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Study of some Physical properties of basalt – clay mixes

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A R T I C L E I N F O

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A B S T R A C T

Jordanian basalt was added to China clay on different mixes up to 60% by weight. Some of physical properties were studied. Mixes basalt showed a remarkable increase in density with increasing basalt addition. Porosity was the property greatly affected with increasing the firing temperature. Maximum reduction in porosity was observed at high firing temperature for all mixes and this will cause increase in hardness values. The different phases were determined by X–ray analysis. The expansion coefficient decreases with the increase of the basalt content. No significant differences of the heating rate are observed on the properties of the thermal expansion after firing at 1100°C for all mixes.

Introduction

Basalt is well known as rock found in virtually every country around the world. It's main use is a crushed rock used in construction industrial and highway engineering [1]. Basalt fine powders and fibers are superior to use in terms of thermal stability, heat and sound insulation properties, vibration resistance and durability [2,3].

Basalt powder together with carbon or ceramic powder as well as various metals is the most advanced and exciting area of application, as they can develop new hybrid composite materials and technologies [4].

Gamlen and lyng[5] showed that melting of basalt results in the recrystallisation of substantially higher proportion of pyroxenes and bring about improvement of the mechanical property as well [5]. They have the advantage an primary basalt in showing homogeneous crystalline texture. Holmstron studied the effect of basalt on the sintering tendency of various clays [6]. He added basalt up to (75 %) to siliceous clay and fired between 950 and 1150°C .The greatest effect was obtained by the addition of (50 %) basalt. He also concluded that during annealing , the formation of neogenic anorthite and wollastonite occurs very intensively .

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The present work aims at following the effect of basalt addition on the pure china clay. Physical, thermal and structural properties of basalt – clay mixes are also studied.

Expermental

Jordanian basalt dark –brown color from Al-Aqaba and china clay is used in this study. Chemical and mineralogical compositions of clay and basalt are given in Table 1. Differential thermal analysis (DTA) of raw materials was examined at the selected temperature using instrument type (Netzsch , sta 409) . This raw materials were ground separately to pass around 250 mesh sieve. The main grain size of raw material used lies between 20 – 30 µm. the proposed mixes are given in table 2. The disc samples 5 cm is a radius and 2.5 mm thickness were fabricated according to ceramic techniques under a pressure of 45 KN, dried at 140 °C and fired between 900 and 1150 °C , with heating rate 5°C / min.

Bulk density and porosity were determined according to the ASTM –C830 [7]. Samples in the form of bars (8 *0.5 *1 cm) were processed under the same condition and fired at the selected temperature to measure the linear thermal expansion , with a heating rate of 10°C/ min. and 5°C/ min. up to 1100°C . The main crystalline phases mullite, institute and quartz in the mixes were quantitatively determined by X- ray diffraction analysis, using the internal standard CaF2 (table 4) . Mohs scale of mineral hardness was used to measure the hardness for all specimens.

RESULTS AND DISCUSSION

The results of thermal properties for raw materials determined from a DTA curves are given in Fig (1). It shows a distinct endothermic peaks at 550°C and 940°C for china clay and basalt respectively. This may be indicating the presence of silica (quarts) and kaolinite as shown in the clay mineral in Table (1). The mineralogical constitution (Table 2) of the basalt also revealed the presence of large amount of feldspar and pyroxene which probably caused the endothermic peak [8,9].

The results of apparent porosity and bulk density properties determined are shown in Fig. (2) and (3) respectively, which gives an idea about the heavier of the mixes during firing. Fig. (3) shows that increasing the basalt in the mixes highered the value of density considerably. Mixes of A- 40 and A – 60 showed bulk density of 2.37 and 2.43 g/cm3 at 1000 and 1100°C respectively. Mixes of A –20 and A – 40, on the other hand have the same value of density at 950°C, but results of porosity of all mixes showed a drop occurring with increasing the firing temperature (Fig. 2). The A – 20 decreased from 22 % at 900°C to 7.57 % at 1150°C compared with mix A 60 at the same temperature which are 13.4 % and reached to 2.55 % at 1150°C.It was presumed that the basalt usually starts to melt at 1050°C giving a less viscous liquid. It goes into complete solution with increasing temperature [5]. This melt acts on the clay mineral and quartz present as impurity in it (Table 1). The interface between basalt and clay mineral could diffuse and expected transformation present with increasing basalt mixes which is expected close the pores under influence of surface tension to fill the pores.

