UNIVERSITI TEKNOLOGI MARA

HYBRID BIOMASS FROM AGRICULTURAL WASTES VIA MICROWAVE IRRADIATION SYSTEM FOR SULPHUR DIOXIDE GAS ADSORBENT

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ABSTRACT

Research on the SO_2 adsorption on single and mixed activated carbon (AC) adsorbents from waste biomass has gained significant interest due to their availability, cheap, and high carbon content. This thesis estimate effectiveness of mixed biomass adsorbent with and without fly ash as natural catalyst for SO_2 gas adsorption. Activated carbon was produced from single and mixed two types of carbon rich agricultural waste materials which were coconut shell (CS) and palm kernel shell (PKS) using microwave heating method by KOH chemical activation. Activation process was performed in a conventional microwave oven at fixed power and time of 600 W and 20 minutes respectively. The effects of various parameters such as mixed ratio of coconut shell:palm kernel shell (g/g) (0:100, 20:80, 50:50, 80:20, 100:0), impregnation ratio of KOH:mixed precursor (g/g) (0.5, 1.0, 1.5) and percentage of KOH as activating agent (30%, 40%, 50%) on the adsorption efficiency of the activated carbons were investigated. It was then characterized by proximate and ultimate analysis, iodine analysis, methylene blue analysis, scanning electron microscope (SEM), pore structure characterization, x-ray fluorescene (XRF) and fourier transform infrared spectroscopy (FTIR). The activated carbons were characterized and used as adsorbent for SO_2 gas adsorption based on effect of mixed ratio, effect of mass sample, effect of temperature and effect of fly ash as catalyst. The results showed that microwave heating is an effective heating method of activated carbon production. The mixed CSPKSAc-40 (20:80) at 1.5 impregnation ratio for 40% KOH concentration produced high surface area and pore sizes in range of micropores at 200.62 m^2g^{-1} and 1.9 nm. The iodine number and methylene blue removal increases from 30% to 40% concentration of KOH and decrease at 50% KOH. These findings were consistent with the surface morphology of samples from SEM image. The major chemical composition found in fly ash is SiO_2 followed by AI_2O_3 >Fe_2O_3 >TiO_2 >CaO >K_2O.Adsorption of common gaseous pollutants of sulphur dioxide (SO_2) on single (CS and PKS), mixed (CSPKSAc) and the aid of fly ash as catalyst on AC in a fixed bed reactor were studied in this thesis. The amount of SO_2 gas adsorbed by single and mixed adsorbent of CSPKSAc was expressed as adsorption breakthrough time of SO_2 from flue gas. Single PKSAc-40 and mixed CSPKSAc-40 (20:80) showed the longer breakthrough time of 17 minutes and 10 minutes, respectively. The obtained results showed that SO_2 gas adsorption increased using catalyst of fly ash in comparison to AC alone. The FTIR observation shows that the mixed CSPKSAc is good adsorbent in SO_2 gas adsorption due to the new band appeared at 1107.57 cm^{-1}, 984.10 cm^{-1} and 602.58 cm^{-1} which is indicating of an –O-SO_3- group,–SO_2- group and S-O stretching, respectively. This study showed the mixed CSPKSAc-40 (20:80) for SO_2 adsorption can be used as a good adsorbent.

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Finally, I hope that the ideas, outcomes and findings from this research work will benefit and contribute to this area of knowledge.

TABLE OF CONTENT

CHAPTER ONE
INTRODUCTION

1.1 Research Background

Concern of environmental issue has increased over the years in the world. Today, air pollution is a big issue that affects human health and natural environment. Power plant normally produces flue gases such as NO, NO_2, SO_2, SO_3 and CO. In addition, increasing emission of flue gas in the world give bad impact to the environment which contributes the main factor of global warming, acid rain and ozone layer depletion (Sodeinde, 2012). According to Hauchhum and Mahanta (2014), total world demand energy that is supplied by thermal power plants comes from fossil fuels is about 85% include coal, oil and gas. Therefore, the solutions and efforts must be developed to decrease or eliminate the gases released to the atmosphere to comply with environmental regulations and standards.

Agricultural industry is one of the large industries in Malaysia that produces economically products. From processing of their products, it contributes a lot of waste biomass to the environment. Malaysia produces agricultural wastes about more than 2 million tonnes annually. Furthermore, Malaysia achieved positive growth of record in agricultural production from 2000 to 2005 and it will be more increase in 2010 (Ghani et al., 2010).

Large amounts of palm kernel shell and coconut shells are generated as agricultural wastes in Malaysia. In the world, Malaysia appears second largest oil palm producer almost 5 million hectare of oil palm plantation. Malaysia produced coconut plant about 63% for domestic and about 37% for industrial sector and export (Ghani et al. 2010). By use coconut shell from waste biomass, it can reduce the large disposal area and automatically save our economic cost.

Besides that, it also contributes in increasing economic growth and quick development and also produces environmental pollution due to the large amount production of by-products from oil extraction process (Evbuomwan et al., 2013). This sector produces large amount of oil palm biomass such as palm oil mill effluent (POME), oil palm shell