Non – Flammable Brick Using Magnesium Oxide

Dr.M.Archana[1], Ms.K.Jayasri[2], Mr.S.J.Jaikavin[3], Ms.M.Gayathri[4], Mr.M.Vishnudharshini[5]

[1]Assistant Professor, Department of Civil Engineering, Dhirajlal Gandhi College of Technology, Salem, India.
[2] B.E. Final Year, Department of Civil Engineering, Dhirajlal Gandhi College of Technology, Salem, India.
[3] B.E. Final Year, Department of Civil Engineering, Dhirajlal Gandhi College of Technology, Salem, India.
[4] B.E. Final Year, Department of Civil Engineering, Dhirajlal Gandhi College of Technology, Salem, India.
[5] B.E. Final Year, Department of Civil Engineering, Dhirajlal Gandhi College of Technology, Salem, India.
[1]archana.civil@dgct.ac.in; [2]kjayasri0809@gmail.com; [3]jaikavin9903@gmail.com; [4]gayathrisangeetha869@gmail.com; [5]vishnudharshini28@gmail.com

---***---

Abstract -.

Magnesium oxide (MgO) bricks, also known as magnesia bricks, are a class of basic refractories characterized by their high melting point, excellent thermal stability, and superior resistance to basic slags. applications, including steelmaking, cement production, and non-ferrous metal refining. The performance of MgO bricks is influenced by several factors such as purity of raw materials, manufacturing processes, and the presence of additives like carbon or spinel-forming agents.. The manufacturing process involves the selection of high-purity magnesite or seawater magnesia, calcination, mixing with binders, shaping, and high-temperature sintering. Innovations such as direct-bonded, chemically bonded, and carbon-containing MgO bricks are also explored for their enhanced corrosion resistance and mechanical strength MgO bricks, including hydration susceptibility and thermal shock resistance, along with recent advancements aimed at improving their performance through nanotechnology, synthetic additives, and optimized microstructure design.

Key Words: Refractories Characterised,Thermal Stablity ,Spinnel Forming Agent ,Direct bonded

1.INTRODUCTION

Magnesium oxide (MgO) bricks, commonly known as magnesia bricks, are a type of basic refractory material renowned for their high refractoriness, excellent resistance to basic slags, and stability at elevated temperatures. These bricks are predominantly composed of periclase (MgO), a mineral form of magnesium oxide, and are extensively used in metallurgical industries, particularly in steelmaking furnaces, cement
and performance under service conditions. rotary kilns, and non-ferrous metalnon-ferrous metal converters converters.industries, particularly in steelmaking furnaces, cement rotary kilns, and non-ferrous metal converters. These bricks are predominantly composed of periclase (MgO), a mineral form of magnesium oxide, and are extensively used in metallurgical industries, particularly in steelmaking furnaces, cement
rotary kilns, and non-ferrous metal converters.The overall performance of MgO bricks is significantly influenced by the presence of secondary oxides, including silica (SiO_2), iron oxide (Fe_2O_3), and lime (CaO), either as impurities or as deliberate additives to modify specific properties. Understanding the interactions among MgO, SiO_2, Fe_2O_3, and CaO is crucial for optimizing the design and performance of MgO-based refractories. Tailoring the composition and processing conditions allows for the development of bricks with improved durability, corrosion resistance, and thermal stability tailored for specific industrial applications. This study focuses on analyzing the role of these secondary oxides in influencing the properties of MgO bricks and explores their impact on phase formation, microstructural evolution,

. 2. OBJECTIVES

➢ Enhance Structural Durability – Investigate the mechanical strength, load-bearing capacity, and longevity of MgO-based materials in various environmental conditions.

➢ Promote Sustainable Construction – Explore the eco-friendly benefits of MgO, including its lower carbon footprint, recyclability, and energy-efficient production.

➢ Optimize Material Composition – Study the

➢ impact of additives and reinforcements on the physical and chemical properties of MgO-based construction materials.

➢ Improve Moisture and Thermal Resistance – Analyze the performance of MgO in humid environments and its insulation capabilities for energy-efficient buildings.

➢ Evaluate Fire Resistance – Assess the fire-retardant properties of Magnesium Oxide (MgO) in comparison to conventional construction materials.

