

# Preparation of Refractory Mortars from Kaolin with Bauxite and Flint Additives

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**ABSTRACT:** Refractory mortars prepared from fired bauxite or flint with small amount of potassium silicate and water added to kaolin with different percentage 10, 20, 30 and 40 wt. % .This mortars can be used for building and plastering of furnaces bricks. Bauxite and flint was burned at 1200 °C then crushed and grinded to powder ranged from 0.2 to 1.18 mm before adding to kaolin. The mortar was formed by adding water and potassium silicate as binder materials. Samples of medium alumina bricks was adhesive by mortar, and after that, firing at 1200 °C to achieve adhesion. Bond strength increased with bauxite and flint additives increasing, as well as decreased the porosity and, conversely, increased the density with low shrinkage when adding bauxite and flint.

**KEYWORDS:** (refractory Mortar, kaolin, mechanical and physical properties)

## I. INTRODUCTION

Refractory materials are substances that have the ability of thermal insulation for high temperatures and it has the ability to withstand high temperatures without breaking or deformation. It also maintains several of their properties under various operating conditions and has a high degree of softening up to more than (1540 °c). Refractory ceramic has special Characteristics such as high resistance to melting, high resistance to thermal shock, with low thermal conductivity and a low thermal expansion. One of the most important uses is to build refractories and furnace linings wall [1].

Refractory products are generally classified into two types: brick and monolithic refractories [2]. Raw clays are the oldest refractories that used, and then the production of refractories rapidly has developed to keep pace with industrial progress[3]. Mortars are available in compositions that either approximate the bricks they are holding together, or they are chosen so that their thermal expansion will be comparable to the bricks with which they are used. The point is to obtain a substance that comes as close as possible to being a monolithic refractory structure [4].

## II. EXPERIMENTAL WORK

For preparing the specimens the kaolin, bauxite and flint stones were sintered at 1200 °c then crushed to a fine powder and finally sieved to different particle sizes (0.2 and 1.18 mm). Bauxite and flint were used as additives in (10, 20, 30 and 40 wt. %) of kaolin weight. firstly a dry mixing to the kaolin and the additives were done then water (6 ml) and potassium silicate (4ml) were added as a binding material for the total mix. The specimens were prepared by hand molding method. They pressed in a cylindrical mold with diameter of (10 mm) and left in air for 24 hours then they fired at 1200°c for 1 hour.

The specimens were prepared according to standard ASTM F1097 – 91[5]. The X-ray diffraction for Kaolin rocks shows that they consist of Kaolinite and Quartz as illustrated in figure (3 – 1), for bauxite rocks it shows that Bauxite rocks consist of Kaolinite and Boehmite as illustrated in figure (3- 2), While for flint rocks the X-ray diffraction test shows that they consist of quartz and calcite as illustrated in figure (3 – 3)

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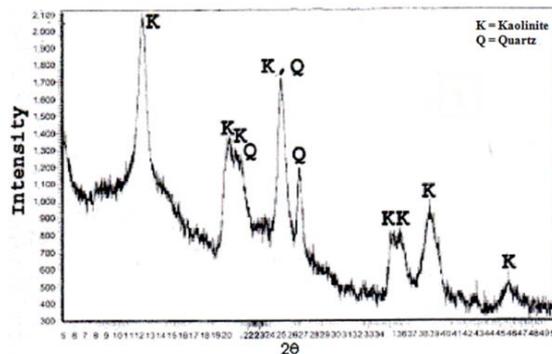


Figure (3 – 1) shows the X-ray diffraction test for Kaolin rocks.

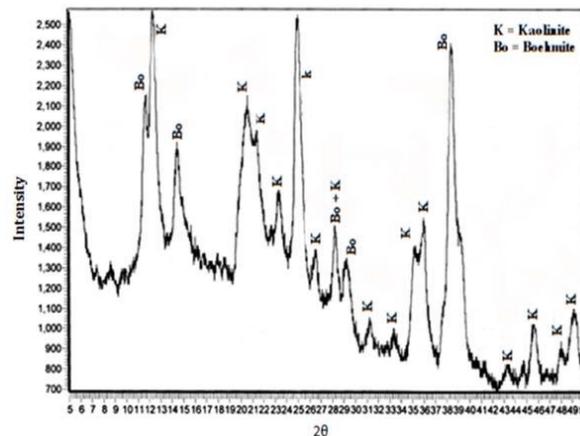


Figure (3 – 2) shows the X-ray diffraction test for bauxite rocks.

