware to be glazed is removed from the furnace and dipped into glaze-slip and continued to bake at high temperature. The glaze material fuses and fills the pores and provides a glossy surface to the ware.

36.3.4 Chemical Stoneware

As the name suggests, the stonewares are quite strong like stone. These are obtained by heating the raw materials at high temperature. A typical stoneware can be prepared by grinding a mixture of clay, kaoline, feldspar, and sand. The plastic like mass so obtained is moulded into the desired shape. The shaped articles are dried and heated at about 1273 K. These are then salt glazed at 1373 K. In salt glazing the hot article is sprinkled with sodium chloride and heated at high temperature. Sodium chloride vapourises and reacts with the ware producing sodium aluminium silicate. This is highly fusible and fills the pores on the surface of the article. This glazing treatment makes the article impermeable to liquids.

The chemical stonewares have low absorption power, high density and chemical resistance. These differ from the whitewares in terms of their colour. The stonewares are used in making sanitary fixtures like bath tubs, wash basins, sinks and drainage pipes, etc.

Intext Question 36.3

1. What are ceramics?

.....

2. What are clay products? How are these classified?

.....

3. List the raw materials used to prepare white wares.

.....

4. List different uses of chemical stone wares.

.....

What You Have Learnt

- Cement is an inorganic material which when mixed with water gradually sets to give a hard mass and can be used to join together bricks, stones, etc.
- There are different types of cement that differ in their composition , mode of preparation and applications. Of these, Portland cement is currently the most commonly used cement .
- Portland cement contains a number of oxides which exist as complex compounds like, tricalcium silicate , dicalcium silicate, tricalcium aluminate, tetracalcium aluminoferrate, etc. These are called **Bogue's compounds.**
- Setting of cement involves two important processes hydration and crystallisation. These processes take long period of time.
- Cement is used in combination with a number of additives like sand, coarse rock, stone, gravel or slag, etc.. depending on the application. These combinations are called mortar or concrete depending on the additive. A concrete reinforced with steel is called R.C.C.
- Glass is 'a rigid amorphous transparent or translucent supercooled liquid' which lacks regular three dimensional internal structure and has extremely high viscosity.
- Glass can be roughly represented as $x\ M^{I}_{2}O\ .\ y\ M^{II}_{O}\ .\ 6SiO_2$ where M^{I} and M^{II} are alkali metal and bivalent metals respectively.
- For manufacturing glass, the raw materials like sand, feldspar, alkali metal and alkaline earth compounds, heavy metal oxides, etc. are mixed in proper proportion, powdered, and fused in a furnace**.**
- Commercial glasses are available in a wide variety. There are used for diverse applications from simple window panes to bullet proof glass etc.
- Ceramics refer to a broad class of chemically inorganic materials that are prepared by high temperature processes or are used at high temperatures and are classified as clay products, and refractories.
- Clay consists of a mixture of aluminosilicates differing in number of water of crystallisation.
- Clay products are classified into structural clay products (like bricks and tiles etc) , Whitewares and stonewares.

Terminal Exercise

1. Match the following

(i)	Mixing of water and cement leads to	Crystallisation
(ii)	Second stage of hardening of cement	Sorel cement
(iii)	Cement with good chemical resistance	Mortar
(iv)	Cement used in repairing marble	High alumnina cement
(v)	Cement used in dental fillings	White cement

2. Describe the process of manufacture of cement.
3. What are Bogue's compounds and what is their importance.
4. Discuss different applications of cement.
5. What is the composition of white cement ? Give some of its applications.
6. Differentiate between

(i) Mortar and concrete

(ii) Concrete and R.C.C

7. Describe the process of manufacture of glass.
8. List different raw materials used for the manufacture of bricks and indicate their role.
9. What do you understand by the term, 'glazing'? Why are certain clay products glazed?