3. MATERIAL SELECTION

1 . Magnesium oxide

Magnesium oxide (MgO) bricks possess excellent high-temperature stability, with a melting point above 2800°C, making them ideal for use in extreme thermal environments. They offer superior resistance to basic slags and corrosive agents, especially insteelmaking and cement industries. MgO bricks also exhibit good thermal conductivity and chemical stability, but they typically have lower resistance to thermal shock compared to other refractories. Their durability and strength at high temperatures make them a key material in various high-heat industrial applications

2.Red soil

Red soil is typically formed from the weathering of ancient crystalline and metamorphic rocks. It gets its characteristic reddish color from the presence of iron oxides. These soils are generally acidic, low in nitrogen, phosphorus, and organic matter, but rich in potassium. Red soil has good drainage but poor water retention, and it tends to be less fertile without proper treatment. It is commonly found in tropical and subtropical regions and supports crops like cotton, groundnut, and pulses when adequately managed.

3.Silica

Silica (SiO_2), also known as silicon dioxide, is a hard, chemically stable, and abundant mineral found in sand, quartz, and various rocks. It has high melting and boiling points, excellent thermal stability, and good resistance to chemical attack, especially from acids. Silica is widely used in the manufacture of glass, ceramics, and refractories due to its durability and insulation properties. In powdered form, it also serves as a filler in construction and industrial applications.

4.Iron oxide

Iron oxide is a chemical compound composed of iron and oxygen, commonly found in nature as hematite (Fe_2O_3) and magnetite (Fe_3O_4). It is known for its reddish or black coloration and strong pigmentation, often used in paints, coatings, and ceramics. Iron oxide is chemically stable, has good thermal conductivity, and is resistant to high temperatures, making it useful in refractory materials. Additionally, it exhibits magnetic properties (especially magnetite) and is widely used in magnetic storage media and as a catalyst in chemical processes.

5.Binder (lime)

Lime, primarily in the form of quicklime (CaO) or slaked lime ($Ca(OH)_2$), is a highly reactive, alkaline material with a white, powdery appearance. It has strong basic properties, making it effective in neutralizing acids and treating wastewater. Lime has high thermal stability and is commonly used in metallurgy, construction (as a binding material in mortar), and the chemical industry. It reacts exothermically with water and plays a key role in improving soil quality and reducing impurities in industrial processes.

4. MIX PROPORTION

proportions	Mgo	Silica	Red Soil	Iron Oxide	Lime
1st	2.55 kg	0.15 kg	0.15 kg	0.09 kg	0.06 kg
2nd	2.4 kg	0.15 kg	0.15 kg	0.09 kg	0.21 kg
3rd	2.25 kg	0.15 kg	0.15 kg	0.09 kg	0.30 kg

5. RESULT AND DISCUSSION

5.1 SOUNDNESS TEST

Soundness refers to the ability of bricks to withstand weathering, erosion, and other environmental factors without deteriorating.

PROCEDURE

Take two bricks: Choose two bricks randomly from the batch.

Strike them together: Hold one brick in each hand and strike them together gently.

Check the Sound : A Clear, metallic Ringing Indicates good Quality Bricks.A dull or Hollow sound may indicate poor Quality bricks.

The soundness test for non-flammable bricks is conducted to assess their durability and resistance to thermal shocks or sudden environmental changes. In this test, a brick sample is first visually inspected for any pre-existing cracks or defects. It is then heated in an oven at a temperature of about 105°C to 110°C for approximately 24 hours. After heating, the brick is allowed to cool at room temperature. This heating and cooling cycle is repeated several times, typically five, to simulate real-life conditions. After completing the cycles, the brick is carefully examined for any signs of cracks, disintegration, or structural deformities. A brick that shows no visible damage after repeated thermal exposure is considered to have good soundness.

TABLE 5.1.2Result of soundness test

PARAMETER	OBSERVATION
Visual Damage	No major cracks, spalls, or deformation should occur
Mass Loss (%)	Should be < 1%–2% depending on grade.
Dimensional Change (%)	Minimal, typically < 0.3% allowed
Number of Cycles Passed.	At least 5–10 cycles without damage indicates good soundness

5.2 HARDNESS TEST

The hardness test of bricks is a simple test to check the durability and quality of bricks. Here's how it works.

PROCEDURE

1. Scratch the brick: Use a fingernail or a sharp object to scratch the surface of the brick.
2. Check the scratch: Observe the scratch mark.

5.2.1RESULTS

TABLE 5.2.2 Result of hardness test

Mineral pick	Hardness Value	Typical Behavior
Orthoclase	**6**	May just scratch MgO
Quartz	**7**	Should scratch MgO
Topaz	**8**	Easily scratches MgO

The MgO brick has a Mohs hardness of approximately 6.5–7.

5.3 EFFLORESENCE TEST

The efflorescence test checks for salt deposits on bricks, which can affect their appearance and durability.

