www.sphinxsai.com

ChemTech

International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN : 0974-4290
Vol.6, No.12, pp 4991-4994, October 2014

CBSE-2014 [2nd and 3rd April 2014]

Challenges in Biochemical Engineering and Biotechnology for Sustainable Environment

Fabrication and Properties of Bagasse Ash Blended Ceramic Tiles

G.Sivakumar[1]*, V.Hariharan[2], M. Shanmugam[2] and K.Mohanraj[3]

[1]CISL, Department of Physics, Annamalai University,
Annamalai Nagar -608002, Tamilnadu, India
[2]Department of Physics, Annamalai University,
Annamalai Nagar -608002, Tamilnadu, India
[3]Department of Physics, Manonmaniam Sundaranar University,
Tirunelveli-627012, Tamilnadu, India.

*Corres.Author: Gsk_Cisl@Yahoo.Com

Abstract : In the present study focuses on the incorporation of sugarcane bagasse ash waste into ceramic tiles fabrication. A slight alter in the properties of ash causes interesting changes in its character and hence have potential application when partial replacement is undertaken using this material in ceramics. The physico-mechanical properties of the product were studied and SEM morphological results are correlated with the reference. An approximately 15% of bagasse ash improve the performance of ceramic products and yields better quality than standard one.
Keywords: *ceramic material, bagasse ash, properties, SEM.*

1 Introduction

In the ceramic industry, two or more natural materials are generally mixed to prepare the ceramic mass with the desired properties. In some cases, fluxing and/or nonplastic materials (e.g., quartz) can be used to improve the sintering process and the final ceramic properties. The composition of traditional porcelain is a triaxial body composed of plastic material (clays), a fluxing agent (feldspar) and quartz. The wide composition range of clays used for manufacturing ceramic tiles makes them good receptors of residues[1]. The possibility to recycle waste materials (ricehusk ash, sugarcane bagasse ash, fly ash and etc) in ceramic is nowadays an advantageous reality in environmental protection and in saving raw materials. Sugarcane bagasse ash (SBA) is widely available in many developing countries. The bagasse ash is still disposed of as waste in landfills causing environmental and other problems[2].

The ash has a very high silica concentration and contains aluminum, iron, calcium, alkalis and alkaline earth oxides in smaller amounts[3]. SBA may be classified as a probable pozzolanic material, with the main factors affecting reactivity being the crystallinity of the silica present in the ash and the presence of impurities such as carbon and unburned material[4]. Good pozzolanic properties are obtained in SBA heated between 800 and 1000 °C for 20 min[5] or treated by air calcination at 600 °C for 3 h. The improved pozzolanic properties[2] are due to the presence of amorphous silica, low carbon content, and high specific surface area[6]. Bagasse ash has many applications: cement replacement (pozzolanic) material adsorbent of heavy metals, and nonplastic material in ceramic materials[7]. The high crystalline silica content worsens some mechanical properties of ceramic materials[8].

The aim is to investigate the substitution of bagasse ash for ceramic body in the tile fabrication and to study the physical, mechanical and morphological properties of the tiles.

2 Experimental

2.1 Material

SBA was collected from Chengalvarayan sugarcane industry, Thirukovilur taluk, Tamilnadu. The washed and dried SBA was calcined through a muffle furnace at a heating rate of 300 °C/hour and then held at 650 °C for 2 hrs. At 500 °C, the organic compounds are decomposed and at 650 °C large amount of ash with high silica content was obtained in amorphous nature of bagasse ash (BGA). These results also indicate that the calcinations conditions adopted are sufficient to remove the carbon and volatile compounds, mainly for temperatures greater than 600 °C the specific surface area of this sample is significantly larger than that observed for SBA generated under uncontrolled burning conditions [9]. The standard raw ceramic bodies (clay, quartz, feldspar) are collected from M/S Oriental ceramic Industry, Viruthachalam. The oxide composition of the experimental materials (ceramic body (CB) and treated bagasse ash (BGA)) is given in Table.1.

Table. 1. Chemical composition (wt%) of experimental materials

Composition	SiO_2	Al_2O_3	K_2O	Fe_2O_3	Na_2O	TiO_2	CaO	MgO
CB	63.58	24.41	6.39	1.84	1.68	1.25	0.53	0.19
BGA	69.81	6.73	2.65	4.35	0.71	0.42	9.4	2.42

2.2 Method

Partial replacement (0 to 25%) of ceramic body by BGA in the ratio of 0, 5, 10, 15, 20, and 25 % by weight. Table.2 shows the mixture of ash and ceramic body (CB) for preparation of tile manufacturing. Specimen RCT represents the reference ceramic tile, P-BCT denotes the bagasse ash blended ceramic tile (where P as a percentage of BGA). Mixture of ash into the ceramic body was homogenized in a ball mill and the moisture was added to a level of 6-8% in the mixture. The tiles were prepared by the pressing technique at a constant pressure using molds and then firing was carried out in an electric kiln at 1250 °C. The quality of the fired ceramic tiles was determined on the basis of water absorption, porosity and bulk density carried out according to ASTM, 1985 [10]. The compressive strength of the specimen was measured by using a universal testing machine. Microstructure of the specimen was observed by secondary electron under a Scanning Electron Microscope (SEM) at 20 kV, available at Centralised Instrumentation and Service Laboratory (CISL), Annamalai University, Tamil Nadu.

