Asian Journal of Chemistry; Vol. 26, No. 6 (2014), 1757-1758

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2014.17345

Study on Properties of High Quality Silicon Mullite Brick†

Zhenying Liu*, Jing Wang, Hengmao Fan and Bin Xu

School of Material and Science and Engineering, Anhui University of Science and Technology, Huainan 232001, Anhui Province, P.R. China

*Corresponding author: Tel: +86 13395547584; E-mail: yingchunliu1007@163.com

Published online: 10 March 2014; AJC-14887

Silicon mullite brick was prepared using high-grade bauxite and ultra-fine silicon carbide as main starting materials. In this study, the effect of zircon sand addition on the physical, chemical and mechanical properties of the bricks was investigated. The results showed that with the increase of zircon sand addition had a great effect on the physical and mechanical properties of the silicon mullite bricks. The bulk density and strength of the samples sintered at different temprature increased first and then declined,thermal shock resistance and alkali erosion of the samples increased significantly, when the optimum addition of zircon sand was 10-15 %, the silicon mullite brick had better alkali resistance.

Keywords: Silicon mullite brick, Zircon sand, Thermal shock resistance.

INTRODUCTION

Recently, the development of China's cement industry was rapid, A lot of solid wastes were used as raw materials and fuels, The main reason of damage to refractory materials, including chemical erosion, mechanical abrasion and thermal stress, which shortened the life of cement kiln refractory lining, with the consumption of refractories, which greatly affected the economic efficiency of enterprises of cement production[1]. Traditional refractory was typically configured in kilns, before the transition zone, after the transition zone, decomposition zone with the different performance of the refractories, such as spinel bricks, magnesia-chrome bricks and anti-stripping bricks. But this kind of bricks had relatively large thermal conductivity, the cylinder temperature reduced abrasion resistance[2-4]. In contrast, materials containing special grade bauxite and those containing silicon carbide were used in experiments to produce silicon mullite bricks. These bricks, being heat-resisting, corrosion-resisting, antiseismic and wear-proof, demonstrated high-quality performance.

EXPERIMENTAL

The bricks were prepared using special grade bauxite (particle size distribution for the 5-3 mm, 3-1 mm, < 1 mm) andalusite (< 0.088 mm), silicon carbide (< 0.088 mm), zircon sand (< 0.088 mm), methylcellulose as a binding agent. The main chemical compositon showed in Table-1.

All aggregate system components were mixed for 2 min in mixer, zircon sand was added as amount of 0 (S1), 5 % (S2), 10 % (S3), 15 % (S4) and 20 % (S5), the materials were packed into metal moulds with a dimension of φ 36 mm × 36 mm, after demoulding, the samples were dried at 110 ºC for 24 h and fired at 1420 and 1480 ºC for 3 h. Dried and fired samples were tested for bulk density, the bulk density of the sintered samples was measured following the Archimedes principle according to GB/T2997-2000 standard and CCS measurements as well as thermal shock stability of the specimens were determined, then take the optimal sample, for X-ray and scanning electron microscopy (SEM).

RESULTS AND DISCUSSION

Fig. 1 showed the effect of zircon sand content on the bulk density of the samples. It could be seen that bulk density increased with the increase of zircon sand content. It was attributed to the better ability of zircon sand to fill the voids. The compressive strength gradually increased, then declined. It was indicated that when the adding amount of zircon sand was 15 %, the performance of samples was better.

Influence of zircon sand content on high temperature properties of samples

Thermal shock stability analysis of the samples: As it could be seen from Table-2, addition of zircon sand improved

†Presented at The 7th International Conference on Multi-functional Materials and Applications, held on 22-24 November 2013, Anhui University of Science & Technology, Huainan, Anhui Province, P.R. China

TABLE-1
CHEMICAL COMPOSITION OF RAW MATERIALS

Raw material	Al_2O_3	Fe_2O_3	SiO_2	CaO	MgO	Na_2O	ZrO_2	SiC
High grade bauxite	88.24	1.15	4.68	0.50	0.67	2.79	–	–
Andalusite	56.94	0.75	41.31	0.05	0.09	0.11	–	–
Zircon sand	0.14	0.05	31.93	0.06	0.06	0.05	67.02	–
Silicon carbide	–	1.22	–	–	–	–	–	90.9

TABLE-2
HIGH TEMPERATURE PROPERTIES OF SAMPLES

Sample number	S1	S2	S3	S4	S5
Thermal shock stability (1100 °C water cooling)/times	18	22	31	25	27
Thermal conductivity 1000 °C (w/m k)	2.3	2.1	1.65	1.96	1.95