PROCEDURE

1. Immerse the brick: Place the brick in water for some time.

2. Dry the brick: Remove the brick from water and let it dry.

3. Observe the brick: Check for white patches or deposits on the brick's surface.

5.3.1 RESULT

TABLE 5.3.1.1Result of effoloresence

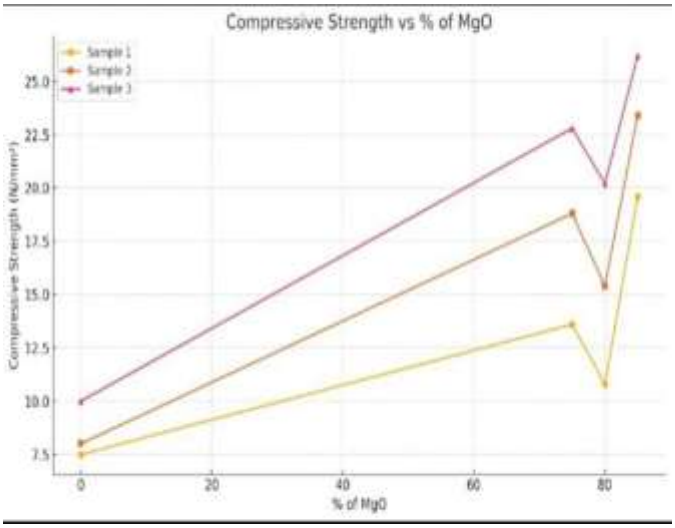
Grade	**Criteria**
Nil	No visible deposits
Slight	Less than 10% of the exposed area affected by thin salt deposits
Moderate	10–50% of the area covered, slight powdering possible
Heavy	More than 50% area covered, surface visibly powdery
Serious	Heavy deposits with surface flaking or spalling

5.4 COMPRESSIVE STRENGTH

The compression test for MgO (magnesia) bricks is conducted to determine their load-bearing capacity and structural integrity under axial stress. The procedure begins with the preparation of standard test specimens, typically cut into cubes or rectangular prisms with dimensions conforming to relevant standards (e.g., ASTM C133 or IS standards). The surfaces of the specimen are ground to ensure they are flat and parallel, which helps achieve uniform load distribution during testing.The load is applied axially at a constant rate (commonly 0.5 to 1 MPa/s), and the maximum load at which the specimen fails or cracks is recorded.

TABLE 5.4.2 COMPRESSIVE STRENGTH

The specimens were tested on the compression testing machine (CTM) and the values are tabulated



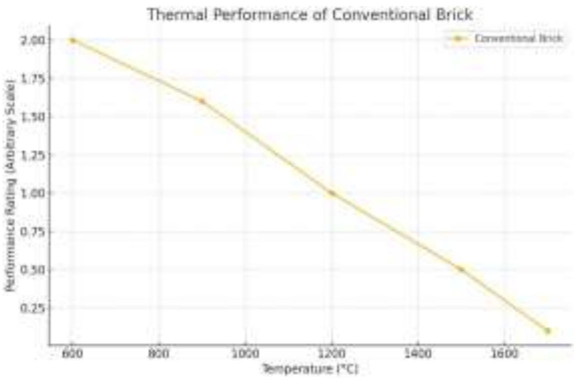
s.no	% of MgO	Compressive strength
1	0%	7.5 N/mm2
	75%	13.6 N/mm2
	80%	10.8 N/mm2
	85%	19.6 N/mm2
2	0%	8 N/mm2
	75%	18.8 N/mm2
	80%	15.4 N/mm2
	85%	23.4 N/mm2
3	0%	10 N/mm2
	75%	22.8 N/mm2
	80%	20.2 N/mm2
	85%	26.2 N/mm2