Table. 2. Constituents (wt%) of specimen

Specimen	RCT	5BCT	10BCT	15BCT	20BCT	25BCT
CB	100	95	90	85	80	75
BGA	0	5	10	25	20	25

3 Results and Discussion

Fig.1 shows the physico-mechanical properties of the prepared tiles. Porosity value changes for sample addition of bagasse ash 0% to 25%. The figure indicates that the percentage of porosity values decreased with increasing ash content up to 15 %(15BCT) when compared to the reference tile. There is a crystallization of new phases, reduction of porosity is attributed to the formation of a liquid phase, which facilitates the process of diffusion during a liquid phase, sintering, mainly above 1000 ºC, where the liquid phase increases and non-plastic material of bagasse ash helps to fills the open pores up to 15BCT [11]. The addition of bagasse ash above 15 %, the porosity values decreased. With the increasing greater amount of ash, the concentration of fluxing also increases and favors the formation of the liquid phase in the clayed material. The above result shows that the addition of 20-25% BGA tends to increase the porosity of the ceramic tiles. Water absorption are consistent with those observed for porosity. Water absorption is an important property because it is related to the effective realization of the sintering process by the liquid phase. The bulk density of the experimental tiles tends to increase by the incorporation of ash up to 15 %.

The compressive strength of the reference ceramic tile (RCT) and ash blended ceramic tiles (BCT) are also shown in Fig.1. The incorporation of 5 to 15% ash tiles have the improved compressive strength than the reference tile. The additions of 20-25 wt% ash have decreased in strength. At 25 wt% of induced the formation of cracks and internal porosity due to the liquid phase, causing a decrease compressive strength in samples.