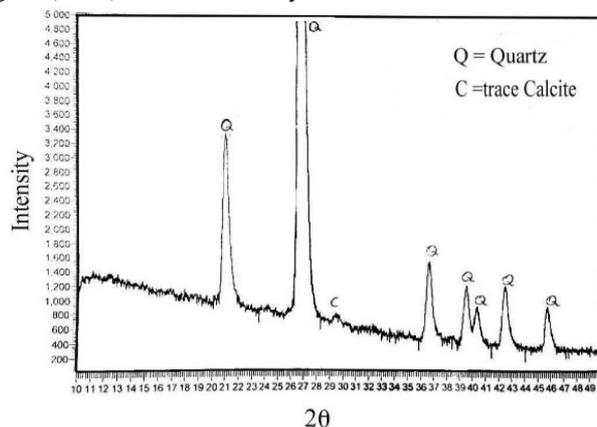


Figure (3 – 3) shows the X-ray diffraction test for flint rocks.

## III. TEST PROCEDURE

### 3.1 Bond strength

The bond strength of the mortar was measured by using three part of silica bricks and bond them together with the prepared mortar according to ASTM C 482 – 02 [6]. The bricks were cut by using a diamond cutter and placed as in the figure below.

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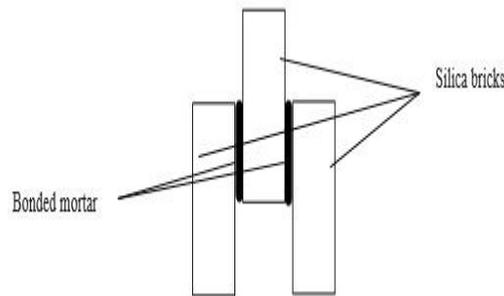


Figure (3-4): shows how bricks bonded by the mortar.

Two types of specimens (bauxite and flint) were prepared and compared with the reference one (only kaolin). The bond strength was calculated by dividing the max load on the bonded area.

$$\text{Bond strength [MPa]} = \text{load [N]} / \text{area [mm}^2\text{]} \quad (3-1)$$

### 3.2 Bulk density and apparent porosity

Bulk density and apparent porosity were measured by specimens' immersion in water. Cylindrical specimens of (20\*10 mm) were used according to ASTM C 20 [7].

$$\text{Bulk density} = D / W - S \quad (3-2)$$

$$\text{Apparent porosity} = [(W - D) / (W - S)] * 100 \quad (3-3)$$

Where: D is the dry weight (gm.), W is the saturated weight (gm.) and S is the suspended weight (gm.).

### 3.3 Linear shrinkage

Linear shrinkage was measured by taking the specimens dimensions before and after firing by using the Vernier. The same cylindrical specimens were used according to ASTM - C1407 [8].

$$\text{L.S (\%)} = \frac{L_0 - L}{L_0} \times 100 \% \quad (3-4)$$

## IV. RESULTS AND DISCUSSION

### 4.1 bond strength

Bond strength of mortar is the most important property which shows the ability of the mortar to adhere two bricks. The figures below show the results of bond strength values for the bauxite and flint and compared with reference specimens.

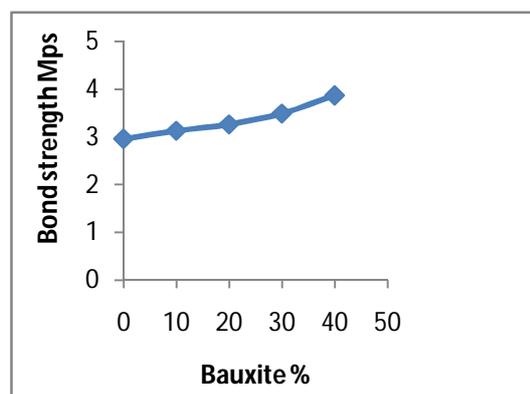


Figure (4-1) shows bond strength for bauxite and reference specimens.

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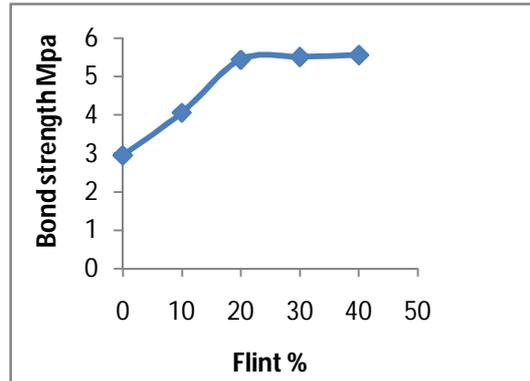


Figure (4-2) shows bond strength for flint and reference specimens.

Results showed that an increasing in strength for bauxite and flintspecimens in comparison with reference. This variation in bond strength due to the formation of Mullite and glass phases causes the bond strength and adhesion force to increase and hence keep two bricks adhered for long time. This is resulted due to phase interference and fusion between the surfaces of brick and refractory mortar.

#### 4-2 Bulk density and apparent porosity

The increasing in apparent density leads to a decreasing in porosity. The density depends more on raw material which are used, also depends on firing temperature and soaking time. Results showed that there was an increasing in density and decreasing in porosity for both Bauxite and flint additives as shown in figures (4-3), (4-4), (4-5) and (4-6). These changes because the volume is reduced due to shrinkage also due to the presence of alumina which has higher density than kaolin.