Answers to Intext Questions

36.1

1. The Portland cement is the most commonly used cement. It contains a number of sliticates like calcium aluminio silicates.
2. Calcareous materials like limestone and chalk and argillaceous materials like, clay, shale or slate, etc. are the principal constituent of cement. In addition to these, powdered coal or fuel oil and gypsum ($CaSO4.2H_2O$) are also used.
3. Setting of cement involves two important processes called hydration and crystallisation. These processes take a long time. On mixing water and cement the constituents of the cement get hydrated and form gel and crystalline products. These cause the paste to stiffen and it is called setting of cement.
4. There are different types of cement with special properties. Some of the special cement are : high alumina cement, while Portland, sorel cement and water proof cement.

36.2

1. Sand, Alkali metal compounds, alkaline earth compounds, heavy metal oxides, borax & cullets.
2. Please refer to section 36.2.3
3. Please refer to 36.2.3
4. Oxides of iron and gold powder

36.3

1. Please refer to section 36.3
2. Please refer to section 36.3.1
3. China clay, feldspar and sand
4. Bath tubs, wash basins, sinks & drainage pipes.

SENIOR SECONDARY COURSE
CHEMISTRY
Student's Assignment – 7

Maximum Marks: 50 **Time : $1\frac{1}{2}$ Hours**

INSTRUCTIONS

- Answer all the questions on a separate sheet of paper.
- Give the following information on your answer sheet:
  - Name
  - Enrolment Number
  - Subject
  - Assignment Number
  - Address
- Get your assignment checked by the subject teacher at your study centre so that you get positive feedback about your performance.

Do not send your assignment to NIOS

1. (a) List two biotic components of environment.
   (b) What are secondary (anthropogenic) pollutants?
   (c) Name one harmful effect of CO as a pollutant.
   (d) Define surface water.
   (e) List two sources of ground water pollution.
   (f) Name the element that causes Minamata disease.
   (g) What is a heavy metal?
   (h) List two ways by which lead enters the human body.
   (i) List two ways (anthropogenic) by which ionizing radiations are exposed in the atmosphere.
   (j) Write names of monomers of terylene. $1 \times 10 = 10$
2. (a) Define pollution. List two sources of natural pollutants.
   (b) Write the sources and the effects of the following pollutants: (i) SO_2 (ii) Lead.
   (c) Define water pollution. What are the two basic factors responsible for water pollution.
   (d) What are the four man-made sources of water pollution?
   (e) Define eutrophication. How is it causes?
   (f) What are the three stages of water treatment. Explain any one stage.
   (g) List six sources by which environment is contaminated by heavy metal.
   (h) Why is it impossible for a nuclear reactor to blow up like a bomb? Explain.

(i) Differentiate acid dyes from basic dyes.

(j) Give two examples of bippolymers. (2 × 10 = 20)

3. (a) How can heavy metal be removed from rivers and sediments?

(b) List three properties of emulsion paints.

(c) Draw a diagram to show the sequence of steps leading to eutrophication of water body?

(d) Define green house effect. Name any four greenhouse gases and their sources.

(3 × 4 = 12)

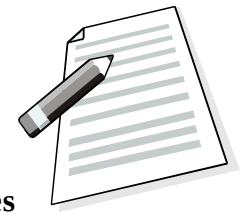
4. (a) Suggest four measures by which exposure of nuclear radiation can be reduced.

