

Note: Answer 5 questions only

Q1: Discuss the following:

(20 marks)

- A) Thermal expansion of a ceramic material depends on bonding strength between atoms.
- B) Flexural strength of refractories depends on the specimen size.
- C) The structure of dolomite refractory becomes more stabilized by addition the serpentine (MgO.SiO₂).
- D) Zircon mineral is more important than Baddeleyite mineral for producing Zirconia (ZrO₂) refractory.
- E) Production rate of firebrick is increased by Grog addition to the brick mix.

Q2:

A) What are the causes of spalling in silica refractory bricks?

(8 marks)

B) Cubic refractory brick heated from 30°C to 1300°C, the volume of the brick was expanded from all dimensions in equal amounts, and the new volume of the brick at 1300°C becomes 65.21 cm³. The volume thermal expansion coefficient (β) of the brick is (1.48 x 10⁻⁵ /°C).
Find:

- 1) The initial length of the refractory brick.
- 2) The linear thermal expansion coefficient (α) of brick at same temperature differences.

(12 marks)

Q3:

A) What is effect of the silicates amount in silica brick on its rigidity at high temperatures?

(8 marks)

B) Which of the materials listed below would be best suited for an application in which a part experiences sudden and severe thermal fluctuations while in service? Prove that in calculations. Assume the Poisson's ratio is (0.25) for all materials.

| Refractory Material | Modulus of Rupture (MPa) | Young Modulus (GPa) | Thermal Expansion (K ⁻¹) |
|---------------------|--------------------------|---------------------|--------------------------------------|
| 1 | 700 | 200 | 9 x 10 ⁻⁶ |
| 2 | 900 | 150 | 4 x 10 ⁻⁶ |
| 3 | 750 | 150 | 3 x 10 ⁻⁶ |

(12 marks)

Q4:

- A) What are the main advantages of Grog addition to firebrick mix during the manufacturing process? (6 marks)
- B) Explain in steps the precipitation method for preparing zirconia (ZrO_2) powder from zircon ($ZrSiO_4$)? (10 marks)
- C) Fill the following blanks: (4 marks)
1. There are five standard classes of the fireclay brick: _____, _____, _____, _____ and _____.
 2. Flux Factor is equal to _____.
 3. The chemical analysis of zircon ($ZrO_2 \cdot SiO_2$) containing not less than _____ % ZrO_2 and not less than _____ % silica SiO_2 .
 4. The natural dolomite ($CaCO_3 \cdot MgCO_3$) refractory can be converted to _____ refractory by high temperature firing.

Q5:

- A) State only the common causes of refractories failures; discuss two of them? (10 marks)
- B) A rectangular refractory specimen has a square cross section loaded using a three-point bending mode. Compute the minimum possible cross section area of the specimen without fracture, given that the applied load is 250 N, the flexural strength is 1250 MPa, and the separation between load points is 30 mm. (10 marks)

Q6:

- A) Define the following: (6 marks)
- 1) Superduty Fireclay.
 - 2) Dead-Burned Magnesia.
- B) How is silica bricks classified? (4 marks)
- C) Explain: (10 marks)
- 1) Production of carborundum refractories.
 - 2) Properties and uses of sintered silicon carbide (SiC).

>>>>> GOOD LUCK <<<<<<