UNIVERSITI TEKNOLOGI MARA

DESULPHURISATION OF MAE MOH LOW-RANK COAL USING ULTRASONIC WAVES AND MICROWAVE IRRADIATION TREATMENT PROCESSES WITH MIXTURE OF HYDROGEN PEROXIDE AND HYDROCHLORIC ACID

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ABSTRACT

Mixture of 6% hydrogen peroxide and 0.1N hydrochloric acid (3:7 volume mixed ratio of peroxide to acid) was used to desulphurise Mae Moh low-rank high sulphur coal in the presence of three different processes i.e. ultrasonic waves, microwave irradiation and conventional magnetically stirring processes. The parameters that were used to investigate the effect of sulphur and ash removal from the coal using the three different processes were leaching time (i.e. 0.25, 0.5, 1, 2, 4 and 8 hour for both ultrasonic waves and magnetically stirring processes, and 0.5, 1, 2, 4, 10 and 20 minutes for microwave irradiation process), leaching temperature (30, 50 and 70°C; for both ultrasonic wave and magnetically stirring), and irradiation power (150, 700 and 100 watts for microwave irradiation). The success of the three different processes toward the total sulphur removal was measured by comparing the S/C atomic ratios of the treated coal with the untreated coal. The percent of inorganic sulphur removal in the treated coal was determined by using ASTM D2492, with organic sulphur being determined by the difference. In general, the treatments of coal sample using three different processes led to *ca.* 35-68, 29-93, 43-100, 2-50% and 37-71% of total sulphur, pyrite, sulphate, organic and ash removal, respectively. The optimal temperature and time for desulphurisation using ultrasonic waves were at 50°C and 0.5 hour, respectively, and for the magnetically stirring process were at 50°C and 0.5 - 8 hour, respectively. The optimal power and time for the microwave irradiation process, however, was at 700 watt and 4 minute, respectively. By comparing the three different processes, the ultrasonic waves treatment at 50°C for 0.5 hour was found to be the optimum condition for sulphur and ash removal with approximately 65, 82, 83, 48 and 55% of total sulphur, pyrite, sulphate, organic and ash reduction were achieved, respectively, without affecting the coal heating value. Moreover, pyrolysis on the treated coal samples via thermogravimetry analysis showed a slight increase in reactivity with comparison to the untreated coal sample. The by-product of coal desulphurisation contained humin compound and can be used in fertilizer industry. Further, the calorific values of treated coal samples were comparable to the untreated coal indicating no significant alteration in the coal macro-structure.

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IN THE NAME OF ALLAH, THE MOST GRACIOUS AND MOST MERCIFUL

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CHAPTER 1

INTRODUCTION

1.1 The Potential Energy from Coal

Coal is one of the world's most abundant fossil fuels and an important source of energy. Historically, China was the first country in the world to use coal. It has been used for three thousand years for small purposes like smelting metals. Coal became more important as an energy source in the early twentieth century when the coal industry was developed in western European countries for different burning purposes which included heating, cooking, harnessing mechanical power, powering steam trains and ships (transportation) and generating heat for the manufacturing process [1].

Petroleum oil was found in the mid twentieth century and there has been an overdependence on this source as a fuel. Hence the potential of coal has not been fully exploited and coal demand has decreased considerably [2]. However, the overdependence on just only one non-renewable source (petroleum oil) as energy has contributed to the current world energy crisis.

Malaysia's National Energy Policy (1979) aims to have an efficient, secure and environmentally sustainable supply of energy in the future as well as to have an efficient and clean utilisation of energy. This strategy was formulated due to the aftermath of the two international oil crisis quantum leaps in price in 1973 and 1979 [3].

Malaysia is committed to manage its energy resources, ranging from fossil fuels to renewable resources. In 1981, the Four-Fuel Diversification Policy was designed to reduce the country's overdependence on oil as an energy source. The policy focuses on four main sources of fuel, namely coal, oil, gas and hydro, aimed at ensuring their