(b) What are the effects of ozone depletion? (4 × 2 = 8)

Notes

TERMS YOU SHOULD KNOW

Abiotic	:	Non living (physical) components of environment such as soil, water,
Acid precipitation	:	Pollutant gases such as SO_2,NO_X are washed out of atomophere and produce acid precipitation as rain of snow.
Acid rain	:	Rain with a pH below 5, containing pollutants such as SO_2, NO_X, hydrocarbons, O_3 and and amonium sulphate This rain changes the ecosystem and damages buildings.
Aerodic pathway	:	Chemical reactions occuringin an organism in the presence of oxygen.
Afforestation	:	Planation of many trees on a barren land.
Anaerobic bacteria	:	Bacteria capable of living in the absence of free oxygen.
Anaeroic pathway	:	Chemical ractionsoccuringin an organism in the absence of O_2.
Anthropogenic	:	Man made.
Autotrophs	:	Organisms manufacturing own food such as plants.
~-particles	:	Positively charged particles emitted by radioactive substances equivalent to helium atoms which have lost their electrons.
Aquatic life	:	Organisms living water.
Atmoshpheric pollutants	:	Unfavourable substances in air.
ATP	:	Adenosine triphosphate, biological energy.
Bioaccumulation	:	Accumulation of toxic substances (such as DDT) in the body of organisms.



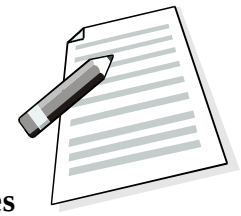
Notes

Biogeochemical cycle	:	Cyclic transformation of certain essential chemical elements as they pass from soil and atomsphere through living components of ecosystem & eventually returned back to soil and atmosphere.
Biomagnification	:	Increased accumulation of toxicaubstances along the food pyramid.
Biosphere	:	Part of globe containing living organisms.
Biosyntheis	:	Synthesis of chemicals required by organisms.
Biotic	:	Living components of the environment e.g. plants, animals etc.
BOD	:	Biological (or Biochemical) Oxygen Demand. The amount in milligrams per litre of dissolved oxygen required by aerobic bacteria ot decompose organic matter in water solution.
–particles	:	A charged particle equivalent to an electron if negative or positive emitted from the nucleus in radioactive decay of fission.
Bronchitis	:	Inflammation of the membrane lining the bronchial tubes.
Carbomino haemoglobin	:	A compound formed by the combination of CO_2 and haemoglobin in blood.
Carcinogenic	:	Cancer causing
Coagulation	:	Clotting or clumping.
Compaction	:	Fertile soil packed closely and firmly to form it a dense solid mass leaving no air space reducing to a barren piece of land.
Consumers	:	Animals which eat plants.
Coronary	:	Pertaining to heart.

Notes

Glossary

Corrosion	:	Gradual eating away (degradation) through chemical action
Crust	:	Outer layers of the earth.
Decibel	:	Unit of loudness or measure of physical pressure extented by sound waves at a given point.
Defence proteins	:	Antibodies which are responsible for immunity and resistance against foreign substances entering body.
Deforestation	:	Cutting down trees in a forest.
Dry deposition	:	Acid gases as SO_2, NO_X have effects as dry gases.
Ecosystem	:	A biological community and the physical environment a associated with it.
Effluent	:	Refuse discharged from factories.
Emphy sema	:	Abnormal distention of an organ or part of the body esecially lungs with air or any other gas.
Environment	:	Sum total of external influences acting on an organism.
Eutrophication	:	Process of aging of abody of water due to growth of algae. Algae flourish and die and their decay depletes water of its dissolved oxygen content.
Food chain	:	Sequence of organisms in which each is food of a later member of the sequence.
Fossil fuel	:	Coal, petroleumand gases or liquids derived therefrom.
Flocculants	:	Chemical agents that cause clumping of undesirable solids in suspension and then precipitation of these solids.



