

MECHANICAL PROPERTIES OF CERAMICS TILES BY REPLACEMENT OF
QUARTZ BY RHA AND POFA

HASSAN USMAN JAMO

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DEDICATION

Specially dedicated to:

For my mother, father

Words cannot express everything you have done to me

Thank you

Wife, brothers, sisters, uncles, aunts, in-laws, friends and all those
who have been a great help in the completion of this thesis

My love for you all remains forever...



PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

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ABSTRACT

Rice husk ash (RHA) and palm oil fuel ash (POFA) have a great potential to replace the quartz element in porcelain composition. RHA and POFA were mostly used by construction industries, and only a few researchers studied its applications in ceramics industries. It is due to the mechanical properties of porcelain are strongly affected by the generated thermal stress during processing because of the deleterious effects of quartz. In this work, the quartz is being replaced by RHA, POFA and the combination of RHA and POFA. The sample's composition was mixed for 90 minutes and pressed at different mold pressures (31, 61, 91 and 121 MPa) and then sintered at the sintering temperatures ranging from 1000 to 1300 °C at different soaking times ranging from 1 to 3 hours respectively. The samples were measured the physical and mechanical properties and then the microstructure observation. It was found that the RHA, POFA and the combination of RHA and POFA have tremendous effects on the properties of porcelain tiles. For the RHA, the highest bulk density (2.42 g/cm³) and compressive strength (44 MPa) were recorded on 20 wt% of RHA at the sintering temperature of 1200 °C and the soaking time of 2 hours. For the POFA, the highest bulk density (2.45 g/cm³) and compressive strength (46 MPa) were achieved on 15 wt% of POFA at the sintering temperature of 1100 °C and the soaking time of 2 hours. For the combination of RHA and POFA, the highest bulk density (2.43 g/cm³) and compressive strength (45 MPa) were recorded on 20 wt% of RHA and POFA at the sintering temperature of 1200 °C and the soaking time of 2 hours. It was observed that the microstructure was enhanced by increasing the sintering temperature, mould pressure and soaking time. It can be concluded that samples containing POFA attained vitrification stage at lower temperature and exhibited higher mechanical properties. Thermal expansion and thermal conductivity measurement are some of the areas that could be explored for further research.

ABSTRAK

Abu sekam padi (ASP) dan abu bakar kelapa sawit (ABKS) mempunyai potensi yang besar untuk menggantikan kuartza dalam komposisi porselin. Kebanyakan ASP dan ABKS digunakan oleh industri pembinaan, kecuali hanya beberapa penyelidik sahaja yang mengkaji penggunaannya dalam industri seramik. Ini adalah disebabkan oleh sifat mekanik porselin yang amat dipengaruhi oleh tekanan terma yang terhasil semasa pemrosesan kerana wujud kesan yang merosakkan kuartza. Dalam kajian ini, kuartza digantikan dengan ASP, ABKS dan kombinasi ASP dan ABKS. Komposisi sampel dicampurkan selama 90 minit dan ditekan pada tekanan acuan yang berbeza (31, 61, 91 dan 121 MPa) dan disinter pada suhu di antara 1000 °C hingga 1300 °C pada masa rendaman yang berbeza, masing-masing antara 1 hingga 3 jam. Sampel itu diukur sifat fizikal dan mekanikal dan kemudiannya dibuat pemerhatian mikrostruktur. Hasil kajian menunjukkan bahawa ASP, ABKS dan kombinasi ASP dan ABKS mempunyai kesan yang sangat baik pada sifat-sifat porselin. Untuk ASP, ketumpatan pukal (2.42 g/cm^3) dan kekuatan mampatan (44 MPa) tertinggi dicatatkan pada 20 % berat ASP pada suhu sinter 1200 °C dan pada masa rendaman 2 jam. Untuk ABKS, ketumpatan pukal (2.45 g/cm^3) dan kekuatan mampatan (46 MPa) tertinggi telah dicapai pada 15% berat ABKS pada suhu sinter 1100 °C dan masa rendaman 2 jam. Untuk kombinasi ASP dan POFA, ketumpatan pukal (2.43 g/cm^3) dan kekuatan mampatan (45 MPa) dicatatkan pada 20% berat ASP dan ABKS pada suhu sinter 1200 °C dan pada masa rendaman 2 jam. Ini dapat diperhatikan bahawa peningkatan dalam suhu sinter, tekanan acuan dan merendam masa meningkatkan mikrostruktur. Kesimpulannya, sampel yang mengandungi ABKS mencapai peringkat pengkacaan pada suhu yang lebih rendah dan mempamerkan sifat mekanikal yang lebih tinggi. Pengukuran pengembangan dan kekonduksian terma adalah beberapa bidang yang boleh diterokai untuk penyelidikan selanjutnya.

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