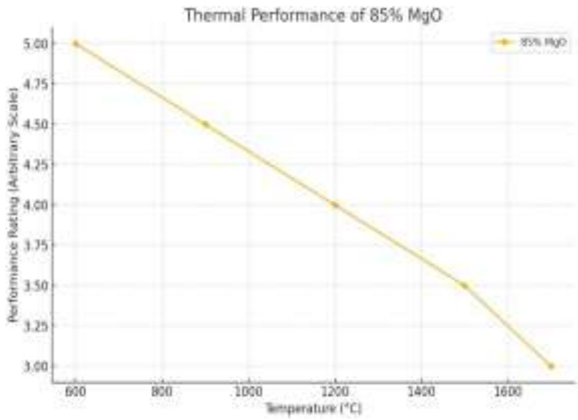
5.5 FIRE RESISTANCE

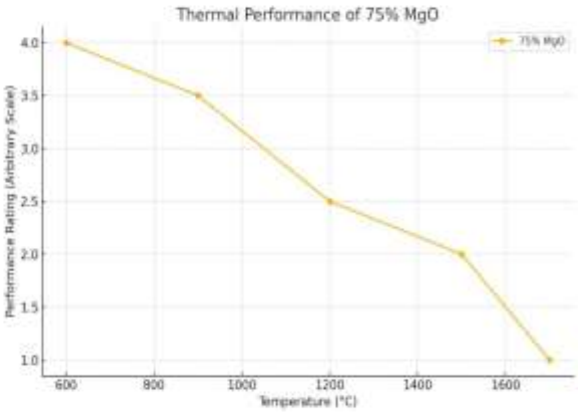
The fire resistance test of bricks is carried out to determine their ability to withstand high temperatures without failing or losing structural integrity. This test helps assess the suitability of bricks for structures exposed to high heat, such as chimneys, kilns, furnaces, and firewalls. The procedure follows the guidelines laid down by ISO 834 / ASTM E119 (Method of Test for Fire Resistance of Building Materials).

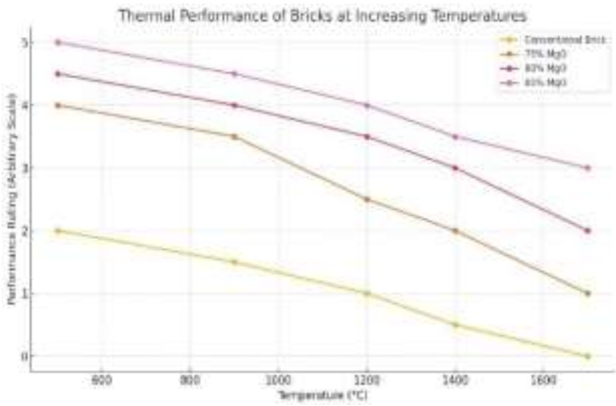
International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 05 | May - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

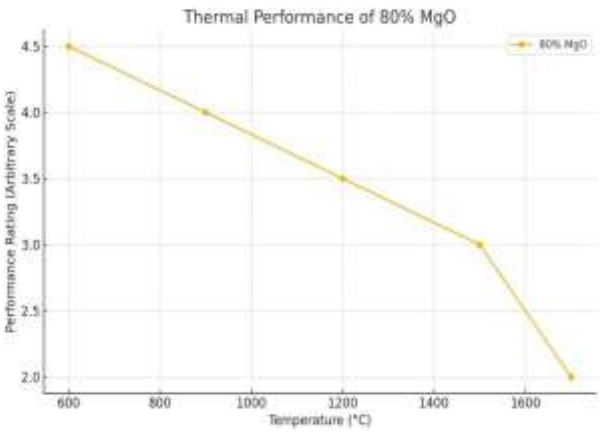
5.5.1 COMPARISON OF CONVENTIONAL AND MgO BRICKS











5.6 CONCLUSION

MgO bricks offer excellent resistance to basic slags, alkaline environments, and corrosion.

Due to their low thermal conductivity, they also contribute to energy conservation by minimizing heat loss, thus improving the overall efficiency of thermal systems.

MgO bricks are eco-friendly and non-toxic, making them a safer option for fire-resistant construction and industrial applications.

75% MgO bricks provide moderate resistance but begin degrading at high temperatures, making them suitable only for intermediate thermal environments.

80% MgO bricks exhibit good stability and strength retention up to 1600°C, making them reliable for many industrial uses.

85% MgO bricks demonstrate the best performance, resisting deformation and maintaining form even at 1800°C, making them ideal for extreme heat applications like steel production, cement kilns, and glass manufacturing.

For critical high-temperature environments, bricks with 85% MgO content are the most effective and reliable choice.

5.7 REFERENCE

Effect of Packaging Method and Storage Environment on Activity of Magnesium Oxide and Mechanical Properties of Basic Magnesium Sulfate Cement (2024)

Effect of Molar Ratios on Magnesium Oxychloride Cement (2022)

Water Resistance and Mechanism of FeSO4 Enhancing Bamboo Scraps/Magnesium Oxychloride Cement Composite (2022)

Research and Engineering Application of Salt Erosion Resistance of Magnesium Oxychloride Cement Concrete Materials (2021)

Research and Engineering Application of Salt Erosion Resistance of Magnesium Oxychloride Cement Concrete Materials (2021)

Published a study on sustainable calcination of magnesium hydroxide for magnesium oxychloride cement production in (2019)

Sustainable Calcination of Magnesium Hydroxide for Magnesium Oxychloride Cement Production (2019)