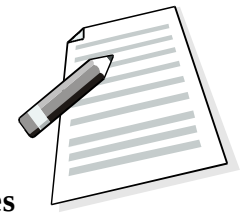
Notes

Fragile	:	Delicate, easily broken.
Geological time	:	Chronoligical age of earth.
Global warning	:	Rise in the normal temperature of earth.
Green house effect	:	Warming of lower layers of atmosphere due to absorption of short wave length solar radiations.
Ground water	:	Water below the earth's surface.
Half life	:	Time required for and unstable element or nuclide to lose one half of its radioactive intensity in the form of a α, β or γ radiation.
Halons	:	Halo carbons - C_xF_x,C_xBr_x used as antifire agents.
Urbanisation	:	City living.
Incubation	:	Keeping at a particular temperature.
Ionision radiation	:	Radiation having enough energy to cause ionisation and produce ions in a system.
Leaching	:	Process by which organic matter and mineral salts are washed out of a layer of soil by percolating rain water.
Marshes	:	A soft and wet area which suffers from poor drainage and frequent water logging.
Membrane transport	:	Movement of molecules acrosscell membranes.
Metabolism	:	Constructive and destructive chemical changes occuring in the living organism.
Methaehaemoglobinemia	:	Presence of methaemoglobin whichis more stable thanoxyhaemoglobin. Excessive leyels of nitrates in water cause it. Babies suffering from methaemoglobinemia are called blue babies.

Notes

Glossary

Microbe	:	A microoorganism such as bacterium.
Mitochondria	:	Cell organelles responsible cellular respiration.
Methanogenic (methanotrophs):		Bacteria which produce CH_4 throught their biological activty.
Nitrifers	:	Bacteria which convert ammonia into nitrities and nitrites into nitrates.
Non-biodegradable	:	Whichcannot be broken down by micro organism.
Nuclear reactor	:	An assembly in which chain reaction is caused to take place in controlled manner.
Nuclear fusion	:	A thermonuclear reactionin which positively charged hydrogen nuclei (protons) unite of fuse to from heliun with evolution of energy.
Oxygen depletion	:	Reduction in the oxygen content.
Oil slick	:	A phenomenon caused by activities of ships of effluents from shore installations. Less volatil components of oil combine with sea water and form dark viscous slick which to sea bed or floats of as tar.
Organic Matter	:	Substance belonging to organisms.
Ozone hole	:	A gap in the ozone layer in the atmosphere lying between 10 to 50 km. above the surface of the earth Ozone hole develops over antartica each spring and size of hole corresponds to the concentration of CFC in polar atmosphere.
PAN	:	Peroxyacyl nitrates found in photochemical smog.
Particulate matter	:	Composed of distinct particles
Pesticide	:	Chemicals used for killing pests such as DDT.



Notes

Photochemical oxidants : Ozone, PAN, aldehydes etc. produced by chemical reaction in the presence of light between usaturated hydrocarbons and nitrogen oxides

Photochemical smog : A complex mixture of undesirable substances formed by the action of sunligh on urban atmosphere polluted with automobile emission

Photosynthesis : Synthesis of starct from CO_2 and H_2O in the presence of light and chlorophyll.

Phytotoxic : Harmful to plants

Plankton : Organisms floating in water.

Producers : Plants which manufacture food for themselves and eaten by other organisms.

Radioactive fallout : Settling of air borne particles of radioactive dust and other material resulting from nuclear explosion on the ground.

Radionuclide : Unstable nuclide undergoing spontaneous radioactive tranformation with emission of particle or phton.

Respiration : Process of taking in oxygen laden air and removing CO_2 laden air.

Stratosphere : Region of upper atmosphere extending from troposphere to about 15 km above earth.

Solar energy : Energy derived from sun.

Surface water : Water flowing in streams and over the ground surface.

Swamps : Wet muddy areas.

Tailing X-ray : Analysis of portionns of washed ore regarded as too poor to be treated further. Also called debris.

Notes

Glossary

Thermal	:	Pertaining to heat.
Fluorsis	:	Poisoning by excessive use of fluorides.
Toxic	:	Poisonous.
Troposphere	:	Inner layer of the atmosphere where cloud formatic occur.
Vehicular combustion	:	Burning of fuel in a vehicle such as petrol in order drive it.
¥-Ray	:	High frequency, highly penetrant electro-magnetic radiation of short wave length emitted from the nuclear of a radioactive atom.