The result of the main crystalline phases present in the mixes are determined by X-ray diffraction analysis, which are summarized in Table (4). The X-ray finding the mullite content are nearly constant in the mixes irrespective of the clay content. The present of quartz decreased with the high basalt mixes. Quartz is present as impurity in the clay as detected by mineralogical constitution (Table 2). The institute content, on the other hand, increases with basalt content.

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Table (1): Typical chemical mineralogical

Composition	Raw Materials	
	China clay	Basalt
SiO2	53.11	50.99
Al2O3	33.44	13.89
Fe2O3	0.51	4.08
FeO	0.23	6.68
TiO2	--	2.35
CaO	0.11	11.43
MgO	0.30	7.11
Loss on ignition	11.33	2.62
Total	99.03	99.15

Table (2): Mineralogical analysis of the raw Analysis of the raw materials materials

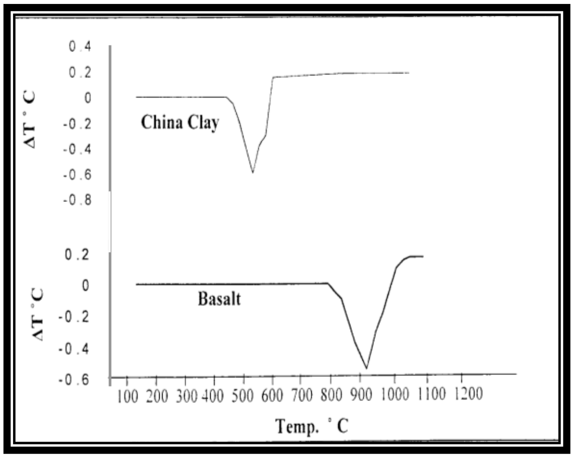
Mineral constitution	Raw Materials	
	China clay	Basalt
Feldspar	-	60.31
Quartz	17.21	-
Pyroxene	-	32.07
Olivine	-	3.11
Kolinite	80.35	-
Iron ore	-	8.15

Table (3): Experimental Mixes

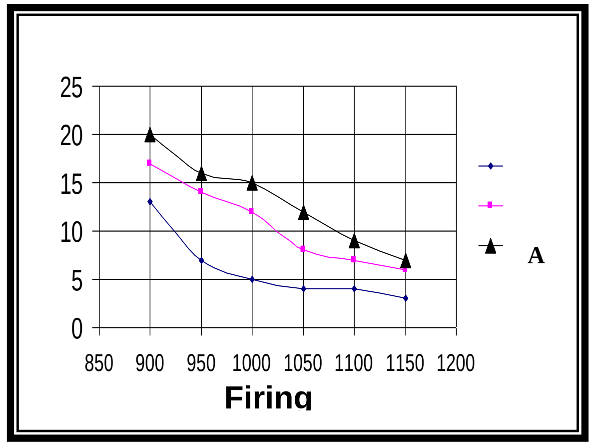
Mixes	Weight %	
	China clay	Basalt
A-20	80	20
A-40	60	40
A-60	40	60

Table (4): X-Ray Diffraction Analysis

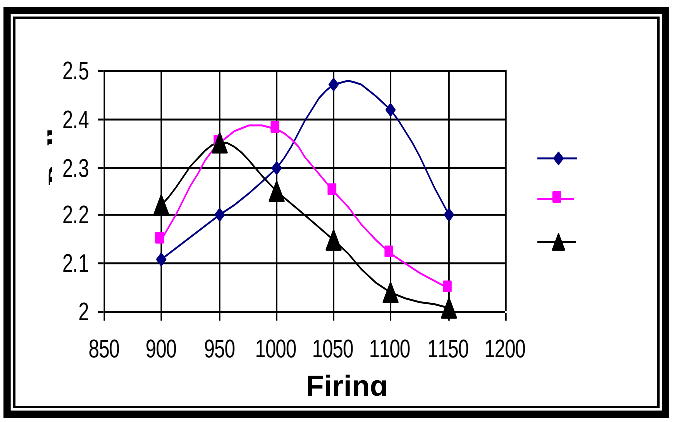
Mixes	Crystalline Phases %		
	Mullite	Quartz	Enstatite
A-20	25.21	8.50	2.15
A-40	24.09	6.07	3.35
A-60	24.50	3.45	4.08



