PHYSICAL AND MECHANICAL PROPERTIES OF CLAY RECYCLE
GLASS – PAPER CERAMIC BY SLIP CASTING TECHNIQUE

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To my beloved mother (Sikam Juraimi) and father (Abu Samah Yaakob) who have given me the meaning of life

For my siblings and friends thanks for the prayers and support
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A series of ceramics based on \((x)\) incinerated paper - (80-\(x\)) cullet – 20 Kaolin clay (where \(10 \leq x \leq 45\) wt %) has successfully been made by slip casting technique followed by sintering at 1000\(^\circ\)C for 2 hours. The physical properties are evaluated based on their density, water absorption and thermal shrinkage. Meanwhile, the hardness, Young’s modulus and impact energy strength are determined using Vickers Indenter, Universal Testing Machine and Izod Impact Tester, respectively. The surface morphology and the elemental compositions of the ceramic are observed using Scanning Electron Microscope (SEM) and Energy Dispersive of X-ray Analysis (EDAX), respectively. The phase identification of the ceramic is performed by using X-Ray Diffraction (XRD) technique. It is found that the density of the ceramic is in the range of 2.170 gcm\(^{-3}\) to 2.420 gcm\(^{-3}\) while the water absorption and thermal shrinkage are in the range of 0.63\% to 31.60\% and 6.50\% to 18.10\%, respectively, depending on the cullet-paper ratio content. It is also found that the mechanical property of ceramic increases as the cullet-paper ratio is increased. The hardness, Young’s modulus and impact energy strength are found in the range of 152.0 MPa to 1463.0 MPa, 1.522 kJm\(^{-2}\) to 7.124 kJm\(^{-2}\) and 195.4 MPa to 603.3 MPa respectively. The morphological studies show that samples at lower cullet level exhibit granular texture, rough surface area and more pores but at higher cullet level, the textures become smooth, vitrified and less pores. From EDAX analysis, the actual contents of the sintered samples are Si, Al, Ca, Na and K. The phases of ceramic are of Quartz (SiO\(_2\)), Wollastonite (CaSiO\(_3\)), Anorthite (Ca(Al\(_2\)SiO\(_8\))), CaO and Al\(_2\)O\(_3\). It can be concluded that this ceramic exhibits a potential application for refractory materials.
ABSTRAK

Beberapa siri seramik berdasarkan \((x)\) incinerated paper - \((80-x)\) cullet – 20 tanah liat kaolin (dengan \(10 \leq x \leq 45\) wt\%) telah berjaya disediakan melalui kaedah tuangan gelinciran diikuti dengan persinteran pada suhu 1000°C selama 2 jam. Sifat fizikal ditentukan berdasarkan kepada ketumpatan, serapan air dan pengecutan bahan. Manakala, kekerasan, modulus Young dan kekuatan tenaga hentak masing-masing ditentukan menggunakan penusuk Vickers, mesin ujian universal dan ujian hentakan Izod. Morfologi permukaan seramik dicerap menggunakan Mikroskop Pengimbasan Elektron (SEM), dan unsur komposisi ditentukan menggunakan Analisis Penyebaran Tenaga Sinar-X(EDAX) manakala perubahan fasa sampel dikaji menggunakan teknik Pembelauan Sinar-X (XRD). Ketumpatan seramik yang diperoleh berada dalam julat 2.170 g cm\(^{-3}\) hingga 2.420 g cm\(^{-3}\) manakala kadar serapan air dan pengecutan terma masing-masing berada dalam julat 0.63% hingga 31.60% dan 6.50% hingga 18.10% bergantung kepada kandungan nisbah kertas-cullet. Didapati juga sifat mekanik seramik meningkat dengan bertambahnya nisbah kertas-cullet. Nilai kekerasan, modulus Young dan kekuatan tenaga hentak masing-masing berada dalam julat 152.0 MPa hingga 1463.0 MPa, 1.522 kJm\(^{-2}\) hingga 7.124 kJm\(^{-2}\) dan 195.4 MPa hingga 603.3 Mpa. Keputusan kajian morfologi pada tahap kandungan cullet rendah mempamerkan tekstur berbutir, kawasan permukaan kasar dan banyak liang rongga tetapi pada tahap cullet yang lebih tinggi, tekstur berubah menjadi licin, berkaca dan kurang liang rongga. Daripada analisis EDAX didapati bahawa kandungan unsur yang terdapat dalam sampel adalah Si, Al, Ca, Na dan K. Fasa-fasa yang wujud di dalam seramik adalah fasa Kuartz (SiO\(_2\)), Wolastonit (CaSiO\(_3\)) dan Anortit (Ca(Al\(_2\)SiO\(_8\))). CaO dan Al\(_2\)O\(_3\). Dapat disimpulkan bahawa seramik ini berpotensi untuk digunakan sebagai bahan refraktori.