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Paper: DSE3T: Industrial Chemistry

Topic: Silicate Industries

PART 2

Comments - Read the lesson in details and complete the given assignment.

Colouring Material of glasses.

Material	Colour.
① Chromium oxide / Fe^{2+} ion	green.
② MnO_2	Purple
③ Fe_2O_3 / CdS	yellow.
④ CoO / Cu^{2+} ion	Black Blue.
⑤ Nickel oxide (NiO)	Black
⑥ Cu_2O	Red
⑦ $AuCl_3$	Ruby.

So the production of coloured glass usually involves the addition of a metal to the glass. This is often accomplished by adding some powdered oxide, sulfide, or other compound of that metal to the glass while it is molten. The table above lists some of the colouring agents of glass and the colours that they produce.

Photo sensitive glass :- Photo sensitive glass is a crystal-clear glass that belongs to the lithium-silicate family of glasses in which an image can be captured by microscopic metallic particles in the glass when it is exposed to short wave radiations such as ultraviolet light. Photo sensitive glass contains microscopic metallic particles. These microscopic metallic ion nanoparticles are made of gold or silver which is responsible for the refractive index change.

Use :- This glass is used in printing and reproducing processes. This glass is like traditional camera film except it reacts to UV light.

Fluorosilicate glass :- Fluorosilicate glass is a glass material composed primarily of fluorine, silicon and oxygen. It has a number of uses in industry and manufacturing especially in semiconductor fabrication where it forms an insulating dielectric. Fluorosilicate glass has a low K dielectric and is used in between copper metal layers during silicon integrated circuit fabrication process.

Cement : Cement is essentially a finely powdered mixture of calcium silicate and aluminates along with small quantities of gypsum which sets into a hard stone like mass when treated with water.

Average composition of Portland cement: Cement is obtained by combining a material rich in lime, CaO with other materials such as clay, which contains silica, SiO₂ along with oxides of aluminium, iron and magnesium.

Lime (CaO) 50-60%

Magnesium oxide (MgO) 2-3%

Silica (SiO₂) 20-25%

Ferric oxide Alumina (Al₂O₃) 5-10%

Sulphur trioxide (SO₃) 1-2%

For a good quality cement, the ratio of alumina to silica should lie between 2.5 to 4 while that of lime to that of silica ,alumina and ferric oxide should be as close to 2 as possible.

Cement manufacturing process: Raw materials required for the manufacture of cement are **1)** limestone (CaCO₃) , **2)** clay which provides both silica and Alumina **3)** gypsum. Small amount of magnesia and iron oxide are also required for imparting suitable colour to cement.

Cement is manufactured by two processes:

1) Wet process (2) Dry process

The wet process is preferred when the raw materials i.e. limestone and clay are soft, climate is humid and fuel is cheap. The dry process is preferred when the raw materials are hard.

The main raw materials are limestone and clay. Wet process supplies lime while the dry process is a source of silica , alumina and iron oxides.

(1) The raw materials are first crushed separately in a suitable machine. They are then mixed in the required proportion(3 parts limestone + 1 part clay) and grounded together finely.This grinding is done either by the dry process or by the wet process.

(2) In the wet process ,the clay is washed with water in a wash mill to remove flint and other foreign substances. It is then mixed with requisite quantity of limestone and pulverised in a special mill.The resulting pasty mass is then thoroughly homogenised to get raw slurry containing about 40% water.

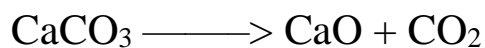
(3) In the dry process, the raw materials are dried and mixed in desired proportion. The mixture is then finely powdered and passed through 300 mesh sieves and homogenised with the help of compressed air. The homogeneous mass is called **raw meal**.

(4) The slurry or raw meal is introduced into the upper end of a rotary kiln by means of screw conveyer. The kiln consist of an inclined steel rotating cylinder, 150-200 ft long and about 10 ft diameter lined inside with fire bricks. The charge travel downwards slowly due to the rotatory motion given to the kiln and is heated by burning coal dust which is blown in front from the lower end. The charge takes about 2-3 hours to cover the entire journey in the kiln.

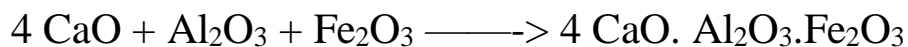
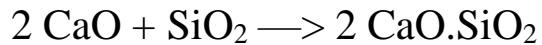
The following changes occur :

(1) In the **upper part** of the kiln, the temperature is around 1000-1100K .Here the charge loses all its water due to evaporation by hot gases.

(2) In the **middle** of the kiln, temperature is around 1100-1200 K. Here limestone decomposes to form calcium oxide and carbon dioxide.



(3) The **lower part** of the kiln, from where coal dust is blown in is the hottest with the temperature ranging between 1770-1870 K. As the charge reaches here, chemical combination takes place between lime, alumina and silica to form calcium silicate and aluminates.



Due to very high temperature in this zone, about 20-30 % combines with solid mass to form grey coloured balls called **cements clinkers**.

The hot clinkers are cooled by cold air and are mixed with 2-3 % gypsum and finely powdered to 325 mesh size in grinding machine. The fine powder called the Portland cement is sieved and packed in bags.

Setting of cement The important constituents present in Portland cement are dicalcium silicate (Ca_2SiO_4), tricalcium silicate (Ca_3SiO_5) and tricalcium aluminate ($\text{Ca}_3\text{Al}_2\text{O}_6$).

When water is added to cement, an exothermic reaction occurs. During this process, cement reacts with water to form a gelatinous mass which slowly sets into a hard mass having three dimensional network structure involving -Si-O-Si- and -Si-O-Al chains.

Tricalcium silicate sets quickly and develops considerable strength within a few days. Dicalcium silicate sets slowly and develops appreciable strength after a month or so. Tricalcium aluminate sets instantaneously in presence of water. The internal strength acquired by cement is primarily due to the setting of tricalcium aluminate.

: Assignment :

1. State the raw materials of glass.
2. What is the composition of Soda glass, Lead glass and Potash glass. Mention their uses.
3. Why other substances are added to silicate glass?
4. What is setting of cement?
5. What are main ingredients used for manufacturing of cement?
6. What is colouring material of glass?