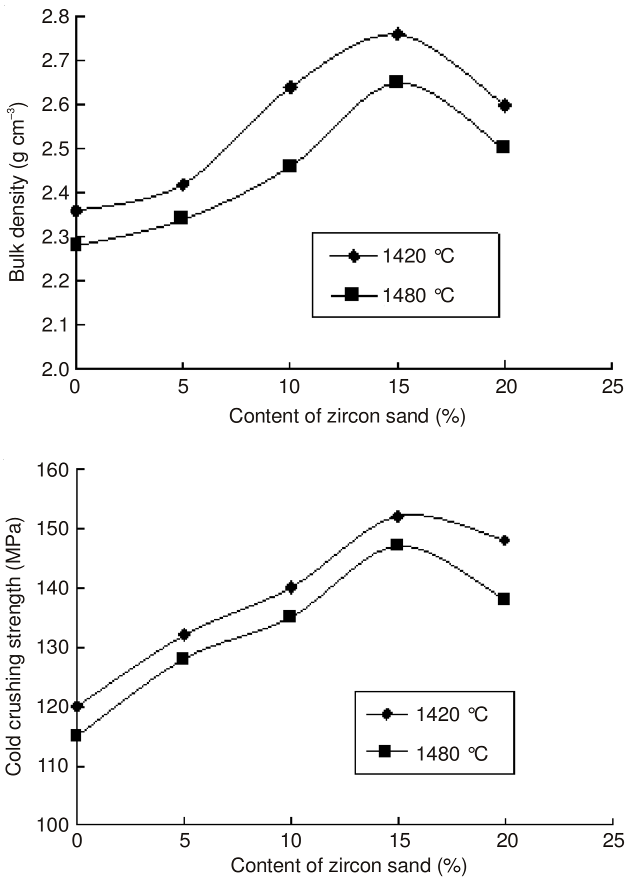

Fig. 1. Effect of zircon sand on bulk density and compressive strength of the samples

the thermal shock resistance of the samples, The test results showed that 31 times water cooling in 1100 °C thermal shock was perfect without any spalling and crack. Mainly it was because the zirconium-containing material was to achieve the toughening function of ZrO_2[5,6]. Following reaction occured at high temperatures:

$$2ZrSiO_4 + 3Al_2O_3 \rightarrow 3Al_2O_3{\cdot}2SiO_2 + 2ZrO_2 \quad (1)$$

Monoclinic ZrO_2 formed during the reaction process of change to the tetragonal ZrO_2 crystal form was accompanied by a volume effect. To a certain extent, reducing the detrimental effect of the crack and absorbing the crack propagation energy, so the performance of thermal shock stability was improved.

Thermal conductivity analysis of the samples: As seen in Table-2, the addition of zircon sand significantly reduced the thermal conductivity of the samples. The thermal conductivity of traditional silicon mullite bricks was too large, which increased in the external wall temperature of the kiln rise. The low thermal conductivity of high quality silicon mullite bricks greatly reduced the rotary kiln temperature and the deformation of the kiln shell, which effectively prevented cylinder and roller of rotary kiln heat expansion.

Conclusion

The results showed that bulk density and strength increased first and then decreased with the increase of zircon sand content. Optimum amount of zircon sand was 10-15 %. It was attributed to the better ability of zircon sand to fill the voids. Because of using zircon sand with high surface area between these particles and matrix, The appropriate amount of zircon sand formed dense mullite bonded phase in the matrix, each other cross-linked network structure, which made matrix structure compact. It made the samples gain the higher strength. The results showed that a certain amount of zircon sand content in the samples increased the cold compression strength and the thermal shock resistance of the bricks.

ACKNOWLEDGEMENTS

This research was supported by Natural Science Foundation of China (51002002) and the Scientific and Technological Project of Huainan Municipality (1I049).

REFERENCES

1. A. Ozturk and M. Timucin, *Adv. Appl. Ceram.*, **110**, 400 (2011).
2. P.K. Xu, *Cement Guide*, **6**, 51 (2010).
3. X.Z. Lin, *Cement Works*, **12**, 53 (2005).
4. H.G. Liu, *Cement*, **4**, 29 (2009).
5. U.V. Bongers, D.I. Riddll and J. Stradtmann, *World Cement*, **12**, 14 (1996).
6. J. Szczerba, *Ceram. Int.*, **36**, 1877 (2010).