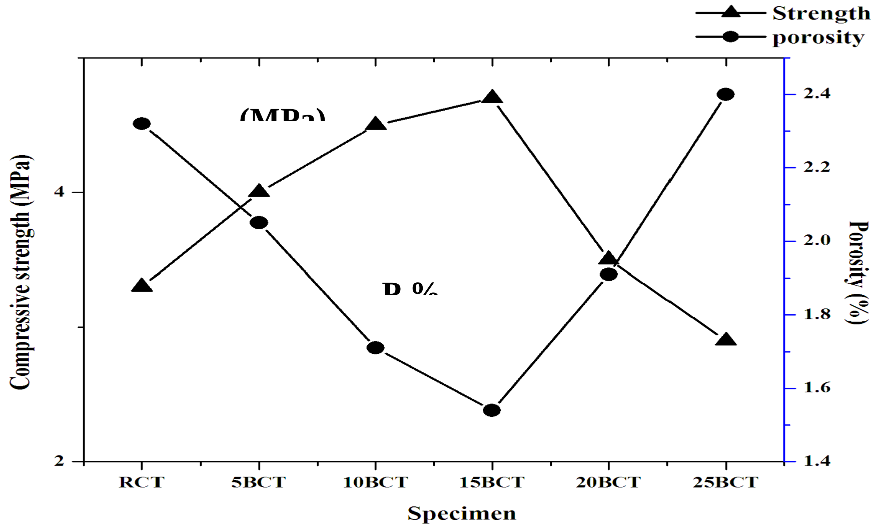

Fig.1. Physico-mechanical properties of experimental tiles

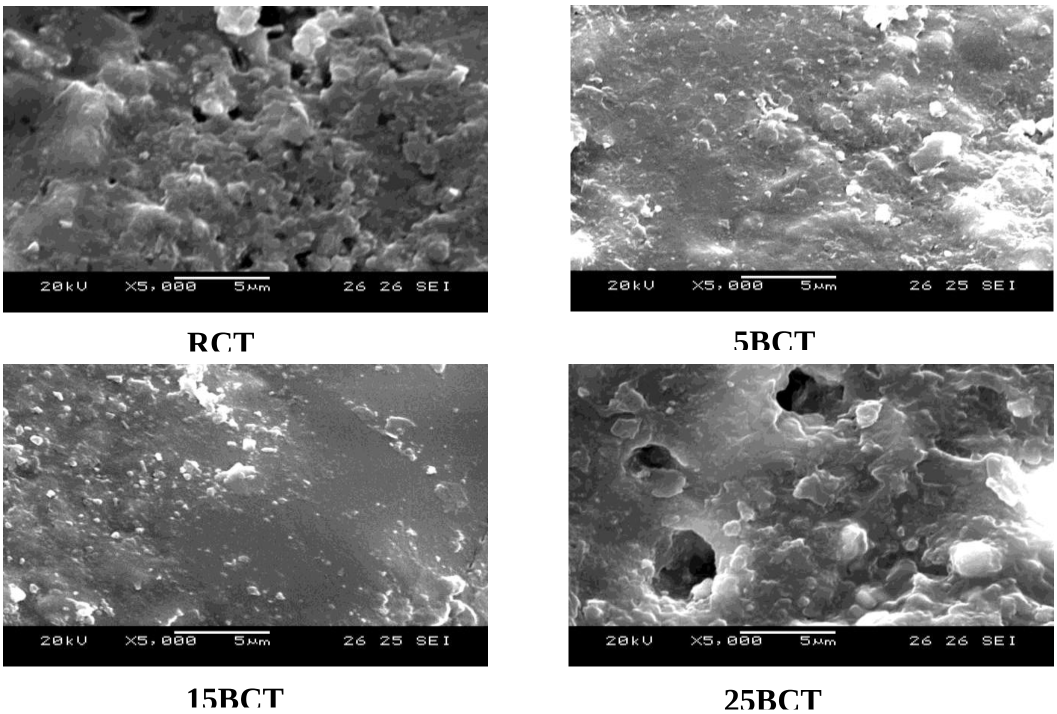

Fig.2. SEM micrographs of experimental tile.

The morphological characterization of the ceramic formulations was performed by scanning electron microscopy on surface of the samples and it is correlated with the physico-mechanical properties porosity of the tiles. Figure 2 shows the SEM microstructure of the samples RCT, 5BCT, 15BCT and 25BCT. The results showed that the presence of fine grained microstructure along with relatively small pores originating most likely from the removal of volatile compounds in RCT. 5BCT has less porosity and irregularity when compared to the reference. However, some elongated grains (mullite crystals) [12], homogeneous surface closed pores with glassy nature could be seen on the surface texture of the 15BCT, which may be responsible for better strength of the tiles. This finding for the ash blended ceramic tile 15BCT leads to an increase of vitrification level and reduction in internal cracks and voids formation. 25BCT shows the well developed a large amount of pores (dark holes) indicated at different sizes that were visible, which affected its mechanical properties and visual aspect. It is may be due to the excess amount of ash.

4 Conclusion

From the experimental results 5-15 %, the bagasse ash substituted tiles exhibit better physical and mechanical property than the reference tile. Microstructural characterization of experimental ceramic tile bearing sugarcane bagasse ash was investigated. The results showed the SEM is a powerfull tool to monitor the surface behavior of the ceramic tiles. It is suggest that 15% addition of BGA should be used to produce ceramic tiles.

The sugarcane bagasse ash was gainfully utilized for the production of high value ceramic products of common people as household articles and as well as construction materials in the construction of low-cost houses.

References

1. Souza G. P, Sanchez R, de Holanda J. N. F. Characteristics and Physical–Mechanical Properties of Fired Kaolinitic Materials. Ceramica., 2002, 48:306, 214–219.
2. Sivakumar G, Hariharan V,.Barathan S. Preparation of Bio-cement using sugarcane bagasse ash and its Hydration behavior. International Journal of Science, Engineering and Technology Research (IJSETR)., 2013, 2:10.
3. Frías, M., Villar, E., Savastano H, 2011, Brazilian sugar cane bagasse ashes from the cogeneration industry as active pozzolans for cement manufacture. Cem. Conc. Comp, 33, 490-496.
4. Martirena, H.J.F, Middendorf B, Gehrke M, Budelmann H. Use of wastes of the sugar industry as pozzolana in lime-pozzolana binders: study of the reaction. Cement and Concrete Research., 1998, 28:1, 1525-1536.
5. Villar-Cociña, E, Rojas M.F, Morales E.V. Sugar cane wastes as pozzolanic materials: application of mathematical model. ACI Materials Journal., 2008, 105:3, 258-264.
6. Cordeiro G.C, Toledo, Filho R.D, Tavares L.M, Fairbairn E.M.R. Ultrafine grinding of sugar cane bagasse ash for application as pozzolanic admixture in concrete. Cement and Concrete Research., 2009, 39:2, 110-115.
7. Silvio Rainho Teixeira, Agda Eunice de Souza, Gleyson Tadeu de Almeida Santos, Angel Fidel Vilche Pena. Sugarcane Bagasse Ash as a Potential Quartz Replacement in Red Ceramic. J. Am. Ceram. Soc., 2008, 91:6, 1883–1887.
8. Vieira C.M.F, Soares T.M, Sánchez R, Monteiro S.N. Incorporation of granite waste in red ceramics. Mat. Science. Eng., 2004, 373, 115-121.
9. Gritsada Sua-iam, Natt Makul. Use of increasing amounts of bagasse ash waste to produce self-compacting concrete by adding limestone powder waste. Journal of Cleaner Production., 2013, 57, 308-319.
10. ASTM - American Society for Testing and Materials, Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products, USA. 1972, 373-72.
11. Souza A.E, Teixeira S.R, Santos G.T.A, Costa F.B, Longo E. Reuse of sugarcane bagasse ash (SCBA) to produce ceramic materials, Journal of Environmental Management., 2011, 92, 2774-2780.
12. Lee WE, Souza GP, McConville CJ, Tarvornpanich T, Iqbal Y. Mullite formation in clays and clay-derived vitreous ceramics. J Eur Ceram Soc., 2008, 2, 465–71.

*****