SYNTHESIS AND CHARACTERIZATION OF SILICA AEROGEL FROM SUGARCANE BAGASSE WITH AMBIENT PRESSURE DRYING METHOD

MUHAMMAD AL-FATEH BIN MOHD SOFIAN

Final Year Project Report Submitted in
Partial Fulfilment of the Requirements for the
Degree of Bachelor of Science (Hons.) Applied Chemistry
in the Faculty of Applied Sciences
Universiti Teknologi MARA

AUGUST 2022

ACKNOWLEDGEMENT

All praises and thanks to God for His guidance and blessings for giving me the strength, determination and patience to complete this thesis successfully. I would also like to express the deepest appreciation towards my supervisor, Dr. Jeyashelly Andas for her constant supervision and guidance as well as providing necessary information regarding the project and also for their support in completing the project. Without his guidance and willingness to share his knowledge and skills, this research would have never been possible. Furthermore, I also would like to thank Puan Norliana and Puan Nor Ramliza for their kind assistance of the laboratory work. In addition, I am forever grateful for my parents who always support me in every way and always with me through thick and thin. My thanks and appreciation also go to my friends in developing the project and lab assistants who have willingly help me out with their ability. Last but not least, I would like to use this opportunity to express my gratitude to everyone who supported me throughout the course of FYP. I am thankful for their aspiring guidance and friendly advice during the project.

ABSTRACT

SYNTHESIS AND CHARACTERIZATION OF SILICA AEROGEL FROM SUGARCANE BAGASSE WITH AMBIENT PRESSURE DRYING METHOD

In this study, silica aerogel was prepared from sodium silicate extracted from sugarcane bagasse ash (SCBA) at ambient pressure drying. In brief, SCBA was boiled in NaOH and neutralized with HCl, which yielded silica as sodium silicate. Surface modification was achieved by ageing alcogel with sylilating agents, Trimethylsilyl chloride (TMCS) prior to drying at 100 °C for 1 h. The sodium silicate and synthesized sugarcane bagasse aerogel were characterized using several spectroscopic techniques and chemical analysis such as Inductively Coupled Plasma-Optical Emission (ICP-OES), Attenuated Total Reflectance-Fourier-Transform Infrared (ATR-FTIR), X-ray diffraction (XRD) and oil absorption test. The prepared sugarcane bagasse aerogel ICP-OES results showed that the concentration of silica in the extracted sodium silicate at different pre-treated temperatures of 400 °C and 600 °C was 139.1625 and 144.5625 ppm, respectively. This presumably due to at higher temperature, high dissolution of silica can be achieved. The ATR-FTIR spectrum show the peaks near 3449 cm^{-1} and 1647 cm^{-1} for both samples that corresponds to the Si-OH (silanol) groups that forms due to condensation reaction during drying. For the SCBA sample synthesized at 400 °C, the bands near 2827 cm^{-1} and 2894 cm^{-1} indicate the presence of OC_2H_5 terminal group, that exhibited a decreasing in peak intensity as temperature increases to 600 °C. To conclude, ATR-FTIR pattern of the synthesized SCBA aerogel is comparable that of reported commercial silica aerogel. Despite the crystalline nature of the silica product, the XRD pattern at $2\theta = 22°–25°$ in SCBA samples at 400 °C and 600 ° confirms the amorphous nature of the synthesized sugarcane bagasse aerogel. The results of oil absorption tests showed that the maximum oil absorption capacity of the prepared sugarcane bagasse aerogel at 400 °C and 600 °C is 2.73 g/g and 2.50 g/g respectively that was greater than its initial weight. The findings proves that the SCBA-synthesized silica aerogel outperformed reported commercial absorbents (Polycaprolactone, 3.9 g/g to 0.3 g/g) in terms of absorption.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Background of study

Most farmers prefer to use the most traditional method, open burning to reduce waste efficiently because it is used in almost all sugarcane plantation areas, not only in Malaysia but in every country that uses sugarcane (Faizal et al., 2019). According to Abdel-Shafy and Mansour (2018), solid residues from agricultural waste are abundant and may represent a serious disposal problem for the environment due to unpleasant odour generated and the attraction of pest as well disease risks. Hence, the needs of safe disposal methods for bagasse ash were explored.

Various usage of bagasse ash such as adsorbent materials, filler for building structures, and high-purity mesoporous silica gels (Nazriati et al., 2014). Since sugarcane bagasse ash (SCBA) is abundant with silica, alkaline extraction and acidification can be used to create high-purity silica gel with a sizably large surface area. (Affandi et al., 2009).