Materials Today: Proceedings 75 (2023) 197–201

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Formulation of Malaysian clay into inert ceramic balls: Effect of sintering temperature

Fikri Hakim Zainudin [a], Muhammad Shafiq Zulkifli [a], Anisah Sajidah Saud [a], Nurjannah Salim [a], Hanafi Ani [b], Anwaruddin Hisyam [c], Agus Geter Edy Sutjipto [a], Mohd Hasbi Ab. Rahim [a,*]

[a] Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Kuantan, Pahang, Malaysia
[b] Department of Manufacturing and Materials, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, 53100 Kuala Lumpur, Malaysia
[c] Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Kuantan, Pahang, Malaysia

ARTICLE INFO

Article history:
Available online 2 January 2023

Keywords:
Ceramic ball
Oil & Gas, Malaysian Clays
Formulation
Powder Metallurgy

ABSTRACT

Ceramic ball support bed materials are used in multiple industries with the aim of providing support for the catalytic materials and assisting the reaction. The majority of ceramic ball products used in Malaysia are either imported as finished products or domestically produced using an imported formulated powder. Besides, the characteristics of sintered ceramic balls depend on the specific powder metallurgy route, including the material composition, range of particle size, and sintering process. Thus, this study focuses on producing inert ceramic balls from local Malaysian raw materials and optimising the sintering temperature with the aim of fulfilling the Universal Oil Products (UOP) standard requirements. The research utilises local clay raw material originating from Trong, Perak, Malaysia. The formulation of each ball was formulated based on a mixture of kaolinite clay, potash feldspar, and silica sand. The sintering process was then varied between 1250 and 1350 °C to tune the character of the finished ceramic ball product. The characterization of the ceramic ball was carried out based on the UOP standard and complemented with X-ray Diffractometer (XRD), Scanning Electron Microscope – Energy Dispersive X-ray (SEM-EDX), and X-ray Fluorescence (XRF) analysis. All tested ceramic balls meet the requirements of the UOP standard. In fact, locally formulated samples had approximately twice the crushing strength of required standards. Different sintering temperatures affect the quartz phase, kaolinite dehydroxylation, mullite formation, and feldspar fusion, thus controlling the final physical–mechanical properties of ceramic balls. Overall, the sintering temperature of 1300 °C provides the most promising output in terms of the quality of ceramic balls and the cost consideration involving the high-temperature heating process.

Selection and peer-review under responsibility of the scientific committee of the Innovative Manufacturing, Mechatronics & Material Forum 2022.

1. Introduction

Ceramic is an inorganic non-metallic material that has been moulded and then solidified at high temperatures. It can be made of metal or non-metal. The treatment facility, gas preparation, and petrochemical industries all use ceramic balls, also known as support balls, as basic components in their synergist processes. The ceramic ball was additionally utilized as a catalyst support bed in oil and gas refining applications [1–5]. Its primary function is to protect catalysts from gas streams with varying densities, temperatures, and flow rates.

There are two kinds of ceramic balls that are generally filled in as catalyst bed support, which are alumina and aluminosilicate. Aluminosilicate or mullite are minerals made of aluminium, silicon, and oxygen. It is a significant segment of kaolin and other clay minerals. Mullite is the particular stable intermediate crystalline phase of the binary system [1–2,6–8].

Different characterization methods comparative with physicomechanical properties, in particular bulk density (g/cm^3), crushing strength (kg), and water absorption (%) of sintered ceramic balls were utilized to gauge the sintered balls' conformance to standard specifications including Universal Oil Products (UOP) standard [2]. On top of that, various physicochemical analyses are used to determine the phase, composition, and morphology of sintered ceramic balls. The required characteristics of a ceramic

* Corresponding author.
E-mail address: mohdhasbi@ump.edu.my (M.H. Ab. Rahim).

https://doi.org/10.1016/j.matpr.2022.12.243
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the Innovative Manufacturing, Mechatronics & Material Forum 2022.