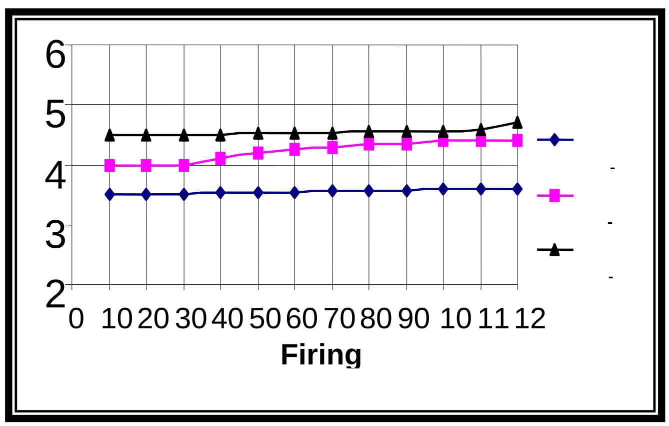
Fig(1) DTA Of raw materials



Fig(2) Apparent porosity of different mixes



Fig(3) Bulk density of different mixes



Fig(4) Thermal expansion coefficent of different mixes

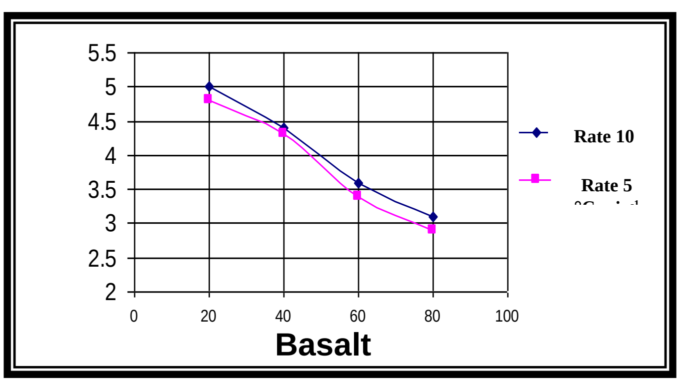
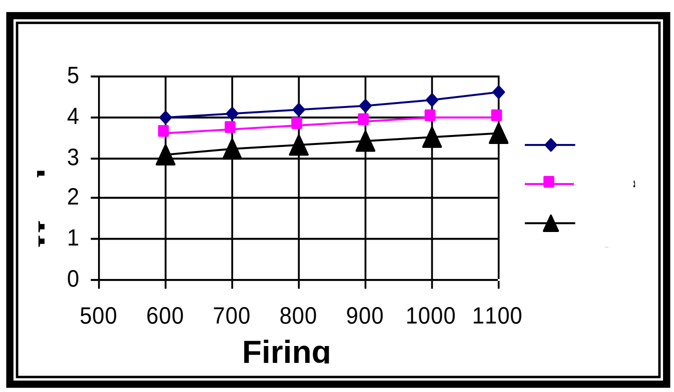


Fig (5) Effect of mode of rate on thermal expansion coefficient after firing at 1100 °C



Fig(6) Mohs scale hardness of different mixes

دراسةبعض الخواص الفيزيائية لخلائط من البازلت – الطين الصيني–

عادل نعمة عيّاش

الخلاصة

تناول البحث دراسة الخواص الفيزيائية، التركيبية والحرارية لنماذج محضرة باستخدام ميتالوروجيا المساحيق من مزج مساحيق من البازلت الأردني بنسب وزنية تصل إلى60% من الطين الصيني. أكدت النتائج التجريبية زيادة قيم الكثافة الظاهرية عند ازدياد درجات حرارة الحرق لكافة نسب البازلت المضافة ، كما لوحظ انخفاض شديد في قيم المسامية مع ارتفاع درجات حرارة الحرق لجميع العينات المدروسة ، مقرونا بزيادة ملحوظة في قيم الصلادة الميكانيكية .أما نتائج الفحوصات التركيبية فقد اظهرت وجود أطوار بلورية مختلفة تم تحديدها من تحليلات الأشعة السينية . أظهرت الفحوصات الحرارية انخفاض في قيم معامل التمدد الحراري مع زيادة نسب البازلت المضافة . كما لوحظ عدم وجود تأثير واضح لمعدلات التسخين المستخدمة على خاصية التمدد الحراري.