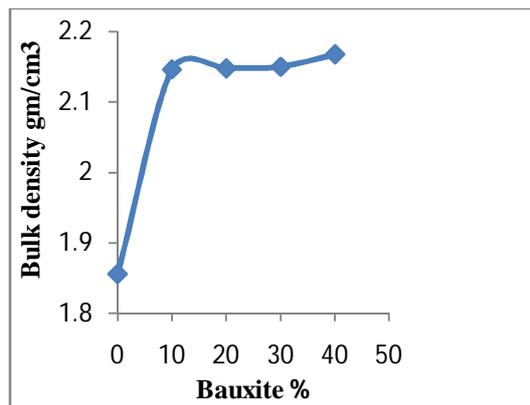


Figure (4-3) shows bulk density for bauxite and reference specimens.

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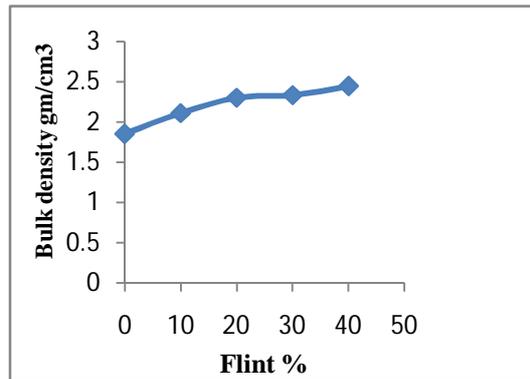


Figure (4-4) shows bulk density for flint and reference specimens.

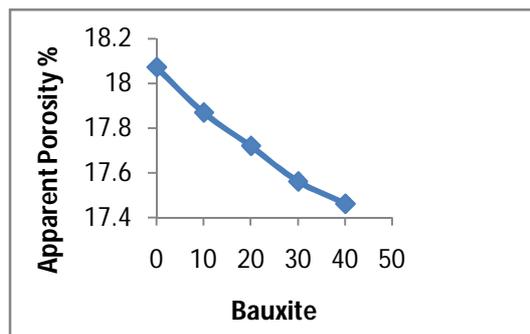


Figure (4-5) shows apparent porosity for bauxite and reference specimens.

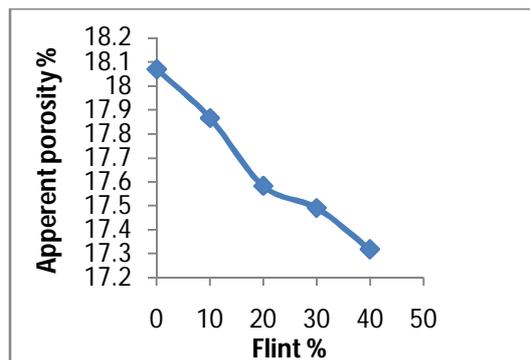


Figure (4-6) shows apparent porosity for flint and reference specimens.

#### 4-4 linear shrinkage

During firing process, the pores size is going to decrease and that will cause shrinkage in specimen dimensions, the value of this shrinkage depends on the raw materials which are used in the mixture, particle size and distribution and firing temperature [87]. Figures (4-7) and (4-8) show an increasing in shrinkage values after firing due to glazing process and Mullite formation. The mullite phase is formed as a result of the reaction between alumina and silica.

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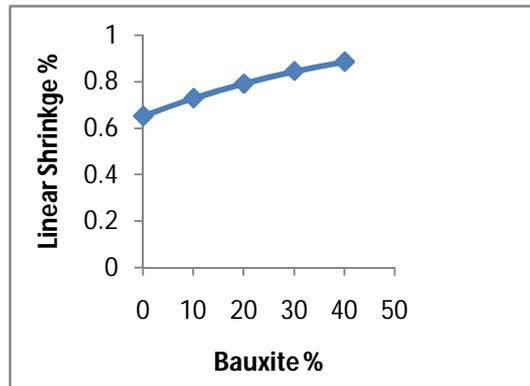


Figure (4-7) shows linear shrinkage for bauxite and reference specimens.

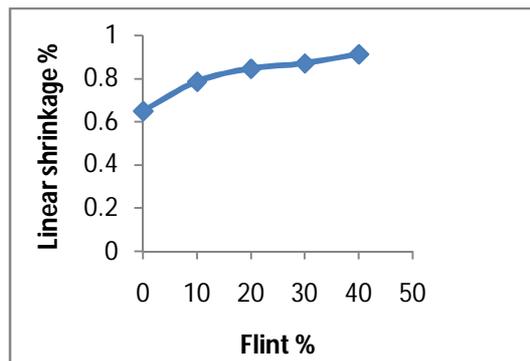


Figure (4-8) shows linear shrinkage for flint and reference specimens.

## V. CONCLUSION

This research has shown the possibilities of production of local refractory binding material. The addition of bauxite and flint to refractory mortar improves the properties of refractory mortar, such as bond strength and bulk density also decreasing in porosity. The best percentage content of addition was found to be 40%.

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